

## 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:

CZE HOL	Base change from 2005 to 2010
ITA SIM	Pedigree edits
ITA HOL	change of genetic groups
NOR RDC	- Evaluation and EDC by Mix99. - Inbreeding considered in setting up A-matrix. - Base change
DFS ALL	Change in lactation weights for all traits and breeds
FRA ALL	Evaluation now performed by a new genetic centre, GENEVAL
JPN ALL	Pedigree modifications
CHE BSW/HOL JER/SIM	Decrease of information due to continuous work on the raw data by herd-book organizations and joined data from two databases (for HOL-CHE and SIM-CHE)
NZL ALL	Continues DNA parentage testing resulting in pedigree editing
PRT HOL	Pedigree corrections
EST RDC	Pedigree updates
SVN ALL	Pedigree updates and phenotypic data improvement

## 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 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 (December Routine Evaluation 2018).  
 Number of records for milk yield by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS	194	132	7457	1640	696	
BEL			1980			
CAN	226	99	12075	715	800	
CHE	2892		3318	86		3174
CZE			4257			
DEA	5894					23586
DEU			27453	195	428	
DFS			12899	2126	7663	
ESP			3761			
EST			1109		428	
FRA	384		16903			457
FRM						4578
GBR	156	328	7040	879	612	94
HUN			3220			214
IRL			2216	167	52	85
ISR			1407			
ITA	2078		9249	171		1655
JPN			5880			
KOR			1343			
LTU			785		437	
LVA			1131		702	
NLD	189		15241	150	75	379
NOR					4118	
NZL	53	60	7691	4874	1382	
POL			10203			
PRT			2403			
SVK			1103			578
SVN	364		533			611
URY			1019			
USA	1092	777	38019	4576	706	49
ZAF			1293	707	141	
HRV			720			801
MEX			607			
CAM					38	
=====						
No. Records	13522	1396	202315	16286	18278	36261
Pub. Proofs	10989	1113	152942	13236	16376	32690
-----						

^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	637.80										
FRA	0.89	636.16									
USA	0.92	0.88	632.77								
CHE	0.91	0.89	0.87	527.28							
ITA	0.88	0.83	0.88	0.87	596.26						
DEA	0.88	0.82	0.86	0.93	0.90	460.72					
NLD	0.88	0.87	0.87	0.85	0.85	0.86	629.62				
SVN	0.83	0.81	0.82	0.81	0.81	0.81	0.82	9.52			
NZL	0.70	0.76	0.71	0.76	0.70	0.73	0.72	0.75	332.63		
GBR	0.86	0.88	0.85	0.87	0.82	0.82	0.86	0.83	0.71	252.06	
AUS	0.74	0.76	0.72	0.73	0.71	0.71	0.75	0.73	0.84	0.74	396.29

BSW fat

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	27.01										
FRA	0.89	27.08									
USA	0.90	0.89	23.66								
CHE	0.87	0.87	0.84	20.76							
ITA	0.89	0.83	0.86	0.87	22.78						
DEA	0.86	0.84	0.83	0.94	0.88	17.27					
NLD	0.87	0.86	0.86	0.84	0.84	0.86	25.96				
SVN	0.82	0.81	0.82	0.81	0.81	0.81	0.82	9.92			
NZL	0.71	0.74	0.71	0.74	0.70	0.82	0.70	0.75	14.88		
GBR	0.86	0.89	0.86	0.88	0.82	0.82	0.87	0.83	0.71	9.10	
AUS	0.73	0.74	0.72	0.71	0.70	0.71	0.72	0.73	0.83	0.72	15.96

BSW pro

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	23.00										
FRA	0.84	20.47									
USA	0.89	0.86	18.91								
CHE	0.86	0.84	0.83	17.10							
ITA	0.85	0.82	0.83	0.85	20.92						
DEA	0.86	0.81	0.82	0.92	0.89	14.34					
NLD	0.86	0.84	0.84	0.83	0.82	0.84	21.23				
SVN	0.82	0.81	0.82	0.81	0.81	0.81	0.82	9.36			
NZL	0.70	0.70	0.70	0.71	0.70	0.74	0.70	0.75	10.54		
GBR	0.85	0.85	0.83	0.85	0.81	0.82	0.85	0.83	0.70	7.37	
AUS	0.70	0.70	0.69	0.70	0.69	0.70	0.70	0.73	0.81	0.71	12.04

GUE mil

	CAN	USA	AUS	GBR	NZL
CAN	744.28				
USA	0.94	701.28			
AUS	0.81	0.76	478.93		
GBR	0.87	0.83	0.76	241.84	
NZL	0.71	0.70	0.84	0.71	326.57

GUE fat

	CAN	USA	AUS	GBR	NZL
CAN	30.14				
USA	0.93	25.22			
AUS	0.79	0.75	17.83		
GBR	0.86	0.84	0.75	11.06	
NZL	0.72	0.71	0.84	0.70	16.39





