

## 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:

SVN (ALL)	Changes in database related to the pedigree completeness as well as phenotypic data improvement resulting in some animals losing information.
ITA (SIM)	Some decrease in information due to parentage verification
ESP (HOL)	Base change
JPN (HOL)	Pedigree corrections
AUS (ALL)	Wrongly allocated parents or genetic groups have been corrected, causing some bulls to be no longer included in the evaluation as their daughters' count has fell under the minimum threshold of 10 daughters. Correction of a bug in the program generating type of proof.
EST (HOL, RDC)	Decrease in information due to pedigree verification
CHE (ALL)	Manual data edits and removal of data errors cause decrease in information. In BSW changes in of herd-year-season assignment causes small decrease in EDC.
USA (ALL)	Seasonal trend causing changing in information.

## INTERBULL CHANGES COMPARED TO THE DECEMBER 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

---

The international genetic evaluation procedure is based on international work described in the following scientific publications:

##### International genetic evaluation computation:

Schaeffer, 1994. J. Dairy Sci. 77:2671-2678  
Klei, 1998. Interbull Bulletin 17:3-7

##### Verification and Genetic trend validation:

Klei et al., 2002. Interbull Bulletin 29:178-182.  
Boichard et al., 1995. J. Dairy Sci. 78:431-437

##### Weighting factors:

Fikse and Banos, 2001. J. Dairy Sci. 84:1759-1767

##### De-regression:

Sigurdsson and G. Banos. 1995. Acta Agric. Scand. 45:207-219  
Jairath et al. 1998. J. Dairy Sci. Vol. 81:550-562

##### Genetic parameter estimation:

Klei and Weigel, 1998, Interbull Bulletin 17:8-14  
Sullivan, 1999. Interbull Bulletin 22:146-148

##### Post-processing of estimated genetic correlations:

Mark et al., 2003, Interbull Bulletin 30:126-135  
Jorjani et al., 2003. J. Dairy Sci. 86:677-679  
<https://wiki.interbull.org/public/rG%20procedure?action=print>

##### Time edits

Weigel and Banos. 1997. J. Dairy Sci. 80:3425-3430

##### International reliability estimation

Harris and Johnson. 1998. Interbull Bulletin 17:31-36

#### NEXT ROUTINE INTERNATIONAL EVALUATION

---

Dates for the next routine evaluation can be found on  
<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 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 (August Routine Evaluation 2019).

Number of records for milk yield by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS	209	135	8186	1776	733	
BEL			2048			
CAN	238	102	12580	753	818	
CHE	2960		3421	88		3259
CZE			4350			
DEA	5980					23963
DEU			27859	210	437	
DFS			13128	2158	7737	
ESP			3869			
EST			1160		438	
FRA	396		17099			469
FRM						4671
GBR	160	344	7250	898	628	94
HUN			3314			218
IRL			2859	170	55	95
ISR			1446			
ITA	2133		9467	170		1716
JPN			6026			
KOR			1406			
LTU			1179		437	
LVA			1183		708	
NLD	194		15530	162	83	400
NOR					4166	
NZL	54	60	7706	4892	1386	
POL			10540			
PRT			2417			
SVK			1119			587
SVN	376		554			624
URY			1051			
USA	1108	785	38752	4728	715	62
ZAF			1302	712	143	
HRV			774			854
MEX			615			
CAM					40	
No. Records	13808	1426	208190	16717	18524	37012
Pub. Proofs	11183	1137	156146	13476	16584	33266

^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	639.30										
FRA	0.89	628.65									
USA	0.92	0.88	635.89								
CHE	0.90	0.88	0.87	547.86							
ITA	0.88	0.83	0.88	0.87	600.89						
DEA	0.88	0.82	0.86	0.94	0.90	462.81					
NLD	0.88	0.87	0.87	0.85	0.85	0.87	650.71				
SVN	0.83	0.81	0.82	0.81	0.81	0.81	0.82	9.43			
NZL	0.70	0.76	0.71	0.75	0.70	0.73	0.72	0.74	338.30		
GBR	0.86	0.88	0.86	0.86	0.82	0.82	0.86	0.83	0.71	249.68	
AUS	0.73	0.75	0.71	0.72	0.70	0.70	0.74	0.72	0.82	0.73	396.96

