

Interbull Routine Genetic Evaluation for Udder Health Traits

August 2014

Introduction

The latest routine international evaluation for udder traits took place as scheduled at the Interbull Centre. Data from twenty-six (26) countries were included in this evaluation.

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

Changes in national procedures

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

DFS (ALL): Drops in information for some bulls due to checking if the herds still register diseases, if not the cows in the herd are dropped

CHR (SIM, HOL): The breeding association for Holstein (mainly red&white) and Simmental revised their breed code assignment for Holstein X Simmental crossbreds.

This caused a decrease in number of herds/daughters/EDC for some bulls.

GBR (ALL) : Base change

ZAF (RDC) : Some bulls have been reported as N for mas.

DEU (HOL) : There is no longer a distinction nationally between 1st and 2nd crop of daughters (as consequences of genomically proven bulls), thus type of proof is either

11 (German bull) or 21 (foreign bull), there are quite a number of bulls mentioned as "missing", however most of these appear now with another (correct) ID, these are mostly Danish bulls

INTERBULL CHANGES COMPARED TO THE DECEMBER ROUTINE RUN

No changes.

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 in the 01x-proof file.

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

The next routine evaluation of Interbull for production, conformation, udder health, longevity, calving, female fertility and workability traits is scheduled for November 2014. Deadline for sending data to the Interbull Centre is Tuesday November 11, 2014, 17:00 CET; confidential distribution of results is targeted for Thursday 20 Nov, 2014, with earliest possible official release of results on November 2, 2014. Please remark the three week turn around time.

NEXT TEST INTERNATIONAL EVALUATION

The next test run for production, conformation, udder health, longevity, calving, female fertility and workability traits will take place in September 2014.

Countries planning to introduce changes in their national evaluation procedures and wishing to have them included in the routine Interbull evaluation, should have their data examined in this test run. New data and validation results should be sent to the Interbull Centre no later than September 2, 2014, 17:00 CET.

PUBLICATION OF INTERBULL TEST RUN

Test evaluation results are meant for review purposes only and should not be published.

^LTable 1. National evaluation data considered in the Interbull evaluation for udder health (August Routine Evaluation 2014).
Number of records for milk somatic cells by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
ARG						
AUS		118	6664	1340	586	
BEL			937			
CAN	190	90	10160	542	698	
CHE	2718		1154			3132
CHR			1897			
CZE			3222			1950
DEA	5000					18108
DEU			24602		381	
DFS			11748	1887	7071	
ESP			2829			
EST			857		352	
FRA	313		15295			340
FRM						3705
FRR			183			
GBR	89	248	5610	595	395	
HUN			2243			142
IRL			1954			
ISR			1141			
ITA	1593		9069			1132
JPN			4916			
KOR			887			
LTU			524		352	
LVA			527		562	
NLD	149		13561	108	52	256
NOR					3601	
NZL	39	56	6234	3719	1093	
POL			6923			
PRT			2125			
SVK			928			494
SVN	332		365			541
URY						
USA	920	637	32064	3529	544	
ZAF		16	1059	501	116	
No. Records	11343	1165	169678	12221	15803	29800
Pub. Proofs	9315	916	135331	10182	15419	27103

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

BSW scs

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0.25									
FRA	0.92	1.03								
NLD	0.89	0.93	4.17							
USA	0.90	0.91	0.87	0.23						
CHE	0.93	0.96	0.93	0.86	10.41					
DEA	0.92	0.96	0.92	0.86	0.98	11.89				
NZL	0.77	0.82	0.86	0.76	0.82	0.78	0.38			
ITA	0.93	0.91	0.87	0.87	0.96	0.93	0.76	13.21		
GBR	0.92	0.96	0.96	0.91	0.95	0.95	0.86	0.90	13.60	
SVN	0.87	0.86	0.86	0.87	0.86	0.86	0.78	0.86	0.87	11.93

BSW mas

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0.25									
FRA	0.64	1.09								
NLD	0.83	0.73	3.46							
USA	0.90	0.59	0.87	0.23						
CHE	0.93	0.51	0.86	0.85	10.41					
DEA	0.92	0.47	0.87	0.87	0.98	11.89				
NZL	0.77	0.53	0.74	0.76	0.81	0.78	0.38			
ITA	0.92	0.61	0.86	0.87	0.96	0.93	0.76	13.21		
GBR	0.92	0.62	0.89	0.90	0.95	0.94	0.85	0.90	13.60	
SVN	0.87	0.51	0.70	0.86	0.86	0.86	0.77	0.86	0.87	11.93