JER fat												
	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	25.94											
DFS	0.90	11.30										
USA	0.90	0.90	24.50									
NZL	0.69	0.70	0.74	12.13								
AUS	0.78	0.71	0.76	0.84	13.57							
GBR	0.83	0.84	0.82	0.69	0.71	10.89						
NLD	0.88	0.87	0.86	0.70	0.71	0.85	24.89					
ZAF	0.81	0.81	0.80	0.69	0.71	0.81	0.81	14.17				
ITA	0.89	0.84	0.86	0.70	0.73	0.82	0.84	0.82	24.53			
DEU	0.90	0.90	0.87	0.70	0.74	0.84	0.89	0.82	0.86	23.13		
IRL	0.80	0.79	0.76	0.81	0.81	0.76	0.80	0.71	0.74	0.79	6.61	
CHE	0.87	0.85	0.84	0.72	0.78	0.85	0.86	0.81	0.84	0.89	0.80	15.89

JER pro												
	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	18.38											
DFS	0.91	10.55										
USA	0.89	0.92	18.54									
NZL	0.69	0.70	0.69	8.54								
AUS	0.73	0.70	0.69	0.81	10.41							
GBR	0.84	0.85	0.81	0.69	0.70	6.55						
NLD	0.88	0.89	0.85	0.70	0.71	0.84	19.73					
ZAF	0.83	0.82	0.80	0.69	0.72	0.81	0.81	11.32				
ITA	0.85	0.84	0.85	0.70	0.70	0.81	0.83	0.85	18.47			
DEU	0.87	0.91	0.86	0.70	0.71	0.83	0.88	0.81	0.85	17.09		
IRL	0.75	0.75	0.73	0.84	0.81	0.74	0.77	0.71	0.72	0.75	5.83	
CHE	0.84	0.84	0.83	0.70	0.71	0.83	0.84	0.81	0.83	0.85	0.78	10.43

RDC mil															
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	592.68														
NOR	0.89	12.60													
USA	0.91	0.90	662.10												
NZL	0.69	0.72	0.69	320.12											
AUS	0.75	0.76	0.76	0.84	417.10										
GBR	0.84	0.83	0.83	0.70	0.77	266.50									
DFS	0.91	0.91	0.90	0.69	0.77	0.84	10.22								
DEU	0.91	0.91	0.89	0.70	0.77	0.83	0.91	603.16							
ZAF	0.82	0.88	0.84	0.70	0.76	0.81	0.81	0.81	546.93						
EST	0.88	0.87	0.88	0.75	0.75	0.83	0.87	0.84	0.83	484.43					
LVA	0.82	0.83	0.81	0.73	0.72	0.82	0.82	0.82	0.82	0.83	315.15				
LTU	0.83	0.83	0.82	0.72	0.72	0.82	0.81	0.82	0.84	0.83	0.82	315.85			
IRL	0.83	0.74	0.81	0.85	0.83	0.81	0.82	0.82	0.78	0.80	0.74	0.75	160.24		
NLD	0.92	0.92	0.89	0.72	0.78	0.86	0.93	0.92	0.81	0.85	0.82	0.83	0.85	793.57	
CAM	0.89	0.90	0.95	0.76	0.77	0.88	0.89	0.89	0.89	0.90	0.89	0.89	0.84	0.89	434.99

RDC fat															
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	22.50														
NOR	0.88	11.73													
USA	0.91	0.84	24.58												
NZL	0.69	0.75	0.69	13.49											
AUS	0.74	0.75	0.78	0.86	15.72										
GBR	0.84	0.82	0.84	0.69	0.74	9.29									
DFS	0.90	0.89	0.89	0.70	0.77	0.85	10.28								
DEU	0.90	0.90	0.89	0.70	0.75	0.86	0.90	24.34							

ZAF	0.81	0.88	0.84	0.70	0.70	0.81	0.81	0.81	19.32						
EST	0.87	0.84	0.87	0.79	0.75	0.83	0.85	0.85	0.83	18.60					
LVA	0.82	0.83	0.82	0.73	0.72	0.82	0.82	0.83	0.83	0.84	13.61				
LTU	0.83	0.83	0.82	0.73	0.72	0.82	0.81	0.82	0.85	0.83	0.82	15.10			
IRL	0.81	0.73	0.79	0.83	0.82	0.79	0.82	0.79	0.71	0.83	0.74	0.76	7.04		
NLD	0.90	0.89	0.88	0.70	0.74	0.87	0.91	0.91	0.81	0.85	0.82	0.83	0.82	27.94	
CAM	0.90	0.89	0.95	0.76	0.80	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.83	0.89	21.69