BSW 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	21.81																														
DEU	0.89	16.72																													
DFS	0.92	0.92	10.69																												
FRA	0.87	0.84	0.91	18.12																											
ITA	0.86	0.83	0.86	0.84	17.65																										
NLD	0.88	0.90	0.89	0.85	0.83	18.91																									
USA	0.91	0.88	0.91	0.88	0.88	0.86	17.45																								
CHE	0.85	0.84	0.87	0.91	0.84	0.85	0.85	18.61																							
GBR	0.85	0.82	0.86	0.86	0.81	0.86	0.84	0.87	7.24																						
NZL	0.68	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	9.02																					
AUS	0.68	0.69	0.69	0.69	0.68	0.69	0.68	0.69	0.70	0.80	10.82																				
BEL	0.80	0.83	0.81	0.81	0.80	0.81	0.80	0.81	0.81	0.69	0.69	14.62																			
IRL	0.74	0.73	0.77	0.81	0.72	0.79	0.75	0.80	0.78	0.80	0.80	0.72	5.59																		
ESP	0.90	0.88	0.89	0.88	0.86	0.87	0.90	0.85	0.84	0.69	0.69	0.81	0.76	15.67																	
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	16.85																
SVN	0.81	0.80	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.70	0.70	0.81	0.70	0.81	0.81	10.63															
EST	0.82	0.85	0.86	0.81	0.81	0.82	0.82	0.84	0.81	0.71	0.70	0.81	0.70	0.81	0.81	0.82	15.77														
ISR	0.83	0.82	0.82	0.83	0.83	0.82	0.83	0.83	0.82	0.63	0.63	0.83	0.62	0.83	0.83	0.84	0.84	9.87													
HUN	0.82	0.81	0.83	0.85	0.87	0.81	0.87	0.82	0.80	0.69	0.68	0.80	0.68	0.82	0.80	0.81	0.81	0.83	21.14												
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	0.81	0.85	0.83	0.84	11.28											
ZAF	0.80	0.80	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.69	0.71	0.81	0.69	0.80	0.80	0.82	0.82	0.83	0.80	0.80	13.44										
JPN	0.91	0.87	0.91	0.87	0.87	0.87	0.91	0.86	0.83	0.69	0.69	0.81	0.75	0.88	0.80	0.81	0.85	0.83	0.81	0.87	0.81	17.17									
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	0.82	0.81	0.83	0.81	0.87	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	0.80	0.80	0.81	0.81	10.78							
LTU	0.81	0.80	0.81	0.81	0.81	0.81	0.80	0.82	0.81	0.70	0.70	0.82	0.70	0.81	0.81	0.83	0.82	0.85	0.81	0.80	0.82	0.81	0.81	0.82	10.88						
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	17.58					
KOR	0.83	0.80	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.69	0.69	0.81	0.69	0.83	0.81	0.82	0.82	0.84	0.80	0.80	0.81	0.82	0.81	0.81	0.82	0.80	13.66				
URY	0.80	0.80	0.80	0.80	0.81	0.80	0.80	0.81	0.80	0.72	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	0.81	0.80	0.80	0.80	5.23		
HRV	0.81	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	0.81	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	11.18		
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	11.04	

-----  
JER mil

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	592.63											
DFS	0.93	9.19										
USA	0.92	0.92	622.26									
NZL	0.74	0.70	0.70	283.26								
AUS	0.80	0.74	0.74	0.83	381.99							
GBR	0.84	0.83	0.82	0.69	0.72	213.15						
NLD	0.92	0.93	0.89	0.71	0.76	0.85	628.16					
ZAF	0.88	0.86	0.85	0.79	0.80	0.81	0.81	379.66				
ITA	0.89	0.87	0.88	0.74	0.78	0.82	0.85	0.87	545.84			
DEU	0.90	0.91	0.89	0.70	0.76	0.82	0.91	0.83	0.88	491.08		
IRL	0.81	0.79	0.77	0.87	0.82	0.76	0.82	0.78	0.79	0.80	182.84	
CHE	0.88	0.88	0.85	0.73	0.80	0.84	0.90	0.81	0.86	0.89	0.84	333.56

-----  
JER fat

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	26.40											
DFS	0.90	11.27										
USA	0.90	0.90	24.37									
NZL	0.69	0.70	0.74	12.06								
AUS	0.77	0.71	0.75	0.83	13.59							
GBR	0.83	0.84	0.82	0.69	0.70	11.69						
NLD	0.88	0.86	0.86	0.70	0.71	0.85	24.59					
ZAF	0.81	0.81	0.80	0.69	0.70	0.81	0.81	14.28				
ITA	0.89	0.84	0.86	0.70	0.72	0.82	0.84	0.82	25.69			
DEU	0.90	0.90	0.87	0.70	0.75	0.84	0.89	0.81	0.86	21.32		
IRL	0.80	0.78	0.76	0.82	0.81	0.76	0.80	0.71	0.74	0.79	6.36	
CHE	0.87	0.85	0.84	0.72	0.76	0.85	0.86	0.81	0.84	0.89	0.80	15.45



GBR	0.83	0.82	0.83	0.69	0.72	7.36									
DFS	0.89	0.88	0.88	0.69	0.71	0.83	10.37								
DEU	0.89	0.91	0.87	0.70	0.71	0.83	0.89	17.34							
ZAF	0.81	0.88	0.81	0.70	0.72	0.81	0.81	0.81	16.12						
EST	0.83	0.83	0.85	0.75	0.73	0.83	0.82	0.84	0.83	14.84					
LVA	0.82	0.83	0.81	0.73	0.72	0.82	0.81	0.81	0.83	0.82	9.28				
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	0.82	0.82	0.77	0.76	0.74	0.71	0.74	0.73	0.75	5.21		
NLD	0.88	0.91	0.85	0.70	0.72	0.85	0.89	0.90	0.81	0.83	0.82	0.83	0.78	25.92	
CAM	0.89	0.89	0.92	0.76	0.78	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.84	0.89	12.20