-----

RDC pro

-----

	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	17.68														
NOR	0.88	11.61													
USA	0.89	0.87	18.81												
NZL	0.69	0.72	0.69	9.57											
AUS	0.69	0.77	0.71	0.80	12.26										
GBR	0.83	0.82	0.83	0.69	0.73	7.36									
DFS	0.89	0.88	0.88	0.69	0.71	0.84	10.33								
DEU	0.88	0.92	0.86	0.70	0.72	0.83	0.90	18.52							
ZAF	0.81	0.88	0.81	0.70	0.73	0.81	0.81	0.81	15.81						
EST	0.83	0.83	0.85	0.75	0.73	0.83	0.82	0.84	0.83	14.71					
LVA	0.82	0.83	0.82	0.73	0.72	0.82	0.81	0.82	0.83	0.82	9.22				
LTU	0.83	0.83	0.82	0.73	0.72	0.82	0.81	0.81	0.85	0.83	0.82	9.51			
IRL	0.74	0.75	0.76	0.82	0.82	0.77	0.77	0.74	0.72	0.74	0.74	0.75	5.14		
NLD	0.88	0.92	0.85	0.70	0.73	0.85	0.89	0.89	0.81	0.84	0.82	0.83	0.78	26.50	
CAM	0.89	0.89	0.91	0.76	0.78	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.83	0.89	10.32

-----

SIM mil

-----

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	622.22												
DEA	0.87	510.12											
FRM	0.96	0.87	619.41										
ITA	0.84	0.80	0.81	497.45									
SVN	0.83	0.81	0.84	0.81	8.65								
FRA	0.93	0.89	0.89	0.85	0.82	678.46							
HUN	0.85	0.82	0.89	0.88	0.83	0.87	399.61						
NLD	0.89	0.94	0.90	0.83	0.82	0.89	0.85	732.03					
IRL	0.82	0.72	0.84	0.74	0.73	0.89	0.79	0.80	176.80				
SVK	0.83	0.81	0.82	0.81	0.82	0.82	0.85	0.82	0.75	321.26			
GBR	0.88	0.88	0.88	0.82	0.81	0.87	0.83	0.86	0.79	0.82	212.91		
HRV	0.82	0.81	0.89	0.81	0.82	0.81	0.83	0.81	0.73	0.82	0.81	10.55	
USA	0.89	0.83	0.88	0.90	0.81	0.91	0.90	0.90	0.83	0.81	0.84	0.81	575.12

-----

SIM fat

-----

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	24.54												
DEA	0.88	19.30											
FRM	0.94	0.90	24.30										
ITA	0.82	0.82	0.81	19.55									
SVN	0.83	0.81	0.83	0.81	8.98								
FRA	0.90	0.91	0.89	0.85	0.82	27.36							
HUN	0.81	0.82	0.88	0.88	0.83	0.87	15.37						
NLD	0.88	0.93	0.90	0.82	0.82	0.88	0.83	27.82					
IRL	0.74	0.71	0.78	0.72	0.73	0.84	0.70	0.79	7.25				
SVK	0.83	0.81	0.82	0.81	0.82	0.82	0.84	0.82	0.73	12.81			
GBR	0.91	0.87	0.87	0.83	0.81	0.89	0.82	0.87	0.77	0.82	8.16		
HRV	0.82	0.81	0.88	0.81	0.82	0.82	0.83	0.81	0.75	0.82	0.81	10.56	
USA	0.86	0.83	0.84	0.90	0.81	0.91	0.90	0.89	0.79	0.81	0.86	0.81	18.62

-----

SIM pro



	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	18.90												
DEA	0.85	15.52											
FRM	0.93	0.88	19.20										
ITA	0.82	0.80	0.81	15.62									
SVN	0.83	0.81	0.83	0.81	8.78								
FRA	0.90	0.86	0.89	0.82	0.82	21.47							
HUN	0.82	0.82	0.88	0.85	0.84	0.85	12.85						
NLD	0.85	0.93	0.87	0.82	0.82	0.85	0.81	23.02					
IRL	0.76	0.71	0.81	0.71	0.72	0.81	0.69	0.74	6.23				
SVK	0.83	0.81	0.82	0.81	0.82	0.82	0.84	0.82	0.73	9.91			
GBR	0.85	0.87	0.87	0.81	0.82	0.86	0.81	0.86	0.75	0.83	6.70		
HRV	0.82	0.81	0.88	0.81	0.82	0.82	0.83	0.81	0.73	0.82	0.81	10.52	
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	15.13

^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	78	164	123	115	130	50	30	24	66	85
FRA	68	0	117	153	178	203	80	51	22	58	58
USA	150	79	0	310	229	315	77	39	30	94	121
CHE	98	114	290	0	424	561	90	73	25	74	108
ITA	97	141	160	367	0	672	119	91	27	81	111
DEA	106	150	278	459	569	0	140	97	33	79	121
NLD	47	66	68	84	100	135	0	41	24	43	52
SVN	26	50	32	70	90	89	42	0	9	25	24
NZL	22	18	26	20	20	28	17	8	0	20	25
GBR	59	45	80	53	54	52	32	18	17	0	56
AUS	85	43	112	67	80	83	39	20	20	45	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	78	164	123	115	130	50	30	24	66	85
FRA	68	0	117	153	178	203	80	51	22	58	58
USA	150	79	0	310	229	315	77	39	30	94	121
CHE	98	114	290	0	424	561	90	73	25	74	108
ITA	97	141	160	367	0	672	119	91	27	81	111
DEA	106	150	278	459	569	0	140	97	33	79	121
NLD	47	66	68	84	100	135	0	41	24	43	52
SVN	26	50	32	70	90	89	42	0	9	25	24
NZL	22	18	26	20	20	28	17	8	0	20	25
GBR	59	45	80	53	54	52	32	18	17	0	56
AUS	85	43	112	67	80	83	39	20	20	45	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	78	164	123	115	130	50	30	24	66	85
FRA	68	0	117	153	178	203	80	51	22	58	58
USA	150	79	0	310	229	315	77	39	30	94	121
CHE	98	114	290	0	424	561	90	73	25	74	108
ITA	97	141	160	367	0	672	119	91	27	81	111

DEA	106	150	278	459	569	0	140	97	33	79	121
NLD	47	66	68	84	100	135	0	41	24	43	52
SVN	26	50	32	70	90	89	42	0	9	25	24
NZL	22	18	26	20	20	28	17	8	0	20	25
GBR	59	45	80	53	54	52	32	18	17	0	56
AUS	85	43	112	67	80	83	39	20	20	45	0

-----  
GUE

-----  
common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	USA	AUS	GBR	NZL
CAN	0	68	46	31	14
USA	59	0	58	90	31
AUS	43	53	0	36	27
GBR	26	92	31	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	68	46	31	14
USA	59	0	58	90	31
AUS	43	53	0	36	27
GBR	26	92	31	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	67	46	31	13
USA	58	0	58	90	31
AUS	43	53	0	36	27
GBR	26	92	31	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	2265	1253	1331	1482	1300	3028	797	1492	675	1139	721	451	1195	992	181	218	106	895	1186	477	1214	416	402	215	957	619	445	246	361
DEU	1488	0	2645	2451	2383	3308	3521	1105	2038	950	1441	1211	763	1487	1837	290	379	153	1197	2226	585	1406	698	709	473	1223	588	478	562	352
DFS	984	1663	0	1536	1457	1913	1909	668	1449	784	1060	801	626	959	1183	231	262	135	849	1425	497	897	436	391	292	898	449	397	352	285
FRA	816	1200	755	0	1597	1853	2370	620	1453	766	1086	867	597	1068	1186	187	235	121	889	1503	469	1131	384	407	224	901	484	383	254	296
ITA	1014	1384	984	761	0	1554	2401	659	1437	699	972	752	549	1173	1196	220	242	123	937	1422	467	1087	456	374	260	964	540	412	328	326
NLD	1173	2945	1590	1068	1155	0	2292	826	1619	982	1206	1211	747	1035	1405	233	325	142	909	1622	510	979	477	512	279	1019	446	404	387	299
USA	3112	2283	1343	1188	1427	1928	0	935	2040	1019	1575	914	646	1465	1570	219	312	163	1224	1851	631	1819	581	521	314	1268	798	645	332	447
CHE	639	950	583	537	573	799	822	0	654	377	499	569	356	530	509	132	150	57	420	617	263	436	259	224	113	487	242	200	181	174
GBR	1646	1433	1028	837	988	1356	1738	582	0	876	1148	819	794	1020	1003	195	232	123	820	1211	505	970	389	358	248	929	464	419	297	319
NZL	663	731	542	433	483	892	960	316	742	0	1006	488	606	508	588	121	126	104	480	621	363	531	231	247	152	549	299	333	193	194
AUS	1039	904	643	631	563	941	1394	400	853	940	0	623	518	738	701	141	175	89	593	804	419	741	291	265	181	651	360	363	212	240
BEL	702	1246	735	835	695	1385	797	579	798	400	494	0	450	631	628	164	177	77	513	753	327	511	278	286	150	645	273	235	239	198
IRL	418	680	524	489	468	713	589	350	815	539	421	444	0	430	458	114	124	83	386	533	294	370	201	185	132	448	206	231	160	164
ESP	700	915	684	744	803	899	909	427	785	385	454	612	414	0	818	179	184	105	721	972	441	843	339	307	199	807	439	347	252	279
CZE	670	1384	734	699	794	1219	1176	355	655	410	380	491	350	552	0	203	241	120	872	1242	391	782	408	457	239	781	446	359	321	272
SVN	129	276	191	127	181	203	166	98	140	86	87	136	87	132	153	0	85	43	148	228	96	153	110	77	54	159	90	70	94	64
EST	116	266	154	106	133	234	204	84	126	65	67	112	69	87	152	52	0	46	182	282	104	186	170	108	74	180	99	94	109	69