SIM mil

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	601.51												
DEA	0.87	512.13											
FRM	0.96	0.87	617.33										
ITA	0.84	0.80	0.81	496.28									
SVN	0.83	0.81	0.84	0.81	8.68								
FRA	0.93	0.89	0.89	0.89	0.85	672.01							
HUN	0.85	0.82	0.89	0.88	0.83	0.87	406.64						
NLD	0.89	0.94	0.89	0.83	0.82	0.89	0.85	732.32					
IRL	0.83	0.73	0.84	0.74	0.73	0.89	0.79	0.80	181.69				
SVK	0.83	0.81	0.82	0.81	0.82	0.82	0.85	0.82	0.75	318.19			
GBR	0.88	0.87	0.87	0.82	0.81	0.87	0.83	0.86	0.79	0.82	215.23		
HRV	0.82	0.81	0.89	0.81	0.82	0.81	0.83	0.81	0.73	0.82	0.81	10.79	
USA	0.89	0.84	0.88	0.90	0.81	0.91	0.89	0.90	0.82	0.81	0.84	0.81	577.58

SIM fat

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	24.08												
DEA	0.88	19.36											
FRM	0.94	0.90	24.26										
ITA	0.82	0.81	0.81	19.48									
SVN	0.83	0.81	0.83	0.81	9.03								
FRA	0.90	0.91	0.89	0.85	0.82	27.18							
HUN	0.81	0.82	0.89	0.88	0.83	0.86	15.39						
NLD	0.88	0.93	0.90	0.82	0.82	0.88	0.82	27.35					
IRL	0.74	0.71	0.78	0.72	0.73	0.84	0.70	0.79	7.63				
SVK	0.82	0.81	0.82	0.81	0.82	0.82	0.84	0.82	0.73	12.73			
GBR	0.91	0.86	0.87	0.82	0.81	0.89	0.82	0.87	0.77	0.82	8.24		
HRV	0.82	0.81	0.88	0.81	0.82	0.81	0.83	0.81	0.74	0.82	0.81	10.79	
USA	0.86	0.83	0.84	0.90	0.81	0.91	0.90	0.88	0.78	0.81	0.86	0.81	18.85

SIM pro

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	18.25												
DEA	0.85	15.57											
FRM	0.93	0.87	19.16										
ITA	0.82	0.80	0.81	15.59									
SVN	0.83	0.81	0.83	0.81	8.81								
FRA	0.89	0.86	0.89	0.82	0.82	21.36							
HUN	0.82	0.82	0.88	0.85	0.83	0.85	13.13						
NLD	0.85	0.93	0.87	0.82	0.82	0.85	0.81	22.97					
IRL	0.77	0.71	0.81	0.71	0.73	0.81	0.69	0.74	6.33				
SVK	0.82	0.81	0.82	0.81	0.82	0.82	0.84	0.82	0.73	9.77			
GBR	0.85	0.86	0.86	0.81	0.81	0.86	0.81	0.86	0.75	0.82	6.68		
HRV	0.82	0.81	0.88	0.81	0.82	0.81	0.83	0.81	0.73	0.82	0.81	10.66	
USA	0.85	0.83	0.83	0.87	0.81	0.88	0.87	0.86	0.75	0.81	0.84	0.81	15.56

^LAPPENDIX II. Number of common bulls

BSW

-----

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	0	83	171	129	122	138	51	33	24	67	91
FRA	72	0	120	159	189	212	83	55	22	58	63
USA	157	80	0	313	236	319	79	41	30	95	124
CHE	105	116	291	0	447	576	94	77	25	74	114
ITA	105	146	167	389	0	703	125	97	27	81	117
DEA	115	156	282	474	598	0	145	103	34	79	127
NLD	48	68	70	87	106	140	0	44	25	43	56
SVN	29	54	33	73	96	95	45	0	11	25	29
NZL	22	18	26	20	21	29	18	10	0	20	26
GBR	59	45	80	53	54	52	32	18	17	0	59
AUS	90	48	117	76	87	89	41	23	20	50	0

-----

BSW

-----

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	0	83	171	129	122	138	51	33	24	67	91
FRA	72	0	120	159	189	212	83	55	22	58	63
USA	157	80	0	313	236	319	79	41	30	95	124
CHE	105	116	291	0	447	576	94	77	25	74	114
ITA	105	146	167	389	0	703	125	97	27	81	117
DEA	115	156	282	474	598	0	145	103	34	79	127
NLD	48	68	70	87	106	140	0	44	25	43	56
SVN	29	54	33	73	96	95	45	0	11	25	29
NZL	22	18	26	20	21	29	18	10	0	20	26
GBR	59	45	80	53	54	52	32	18	17	0	59
AUS	90	48	117	76	87	89	41	23	20	50	0