ISR	69	125	104	62	77	114	148	37	84	87	50	51	66	61	88	32	28	0	103	127	61	95	63	47	42	99	53	63	59	42
HUN	788	924	647	569	768	736	1166	332	702	377	380	442	344	562	769	113	111	76	0	878	390	668	306	306	187	697	423	351	231	285
POL	896	1893	1087	908	1018	1435	1678	503	956	467	471	690	456	666	993	205	201	98	754	0	409	905	554	422	320	978	523	394	406	313
ZAF	412	450	378	326	348	427	613	215	437	302	338	279	265	390	259	66	53	42	319	303	0	416	163	178	102	426	262	267	142	211
JPN	529	522	436	365	449	464	728	265	455	265	345	308	247	372	318	84	62	39	356	446	272	0	314	291	178	668	504	365	188	291
LVA	233	560	272	175	290	323	473	131	229	135	126	173	127	186	282	73	109	44	232	449	94	133	0	172	155	386	205	172	224	138
SVK	270	533	198	209	212	348	335	113	199	146	118	175	93	153	373	45	49	19	216	288	97	101	85	0	90	312	197	174	121	122
LTU	97	446	150	57	122	150	198	43	115	67	58	67	60	82	145	27	34	19	112	239	38	49	111	41	0	192	126	104	130	67
PRT	963	1121	787	750	873	1023	1325	429	848	450	455	653	411	765	643	127	127	74	689	980	384	388	307	214	118	0	442	378	290	333
KOR	558	383	306	267	422	306	906	166	332	216	220	199	150	306	314	55	50	32	349	435	199	285	118	120	55	373	0	283	120	250
URY	416	337	282	222	304	317	802	149	352	266	257	181	187	278	265	42	59	34	300	333	227	217	107	114	60	342	233	0	122	232
HRV	124	576	268	151	235	346	247	120	209	112	114	199	120	193	237	76	78	43	178	356	95	85	181	61	88	234	53	74	0	107
MEX	359	286	235	227	295	245	531	151	284	152	175	184	144	250	222	47	49	26	270	289	196	218	91	75	29	344	233	218	73	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	2266	1253	1332	1486	1300	3029	797	1492	675	1139	721	451	1195	992	181	218	106	895	1187	477	1212	416	402	215	957	618	445	246	140
DEU	1491	0	2645	2451	2386	3308	3521	1105	2037	950	1441	1211	763	1487	1837	290	379	153	1197	2226	585	1403	698	709	473	1223	586	478	562	134
DFS	985	1663	0	1536	1460	1913	1909	668	1448	784	1060	801	626	959	1183	231	262	135	849	1425	497	896	436	391	292	898	447	397	352	119
FRA	817	1200	755	0	1599	1853	2370	620	1452	766	1086	867	597	1068	1186	187	235	121	889	1503	469	1129	384	407	224	901	482	383	254	123
ITA	1020	1389	989	766	0	1557	2405	660	1439	702	973	754	551	1176	1197	220	242	124	939	1423	469	1086	456	375	260	966	538	413	328	122
NLD	1175	2945	1590	1068	1160	0	2292	826	1618	982	1206	1211	747	1035	1405	233	325	142	909	1622	510	975	477	512	279	1019	444	404	387	125
USA	3115	2283	1343	1188	1434	1928	0	935	2040	1019	1575	914	646	1465	1570	219	312	163	1224	1851	631	1816	581	521	314	1268	796	645	332	147
CHE	640	950	583	537	574	799	822	0	653	377	499	569	356	530	509	132	150	57	420	617	263	434	259	224	113	487	242	200	181	94
GBR	1648	1433	1028	837	994	1356	1738	582	0	875	1148	818	794	1020	1002	195	232	123	820	1210	505	967	388	358	248	928	462	419	296	129
NZL	664	731	542	433	489	892	960	316	742	0	1006	488	606	508	588	121	126	104	480	621	363	530	231	247	152	549	297	333	193	100
AUS	1039	904	643	631	566	941	1394	400	853	940	0	623	518	738	701	141	175	89	593	804	419	738	291	265	181	651	358	363	212	114
BEL	702	1246	735	835	698	1385	797	579	798	400	494	0	450	631	628	164	177	77	513	753	327	510	278	286	150	645	272	235	239	103
IRL	418	680	524	488	471	712	588	350	814	539	421	443	0	430	458	114	124	83	386	533	294	368	201	185	132	448	206	231	160	86
ESP	701	915	684	744	807	899	909	427	785	385	454	612	413	0	818	179	184	105	721	972	441	842	339	307	199	807	438	347	252	120
CZE	670	1383	733	699	797	1218	1176	355	655	410	380	490	350	551	0	203	241	120	872	1242	391	781	408	457	239	781	445	359	321	95
SVN	129	276	191	127	181	203	166	98	140	86	87	136	87	132	153	0	85	43	148	228	96	152	110	77	54	159	90	70	94	33
EST	116	266	154	106	133	234	204	84	126	65	67	112	69	87	152	52	0	46	182	282	104	183	170	108	74	180	98	94	109	26
ISR	69	125	104	62	79	114	148	37	84	87	50	51	65	61	88	32	28	0	103	127	61	95	63	47	42	99	53	63	59	15
HUN	789	924	647	569	772	736	1166	332	702	377	380	442	344	562	769	113	111	76	0	878	390	667	306	306	187	697	422	351	231	110
POL	898	1893	1087	908	1021	1435	1678	503	956	467	471	690	456	666	992	205	201	98	754	0	409	901	554	422	320	978	522	394	406	102
ZAF	413	450	378	326	351	427	613	215	437	302	338	279	265	390	259	66	53	42	319	303	0	415	163	178	102	426	261	267	142	104
JPN	527	520	435	362	448	459	722	263	452	263	342	306	246	370	317	83	60	39	355	441	271	0	313	290	178	666	502	364	188	127
LVA	233	560	272	175	290	323	473	131	229	135	126	173	126	186	282	73	109	44	232	449	94	132	0	172	155	386	203	172	224	45
SVK	270	533	198	209	214	348	335	113	199	146	118	175	93	153	372	45	49	19	216	288	97	100	85	0	90	312	196	174	121	56
LTU	97	446	150	57	122	150	198	43	115	67	58	67	60	82	145	27	34	19	112	239	38	49	111	41	0	192	126	104	130	25
PRT	964	1121	787	749	876	1023	1324	429	848	450	455	653	410	764	643	127	127	74	689	980	384	386	307	214	118	0	441	378	290	125
KOR	558	382	305	266	421	305	904	166	331	215	219	199	150	306	314	55	50	32	349	435	199	283	118	120	55	373	0	283	119	96
URY	416	337	282	222	306	317	802	149	352	266	257	181	187	278	265	42	59	34	300	333	227	214	107	114	60	342	233	0	122	100
HRV	124	576	268	151	235	346	247	120	209	112	114	199	120	193	237	76	78	43	178	356	95	85	181	61	88	234	53	74	0	45
MEX	165	143	122	123	125	132	185	93	150	96	105	113	94	132	74	26	16	10	113	99	113	121	27	42	7	144	97	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	2265	1253	1331	1482	1300	3022	797	1492	675	1139	721	451	1195	992	181	218	106	895	1186	477	1210	416	402	215	957	619	445	246	138
DEU	1488	0	2645	2451	2383	3308	3517	1105	2037	950	1441	1211	763	1487	1837	290	379	153	1197	2226	585	1403	698	709	473	1223	588	478	562	132
DFS	984	1663	0	1536	1457	1913	1907	668	1448	784	1060	801	626	959	1183	231	262	135	849	1425	497	896	436	391	292	898	449	397	352	117
FRA	816	1200	755	0	1597	1853	2369	620	1452	766	1086	867	597	1068	1186</															