-----

BSW

-----

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	0	83	171	129	122	138	51	33	24	67	91
FRA	72	0	120	159	189	212	83	55	22	58	63
USA	157	80	0	313	236	319	79	41	30	95	124
CHE	105	116	291	0	447	576	94	77	25	74	114
ITA	105	146	167	389	0	703	125	97	27	81	117
DEA	115	156	282	474	598	0	145	103	34	79	127
NLD	48	68	70	87	106	140	0	44	25	43	56
SVN	29	54	33	73	96	95	45	0	11	25	29
NZL	22	18	26	20	21	29	18	10	0	20	26
GBR	59	45	80	53	54	52	32	18	17	0	59
AUS	90	48	117	76	87	89	41	23	20	50	0

-----

GUE

-----

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	USA	AUS	GBR	NZL
CAN	0	71	46	32	14
USA	62	0	61	91	31
AUS	44	57	0	37	23
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 USA AUS GBR NZL

CAN 0 71 46 32 14
USA 62 0 61 91 31
AUS 44 57 0 37 23
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 USA AUS GBR NZL

CAN 0 71 46 32 14
USA 62 0 61 91 31
AUS 44 57 0 37 23
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 2424 1381 1421 1599 1441 3264 852 1596 720 1363 788 563 1259 1091 198 247 118 987 1321 508 1289 469 423 286 1017 676 490 294 374
DEU 1697 0 2728 2514 2446 3430 3625 1147 2094 959 1661 1249 910 1520 1876 302 410 154 1226 2353 592 1441 729 723 612 1230 618 497 603 353
DFS 1146 1770 0 1579 1500 1995 1985 698 1492 791 1230 835 742 984 1212 243 278 138 871 1503 504 925 452 399 352 908 470 410 387 287
FRA 906 1258 786 0 1653 1904 2422 647 1484 772 1229 899 736 1107 1216 199 248 122 919 1576 475 1160 404 415 279 907 507 397 281 297
ITA 1194 1460 1038 807 0 1616 2472 684 1483 706 1141 779 646 1201 1224 226 262 127 966 1492 474 1120 476 383 317 972 567 429 355 327
NLD 1346 3100 1694 1118 1233 0 2380 859 1666 996 1406 1247 888 1063 1448 248 343 145 939 1722 514 1012 501 522 376 1024 469 419 419 301
USA 3548 2405 1435 1226 1516 2028 0 972 2123 1026 1818 945 783 1500 1614 228 330 170 1263 1958 638 1870 610 530 390 1278 832 664 366 448
CHE 712 998 615 556 596 834 861 0 678 385 593 583 400 546 521 137 160 58 429 653 269 450 272 229 168 497 259 209 200 175
GBR 1810 1506 1089 868 1045 1421 1839 612 0 890 1344 840 941 1042 1027 203 242 131 840 1270 511 993 405 366 293 935 484 435 321 320
NZL 723 738 550 440 489 905 965 321 755 0 1159 501 709 517 596 124 133 104 487 627 365 538 241 253 173 554 311 346 211 196
AUS 1361 1195 861 799 787 1216 1777 521 1133 1157 0 732 720 859 830 171 207 103 699 988 478 854 364 305 242 770 435 422 286 268
BEL 782 1297 772 873 735 1435 834 594 831 408 641 0 523 651 652 170 186 81 534 788 333 527 293 293 202 652 286 245 260 200
IRL 534 794 606 574 533 836 701 403 960 616 621 521 0 503 528 124 135 99 443 610 335 439 217 211 162 498 241 268 188 176
ESP 792 950 720 774 840 933 945 437 813 392 601 637 481 0 837 184 196 107 744 1006 447 870 354 310 226 812 464 358 272 282
CZE 784 1433 774 727 828 1268 1226 364 685 417 529 511 390 564 0 214 250 121 895 1294 398 805 425 464 313 792 466 376 353 273
SVN 142 289 199 137 187 214 173 99 149 88 120 141 93 137 159 0 90 43 156 242 97 158 115 78 74 162 96 74 108 66
EST 144 289 164 113 140 247 213 88 133 66 101 119 72 90 156 55 0 46 190 304 105 193 185 112 111 190 110 101 120 70
ISR 84 125 106 63 78 115 155 36 88 87 66 53 74 62 89 32 28 0 105 134 63 96 65 47 53 99 56 66 65 41
HUN 919 955 675 598 797 766 1214 341 728 383 521 458 392 583 793 119 115 77 0 921 396 686 322 311 214 701 443 366 251 286
POL 1091 2058 1175 967 1084 1553 1817 529 1038 473 729 725 505 690 1048 219 217 103 800 0 416 937 585 440 416 994 549 413 444 314