NZL	663	731	542	433	483	892	960	316	742	0	1006	488	606	508	588	121	126	104	480	621	363	530	231	247	152	549	299	333	193	99
AUS	1039	904	643	631	563	940	1393	400	853	940	0	623	518	738	701	141	175	89	593	804	419	738	291	265	181	651	360	363	212	112
BEL	702	1246	735	835	695	1384	796	579	798	400	494	0	450	631	628	164	177	77	513	753	327	510	278	286	150	645	273	235	239	101
IRL	417	680	524	488	467	712	588	350	814	539	421	443	0	430	458	114	124	83	386	533	294	368	201	185	132	448	206	231	160	84
ESP	700	915	684	744	803	898	909	427	785	385	454	612	413	0	818	179	184	105	721	972	441	842	339	307	199	807	439	347	252	118
CZE	670	1383	733	699	794	1218	1176	355	655	410	380	490	350	551	0	203	241	120	872	1242	391	781	408	457	239	781	446	359	321	93
SVN	129	276	191	127	181	203	166	98	140	86	87	136	87	132	153	0	85	43	148	228	96	152	110	77	54	159	90	70	94	33
EST	116	266	154	106	133	234	204	84	126	65	67	112	69	87	152	52	0	46	182	282	104	182	170	108	74	180	99	94	109	26
ISR	69	125	104	62	77	114	148	37	84	87	50	51	65	61	88	32	28	0	103	127	61	95	63	47	42	99	53	63	59	15
HUN	788	924	647	569	768	735	1166	332	702	377	380	442	344	562	769	113	111	76	0	878	390	667	306	306	187	697	423	351	231	108
POL	896	1893	1087	908	1018	1434	1678	503	956	467	471	690	456	666	992	205	201	98	754	0	409	901	554	422	320	978	523	394	406	100
ZAF	412	450	378	326	348	427	613	215	437	302	338	279	265	390	259	66	53	42	319	303	0	415	163	178	102	426	262	267	142	102
JPN	525	520	435	362	447	458	721	263	452	263	342	306	246	370	317	83	59	39	355	441	271	0	313	290	178	666	504	364	188	125
LVA	233	560	272	175	290	322	473	131	229	135	126	173	126	186	282	73	109	44	232	449	94	132	0	172	155	386	205	172	224	44
SVK	270	533	198	209	212	348	334	113	199	146	118	175	93	153	372	45	49	19	216	288	97	100	85	0	90	312	197	174	121	56
LTU	97	446	150	57	122	150	198	43	115	67	58	67	60	82	145	27	34	19	112	239	38	49	111	41	0	192	126	104	130	24
PRT	963	1121	787	750	873	1022	1325	429	848	450	455	653	410	765	643	127	127	74	689	980	384	386	307	214	118	0	442	378	290	123
KOR	558	383	306	267	422	305	907	166	332	216	220	199	150	306	314	55	50	32	349	435	199	284	118	120	55	373	0	283	120	96
URY	416	337	282	222	304	317	802	149	352	266	257	181	187	278	265	42	59	34	300	333	227	214	107	114	60	342	233	0	122	99
HRV	124	576	268	151	235	346	247	120	209	112	114	199	120	193	237	76	78	43	178	356	95	85	181	61	88	234	53	74	0	44
MEX	162	141	121	122	123	131	183	92	148	95	104	112	93	131	72	26	15	10	112	98	112	119	27	42	7	143	97	104	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	74	389	161	213	145	33	145	67	70	11	35
DFS	59	0	148	120	110	141	90	125	96	117	37	53
USA	402	118	0	335	424	216	78	287	100	120	41	61
NZL	170	94	409	0	384	198	68	190	85	86	105	48
AUS	211	74	445	419	0	180	60	211	78	77	44	44
GBR	143	124	232	200	174	0	74	157	102	98	60	64
NLD	26	87	82	61	45	67	0	67	56	62	29	37
ZAF	140	100	298	197	192	156	62	0	91	88	33	52
ITA	64	93	107	83	71	103	56	84	0	74	19	45
DEU	67	108	122	80	65	95	58	83	76	0	26	46
IRL	7	30	41	115	38	60	27	32	18	26	0	17
CHE	28	49	61	40	35	62	32	47	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	74	389	161	213	144	33	145	67	70	11	35
DFS	59	0	148	120	110	140	90	125	96	117	37	53
USA	402	118	0	335	424	215	78	287	100	120	41	61
NZL	170	94	409	0	384	197	68	190	85	86	105	49
AUS	211	74	445	419	0	179	60	211	78	77	44	44
GBR	143	124	232	200	174	0	74	157	101	98	60	64
NLD	26	87	82	61	45	67	0	67	56	62	29	37
ZAF	140	100	298	197	192	156	62	0	91	88	33	52
ITA	64	93	107	83	71	103	56	84	0	74	19	45
DEU	67	108	122	80	65	95	58	83	76	0	26	46
IRL	7	30	41	115	38	60	27	32	18	26	0	17
CHE	28	49	61	40	35	62	32	47	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	74	389	161	213	144	33	145	67	70	11	35
DFS	59	0	148	120	110	140	90	125	96	117	37	53
USA	402	118	0	335	424	215	78	287	100	120	41	61
NZL	170	94	409	0	384	197	68	190	85	86	105	48
AUS	211	74	445	419	0	179	60	211	78	77	44	44
GBR	143	124	232	200	174	0	74	157	101	98	60	64
NLD	26	87	82	61	45	67	0	67	56	62	29	37
ZAF	140	100	298	197	192	156	62	0	91	88	33	52
ITA	64	93	107	83	71	103	56	84	0	74	19	45
DEU	67	108	122	80	65	95	58	83	76	0	26	46
IRL	7	30	41	115	38	60	27	32	18	26	0	17
CHE	28	49	61	40	35	62	32	47	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	5	195	80	92	78	145	15	74	2	10	17	2	5	0
NOR	5	0	68	40	58	44	118	19	0	19	19	27	47	38	0
USA	180	69	0	114	114	103	172	29	63	19	24	37	23	35	20
NZL	78	39	113	0	129	72	163	22	37	8	17	28	8	18	10
AUS	92	49	114	131	0	73	162	41	37	27	35	45	11	25	10
GBR	76	46	95	67	72	0	94	19	38	7	17	26	16	29	0
DFS	145	91	165	157	137	88	0	68	51	96	121	116	13	42	0
DEU	14	19	28	21	40	18	58	0	2	26	35	39	5	16	0
ZAF	76	0	57	32	36	33	48	2	0	0	2	5	2	2	0
EST	2	19	18	7	24	6	84	25	0	0	48	26	0	14	0
LVA	10	17	21	14	32	16	81	30	2	42	0	54	2	11	0
LTU	16	22	30	24	41	24	99	35	5	25	48	0	4	16	0
IRL	2	46	23	8	10	15	10	5	2	0	2	4	0	9	0
NLD	5	38	33	17	23	28	40	16	2	13	10	13	9	0	0
CAM	0	0	20	10	10	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	5	195	80	92	78	145	15	74	2	10	17	2	5	0
NOR	5	0	68	40	58	44	118	19	0	19	19	27	47	38	0
USA	180	69	0	114	114	102	172	29	63	19	24	37	23	35	20
NZL	78	39	113	0	129	72	163	22	37	8	17	28	8	18	10
AUS	92	49	114	131	0	73	162	41	37	27	35	45	11	25	10
GBR	76	46	95	67	72	0	94	19	38	7	17	26	16	29	0
DFS	145	91	165	157	137	88	0	68	51	96	121	116	13	42	0
DEU	14	19	28	21	40	18	58	0	2	26	35	39	5	16	0
ZAF	76	0	57	32	36	33	48	2	0	0	2	5	2	2	0
EST	2	19	18	7	24	6	84	25	0	0	48	26	0	14	0
LVA	10	17	21	14	32	16	81	30	2	42	0	54	2	11	0
LTU	16	22	30	24	41	24	99	35	5	25	48	0	4	16	0
IRL	2	46	23	8	10	15	10	5	2	0	2	4	0	9	0
NLD	5	38	33	17	23	28	40	16	2	13	10	13	9	0	0
CAM	0	0	20	10	10	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	5	195	80	92	78	145	15	74	2	10	17	2	5	0
NOR	5	0	68	40	58	44	118	19	0	19	19	27	47	38	0
USA	180	69	0	114	114	102	172	29	63	19	24	37	23	35	20