ZAF 466 456 383 329 357 432 622 218 444 303 417 284 299 395 264 67 54 43 325 309 0 421 170 181 117 431 267 272 151 212
JPN 611 551 461 380 473 492 765 277 476 272 446 324 271 386 336 87 65 39 366 474 277 0 333 295 204 677 530 381 210 293
LVA 281 586 281 186 304 337 499 138 237 139 185 179 133 196 292 75 117 46 244 478 99 141 0 179 221 394 220 182 244 139
SVK 294 543 203 213 218 358 345 117 208 151 153 178 109 154 378 46 52 20 218 303 99 101 92 0 130 318 205 180 139 125
LTU 150 575 197 90 160 224 257 73 144 76 104 101 75 93 207 41 56 26 129 322 46 62 156 66 0 233 138 117 164 69
PRT 1062 1132 796 754 882 1027 1332 434 852 454 608 659 453 773 651 128 132 74 694 995 387 393 311 219 148 0 455 391 309 335
KOR 639 405 325 284 445 325 946 179 349 226 316 210 174 324 331 60 53 35 362 457 202 306 128 125 58 383 0 291 135 254
URY 478 355 293 230 316 329 827 158 359 272 315 190 214 286 280 44 63 34 312 350 229 226 111 118 67 353 236 0 137 236
HRV 170 616 292 166 253 372 274 127 224 123 175 214 128 202 254 84 87 45 185 391 99 95 193 69 113 247 58 86 0 113
MEX 390 293 240 231 300 252 537 154 289 157 223 188 155 256 226 50 49 26 275 295 199 226 95 76 29 351 238 221 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	2424	1381	1421	1602	1441	3264	852	1596	720	1363	788	548	1259	1091	198	247	118	987	1321	507	1285	469	423	286	1017	675	490	294	141
DEU	1697	0	2728	2514	2450	3430	3625	1147	2093	959	1661	1249	891	1520	1876	302	410	154	1226	2353	591	1436	729	723	612	1230	617	497	603	134
DFS	1146	1770	0	1579	1503	1995	1985	698	1491	791	1230	835	725	984	1212	243	278	138	871	1503	503	922	452	399	352	908	470	410	387	120
FRA	906	1258	786	0	1655	1904	2422	647	1483	772	1229	899	725	1107	1216	199	248	122	919	1576	474	1158	404	415	279	907	506	397	281	123
ITA	1200	1466	1043	812	0	1619	2475	685	1485	709	1143	781	631	1204	1225	226	262	128	968	1493	475	1118	476	384	317	974	566	430	355	122
NLD	1346	3100	1694	1118	1238	0	2380	859	1665	996	1406	1247	869	1063	1448	248	343	145	939	1722	514	1007	501	522	376	1024	469	419	419	125
USA	3548	2405	1435	1226	1523	2028	0	972	2123	1026	1818	945	759	1500	1614	228	330	170	1263	1958	637	1866	610	530	390	1277	831	664	366	147
CHE	712	998	615	556	597	834	861	0	677	385	593	583	392	546	521	137	160	58	429	653	269	446	272	229	168	497	259	209	200	94
GBR	1810	1506	1089	868	1051	1421	1839	612	0	889	1343	839	920	1042	1026	203	242	131	840	1269	511	991	404	366	293	934	484	435	320	129
NZL	723	738	550	440	495	905	965	321	755	0	1159	501	698	517	596	124	133	104	487	627	365	538	241	253	173	554	310	346	211	100
AUS	1361	1195	861	799	791	1216	1777	521	1133	1157	0	732	705	859	830	171	207	103	699	988	478	851	364	305	242	770	434	422	286	118
BEL	782	1297	772	873	738	1435	834	594	831	408	641	0	511	651	652	170	186	81	534	788	332	526	293	293	202	652	286	245	260	104
IRL	519	779	592	565	525	817	677	394	940	605	607	508	0	495	522	122	134	95	438	599	334	430	217	210	159	495	240	267	188	91
ESP	792	950	720	774	844	933	945	437	813	392	601	637	474	0	837	184	196	107	744	1006	446	868	354	310	226	812	463	358	272	120
CZE	784	1432	773	727	831	1267	1226	364	685	417	529	510	386	563	0	214	250	121	895	1294	397	803	425	464	313	792	466	376	353	95
SVN	142	289	199	137	187	214	173	99	149	88	120	141	93	137	159	0	90	43	156	242	97	157	115	78	74	162	96	74	108	33
EST	144	289	164	113	140	247	213	88	133	66	101	119	72	90	156	55	0	46	190	304	105	191	185	112	111	190	110	101	120	27
ISR	84	125	106	63	80	115	155	36	88	87	66	53	72	62	89	32	28	0	105	134	63	96	65	47	53	99	56	66	65	15
HUN	919	955	675	598	801	766	1214	341	728	383	521	458	388	583	793	119	115	77	0	921	395	685	322	311	214	701	443	366	251	110
POL	1091	2058	1175	967	1087	1553	1817	529	1038	473	729	725	496	690	1047	219	217	103	800	0	415	931	585	440	416	994	549	413	444	102
ZAF	465	455	382	329	359	432	620	218	443	303	417	284	298	394	263	67	54	43	324	308	0	419	169	181	117	430	266	272	151	104
JPN	606	546	459	377	470	486	758	274	473	271	441	322	265	384	334	86	63	39	365	467	275	0	332	294	203	674	530	380	210	127
LVA	281	586	281	186	304	337	499	138	237	139	185	179	132	196	292	75	117	46	244	478	98	140	0	179	221	393	219	182	244	46
SVK	294	543	203	213	220	358	345	117	208	151	153	178	108	154	377	46	52	20	218	303	99	100	92	0	130	318	205	180	139	58
LTU	150	575	197	90	160	224	257	73	144	76	104	101	73	93	207	41	56	26	129	322	46	61	156	66	0	233	138	117	164	26
PRT	1062	1132	796	753	885	1027	1331	434	852	454	608	659	450	773	651	128	132	74	694	995	386	390	311	219	148	0	455	391	309	125
KOR	638	405	324	284	444	325	944	179	349	225	315	210	173	323	330	59	53	35	362	456	201	305	128	125	58	383	0	291	135	99
URY	478	355	293	230	318	329	827	158	359	272	315	190	213	286	280	44	63	34	312	350	229	223	111	118	67	353	236	0	137	102
HRV	170	615	291	166	252	371	274	127	224	122	174	213	128	202	253	83	87	44	185	390	99	95	193	69	112	247	58	86	0	46
MEX	170	143	123	123	126	132	185	93	150	96	121	114	99	132	74	26	16	10	113	100	113	123	28	42	7	144	99	106	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	2424	1381	1421	1599	1441	3257	852	1596	720	1362	788	548	1258	1091	198	247	118	987	1321	507	1283	469	423	286	1017	676	490	294	136
DEU	1697	0	2728	2514	2446	3430	3621	1147	2093	959	1661	1249	891	1520	1876	302	410	154	1226	2353	591	1436	729	723	612	1230	618	497	603	128
DFS	1146	1770	0	1579	1500	1995	1983	698	1491	791	1230	835	725	984	1212	243	278	138	871	1503	503	922	452	399	352	908	470	410	387	116
FRA	906	1258	786	0	1653	1904	2421	647	1483	772	1229	899	725	1107	1216	199	248	122	919	1576	474	1158	404	415	279	907	507	397	281	118
ITA	1194	1460	1038	807	0	1616	2472	684	1482	706	1141	779	629	1201	1224	226	262	127	966	1492	473	1117	476	383	317	972	567	429	355	116
NLD	1346	3100	1694	1118	1233	0	2379	859	1665	996	1406	1247	869	1063	1448	248	343	145	939	1722	514	1006	501	522	376	1024	469	419	419	121
USA	3544	2403	1435	1226	1516	2028	0	972	2122	1026	1815	944	759	1499	1614	228	330	170	1263	1958	637	1863	610	529	390	1277	833	664	366	142
CHE	712	998	615	556	596	834	861	0	677	385	593	583	392	546	521	137	160	58	429	653	269	445	272	229	168	497	259	209	200	91
GBR	1810	1506	1089	868	1045	1421	1839	612	0	889	1343	839	920	1042	1026	203	242	131	840	1269	511	991	404	366	293	934	484	435	320	126
NZL	723	738	550	440	489	905	965	321	755	0	1159	501	698	517	596	124	133	104	487	627	365	538	241	253	173	554	311	346	211	98
AUS	1360	1195	861	799	787	1216	1776	521	1133	1157	0	732	705	859	830	171	207	103	699	988	478	851	364	305	242	770	435	422	286	114
BEL	782	1297	772	873	735	1435	833	594	831	408	641	0	511	651	652	170	186	81	534	788	332	526	293	293	202	652	286	245	260	101
IRL	519	779	592	565	520	817	677	394	940	605	607	508	0	495	522	122	134	95	438	599	334	430	217	210	159	495	240	267	188	87
ESP	792	950	720	774	840	933	945	437	813	392	601	637	474	0	837	184	196	107	744	1006	446	868	354	310	226	812	464	358	272	115
CZE	784	1432	773	727	828	1267	1226	364	685	417	529	510	386	563	0	214	250	121	895	1294	397	803	425	464	313	792	466	376	353	92
SVN	142	289	199	137	187	214	173	99	149	88	120	141	93	137	159	0	90	43	156	242	97	157	115	78	74	162	96	74	108	33
EST	144	289	164	113	140	247	213	88	133	66	101	119	72	90	156	55	0	46	190	304	105	190	185	112	111					