NZL	78	39	113	0	129	72	163	22	37	8	17	28	8	18	10
AUS	92	49	114	131	0	73	162	41	37	27	35	45	11	25	10
GBR	76	46	95	67	72	0	94	19	38	7	17	26	16	29	0
DFS	145	91	165	157	137	88	0	68	51	96	121	115	13	42	0
DEU	14	19	28	21	40	18	58	0	2	26	35	39	5	16	0
ZAF	76	0	57	32	36	33	48	2	0	0	2	5	2	2	0
EST	2	19	18	7	24	6	84	25	0	0	48	26	0	14	0
LVA	10	17	21	14	32	16	81	30	2	42	0	54	2	11	0
LTU	16	22	30	24	41	24	98	35	5	25	48	0	4	16	0
IRL	2	46	23	8	10	15	10	5	2	0	2	4	0	9	0
NLD	5	38	33	17	23	28	40	16	2	13	10	13	9	0	0
CAM	0	0	20	10	10	0	0	0	0	0	0	0	0	0	0

SIM

common bulls below diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	0	318	183	86	6	12	2	82	50	31	55	1	19
DEA	282	0	245	853	180	253	46	279	53	370	53	504	19
FRM	234	290	0	159	17	3	3	110	63	57	72	2	33
ITA	88	755	193	0	104	142	21	181	54	139	47	216	21
SVN	6	166	17	97	0	55	12	48	2	46	0	69	0
FRA	9	213	1	127	52	0	12	60	1	54	0	84	1
HUN	1	32	1	17	10	9	0	6	2	13	0	20	0
NLD	85	292	135	177	46	58	6	0	48	63	52	89	16
IRL	46	45	67	51	2	1	2	43	0	10	36	4	15
SVK	26	377	57	116	45	45	11	54	3	0	11	88	4
GBR	63	56	93	53	0	0	0	53	31	6	0	0	19
HRV	1	527	1	204	59	78	18	86	3	70	0	0	1
USA	20	25	48	28	0	1	0	19	15	4	27	1	0

SIM

common bulls below diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	0	318	183	86	6	12	2	82	50	31	55	1	19
DEA	282	0	245	853	180	253	46	279	53	370	53	502	19
FRM	234	290	0	159	17	3	3	110	63	57	72	2	33
ITA	88	755	193	0	104	142	21	181	54	139	47	214	21
SVN	6	166	17	97	0	55	12	48	2	46	0	69	0
FRA	9	213	1	127	52	0	12	60	1	54	0	84	1
HUN	1	32	1	17	10	9	0	6	2	13	0	20	0
NLD	85	292	135	177	46	58	6	0	48	63	52	89	16
IRL	46	45	67	51	2	1	2	43	0	10	36	4	15
SVK	26	377	57	116	45	45	11	54	3	0	11	86	4
GBR	63	56	93	53	0	0	0	53	31	6	0	0	19
HRV	1	525	1	202	59	78	18	86	3	68	0	0	1
USA	20	25	48	28	0	1	0	19	15	4	27	1	0

SIM

common bulls below diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	0	317	183	86	6	12	2	82	50	31	55	1	19
DEA	281	0	245	853	180	253	46	279	53	370	53	503	19
FRM	234	290	0	159	17	3	3	110	63	57	72	2	33
ITA	88	755	193	0	104	142	21	181	54	139	47	215	21
SVN	6	166	17	97	0	55	12	48	2	46	0	69	0
FRA	9	213	1	127	52	0	12	60	1	54	0	84	1
HUN	1	32	1	17	10	9	0	6	2	13	0	20	0

NLD	85	292	135	177	46	58	6	0	48	63	52	89	16
IRL	46	45	67	51	2	1	2	43	0	10	36	4	15
SVK	26	377	57	116	45	45	11	54	3	0	11	87	4
GBR	63	56	93	53	0	0	0	53	31	6	0	0	19
HRV	1	526	1	203	59	78	18	86	3	69	0	0	1
USA	20	25	48	28	0	1	0	19	15	4	27	1	0

---