KOR	638	405	324	284	444	325	946	179	349	225	315	210	173	323	330	59	53	35	362	456	201	305	128	125	58	383	0	291	135	95
URY	478	355	293	230	316	329	827	158	359	272	315	190	213	286	280	44	63	34	312	350	229	223	111	118	67	353	236	0	137	102
HRV	170	616	292	166	253	372	274	127	224	123	175	214	128	202	254	84	87	45	185	391	99	95	193	69	113	247	58	86	0	45
MEX	166	137	119	118	123	131	180	90	147	93	119	111	96	131	75	26	15	10	111	96	111	119	28	39	7	140	96	105	29	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	79	417	166	252	151	36	154	70	78	13	36
DFS	64	0	152	124	122	145	97	128	96	123	39	54
USA	436	122	0	345	469	224	81	290	100	132	44	63
NZL	174	97	420	0	430	204	71	196	84	91	109	49
AUS	262	87	514	484	0	208	66	226	84	93	54	51
GBR	151	127	241	204	208	0	75	162	103	102	67	66
NLD	31	95	86	64	57	67	0	70	55	68	30	38
ZAF	150	103	304	202	217	159	65	0	90	91	37	55
ITA	67	93	107	82	79	104	55	83	0	74	20	45
DEU	75	114	133	85	83	97	63	86	76	0	28	47
IRL	9	32	44	119	50	66	28	36	19	28	0	19
CHE	29	50	63	40	42	63	32	48	42	43	14	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	79	417	166	252	150	36	154	70	78	13	36
DFS	64	0	152	124	122	144	97	128	96	123	39	54
USA	436	122	0	345	469	223	81	290	100	132	44	63
NZL	174	97	420	0	430	203	71	196	84	91	109	50
AUS	262	87	514	484	0	207	66	226	84	93	54	51
GBR	151	127	241	204	208	0	75	162	102	102	67	66
NLD	31	95	86	64	57	67	0	70	55	68	30	38
ZAF	150	103	304	202	217	159	65	0	90	91	37	55
ITA	67	93	107	82	79	104	55	83	0	74	20	45
DEU	75	114	133	85	83	97	63	86	76	0	28	47
IRL	9	32	44	119	50	66	28	36	19	28	0	19
CHE	29	50	63	40	42	63	32	48	42	43	14	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	79	417	166	252	150	36	154	70	78	13	36
DFS	64	0	152	124	122	144	97	128	96	123	39	54
USA	436	122	0	345	469	223	81	290	100	132	44	63
NZL	174	97	420	0	430	203	71	196	84	91	109	49
AUS	262	87	514	484	0	207	66	226	84	93	54	51
GBR	151	127	241	204	208	0	75	162	102	102	67	66
NLD	31	95	86	64	57	67	0	70	55	68	30	38
ZAF	150	103	304	202	217	159	65	0	90	91	37	55
ITA	67	93	107	82	79	104	55	83	0	74	20	45
DEU	75	114	133	85	83	97	63	86	76	0	28	47
IRL	9	32	44	119	50	66	28	36	19	28	0	19
CHE	29	50	63	40	42	63	32	48	42	43	14	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	6	200	81	97	80	155	15	75	2	10	17	2	6	0
NOR	6	0	69	40	63	48	123	20	0	20	19	25	49	41	0
USA	184	71	0	113	120	105	174	27	64	17	23	34	25	37	20
NZL	80	39	114	0	131	74	166	22	37	8	17	26	10	18	10
AUS	98	53	124	136	0	78	169	45	37	31	34	42	15	29	10
GBR	77	50	97	69	77	0	95	19	39	7	17	26	18	32	0
DFS	158	96	168	161	145	88	0	71	52	101	120	104	15	47	0
DEU	14	19	27	21	44	18	60	0	2	28	35	38	6	18	0
ZAF	77	0	58	33	38	34	49	2	0	0	2	5	2	3	0
EST	2	20	16	7	28	6	89	27	0	0	48	25	1	17	0
LVA	10	17	20	14	32	16	81	30	2	42	0	52	3	11	0
LTU	16	22	29	24	42	24	99	35	5	25	48	0	5	15	0
IRL	2	48	25	10	14	17	12	6	2	1	2	5	0	10	0
NLD	6	41	36	17	27	31	45	18	3	16	10	13	10	0	0
CAM	0	0	21	11	11	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	6	200	81	97	80	155	15	75	2	10	17	2	6	0
NOR	6	0	69	40	63	48	123	20	0	20	19	25	49	41	0
USA	184	71	0	113	120	105	174	27	64	17	23	34	25	37	20
NZL	80	39	114	0	131	74	166	22	37	8	17	26	10	18	10
AUS	98	53	124	136	0	78	169	45	37	31	34	42	15	29	10
GBR	77	50	97	69	77	0	95	19	39	7	17	26	18	32	0
DFS	158	96	168	161	145	88	0	71	52	101	120	104	15	47	0
DEU	14	19	27	21	44	18	60	0	2	28	35	38	6	18	0
ZAF	77	0	58	33	38	34	49	2	0	0	2	5	2	3	0
EST	2	20	16	7	28	6	89	27	0	0	48	25	1	17	0
LVA	10	17	20	14	32	16	81	30	2	42	0	52	3	11	0
LTU	16	22	29	24	42	24	99	35	5	25	48	0	5	15	0
IRL	2	48	25	10	14	17	12	6	2	1	2	5	0	10	0
NLD	6	41	36	17	27	31	45	18	3	16	10	13	10	0	0
CAM	0	0	21	11	11	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	6	200	81	97	80	155	15	75	2	10	17	2	6	0
NOR	6	0	69	40	63	48	123	20	0	20	19	25	49	41	0
USA	184	71	0	113	120	105	174	27	64	17	23	34	25	37	20
NZL	80	39	114	0	131	74	166	22	37	8	17	26	10	18	10
AUS	98	53	124	136	0	78	169	45	37	31	34	42	15	29	10
GBR	77	50	97	69	77	0	95	19	39	7	17	26	18	32	0
DFS	158	96	168	161	145	88	0	71	52	101	120	103	15	47	0
DEU	14	19	27	21	44	18	60	0	2	28	35	38	6	18	0
ZAF	77	0	58	33	38	34	49	2	0	0	2	5	2	3	0
EST	2	20	16	7	28	6	89	27	0	0	48	25	1	17	0
LVA	10	17	20	14	32	16	81	30	2	42	0	52	3	11	0
LTU	16	22	29	24	42	24	98	35	5	25	48	0	5	15	0
IRL	2	48	25	10	14	17	12	6	2	1	2	5	0	10	0
NLD	6	41	36	17	27	31	45	18	3	16	10	13	10	0	0
CAM	0	0	21	11	11	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	SVK	GBR	HRV	USA
CHE	0	326	193	86	6	12	2	84	56	31	55	2	22
DEA	291	0	253	893	186	260	47	300	60	378	53	549	24
FRM	245	293	0	160	17	3	3	114	70	59	72	2	45
ITA	89	796	193	0	109	146	21	195	59	141	47	241	23
SVN	6	172	17	103	0	56	12	50	2	48	0	76	0
FRA	9	219	1	131	53	0	12	65	1	55	0	90	1
HUN	1	33	1	17	10	9	0	6	2	13	0	20	0
NLD	87	312	138	188	48	63	6	0	52	64	52	106	19
IRL	53	54	75	57	2	1	2	47	0	12	39	4	16
SVK	26	385	57	118	47	45	11	55	4	0	11	95	6
GBR	63	56	93	53	0	0	0	53	34	6	0	0	19
HRV	2	573	1	224	63	82	18	100	3	75	0	0	2
USA	21	27	60	29	0	1	0	21	15	5	27	2	0

SIM

common bulls below diagonal

common three quarter sib group above diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	0	326	193	86	6	12	2	84	56	31	55	2	22
DEA	291	0	253	893	186	260	47	300	60	378	53	547	24
FRM	245	293	0	160	17	3	3	114	70	59	72	2	45
ITA	89	796	193	0	109	146	21	195	59	141	47	239	23
SVN	6	172	17	103	0	56	12	50	2	48	0	76	0
FRA	9	219	1	131	53	0	12	65	1	55	0	90	1
HUN	1	33	1	17	10	9	0	6	2	13	0	20	0
NLD	87	312	138	188	48	63	6	0	52	64	52	106	19
IRL	53	54	75	57	2	1	2	47	0	12	39	4	16
SVK	26	385	57	118	47	45	11	55	4	0	11	93	6
GBR	63	56	93	53	0	0	0	53	34	6	0	0	19
HRV	2	571	1	222	63	82	18	100	3	73	0	0	2
USA	21	27	60	29	0	1	0	21	15	5	27	2	0

SIM

common bulls below diagonal

common three quarter sib group above diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	0	326	193	86	6	12	2	84	56	31	55	2	22
DEA	291	0	253	893	186	260	47	300	60	378	53	548	24
FRM	245	293	0	160	17	3	3	114	70	59	72	2	45
ITA	89	796	193	0	109	146	21	195	59	141	47	240	23
SVN	6	172	17	103	0	56	12	50	2	48	0	76	0
FRA	9	219	1	131	53	0	12	65	1	55	0	90	1
HUN	1	33	1	17	10	9	0	6	2	13	0	20	0
NLD	87	312	138	188	48	63	6	0	52	64	52	106	19
IRL	53	54	75	57	2	1	2	47	0	12	39	4	16
SVK	26	385	57	118	47	45	11	55	4	0	11	94	6
GBR	63	56	93	53	0	0	0	53	34	6	0	0	19
HRV	2	572	1	223	63	82	18	100	3	74	0	0	2
USA	21	27	60	29	0	1	0	21	15	5	27	2	0