GUE scs

	CAN	GBR	USA	AUS	NZL	ZAF
CAN	0.25					
GBR	0.92	13.27				
USA	0.94	0.91	0.27			
AUS	0.85	0.92	0.82	29.48		
NZL	0.78	0.87	0.78	0.96	0.63	
ZAF	0.89	0.90	0.88	0.88	0.86	24.04

HOL	scs																
	CAN	CHE	DEU	DFS	EST	FRA	FRR	GBR	NLD	USA	ISR	ITA	AUS	CHR	HUN	BEL	JPN
	ZAF	NZL	IRL	CZE	SVK	POL	LTU	LVA	PRT	KOR	SVN						
ESP																	
CAN	0.27																
CHE	0.91	11.34															
DEU	0.92	0.96	0.49														
DFS	0.92	0.95	0.96	11.91													
EST	0.87	0.90	0.94	0.93	13.56												
FRA	0.93	0.95	0.95	0.97	0.90	1.20											
FRR	0.91	0.92	0.94	0.93	0.91	0.96	1.10										
GBR	0.93	0.95	0.94	0.94	0.91	0.96	0.93	12.84									
NLD	0.91	0.95	0.95	0.95	0.91	0.94	0.95	0.97	4.70								
USA	0.95	0.87	0.89	0.88	0.90	0.90	0.89	0.90	0.87	0.23							
ISR	0.84	0.83	0.82	0.82	0.86	0.85	0.83	0.80	0.78	0.89	0.24						
ITA	0.91	0.92	0.94	0.93	0.93	0.93	0.90	0.90	0.88	0.90	0.87	5.87					
AUS	0.83	0.93	0.87	0.89	0.84	0.90	0.86	0.93	0.93	0.78	0.75	0.80	30.00				
CHR	0.86	0.97	0.91	0.91	0.87	0.90	0.90	0.91	0.91	0.85	0.79	0.85	0.91	10.34			
HUN	0.89	0.90	0.92	0.91	0.89	0.91	0.90	0.89	0.87	0.93	0.88	0.93	0.80	0.88	1.28		
BEL	0.92	0.96	0.96	0.96	0.93	0.96	0.94	0.95	0.94	0.90	0.82	0.95	0.89	0.92	0.93	0.49	
JPN	0.87	0.85	0.85	0.88	0.86	0.90	0.88	0.86	0.87	0.87	0.78	0.85	0.82	0.85	0.85	0.85	0.42
ESP	0.92	0.93	0.95	0.93	0.94	0.94	0.91	0.93	0.90	0.91	0.87	0.95	0.83	0.88	0.93	0.95	0.85
11.23																	
ZAF	0.90	0.91	0.90	0.91	0.90	0.91	0.87	0.92	0.89	0.90	0.86	0.92	0.88	0.87	0.92	0.92	0.86
0.95	26.66																
NZL	0.77	0.87	0.82	0.85	0.83	0.85	0.82	0.88	0.88	0.76	0.75	0.76	0.97	0.87	0.76	0.83	0.82
0.77	0.85	0.40															
IRL	0.88	0.96	0.93	0.93	0.89	0.94	0.90	0.96	0.94	0.85	0.78	0.88	0.96	0.93	0.87	0.95	0.85
0.90	0.91	0.93	0.11														
CZE	0.87	0.86	0.89	0.88	0.90	0.88	0.91	0.85	0.85	0.87	0.83	0.91	0.76	0.85	0.90	0.89	0.85
0.90	0.88	0.75	0.85	16.39													
SVK	0.85	0.88	0.90	0.89	0.89	0.90	0.88	0.87	0.86	0.88	0.84	0.88	0.78	0.87	0.95	0.90	0.85
0.93	0.89	0.76	0.85	0.89	0.41												
POL	0.89	0.90	0.92	0.92	0.90	0.92	0.92	0.89	0.87	0.87	0.81	0.92	0.83	0.86	0.89	0.93	0.85
0.92	0.89	0.79	0.89	0.89	0.86	10.08											
LTU	0.86	0.88	0.88	0.86	0.86	0.86	0.86	0.85	0.85	0.85	0.78	0.85	0.78	0.87	0.85	0.87	0.86
0.89	0.85	0.76	0.83	0.85	0.87	0.85	0.37										
LVA	0.87	0.91	0.94	0.92	0.93	0.90	0.88	0.89	0.89	0.85	0.78	0.91	0.85	0.87	0.87	0.94	0.86
0.89	0.87	0.84	0.90	0.87	0.86	0.94	0.89	0.48									
PRT	0.85	0.85	0.85	0.85	0.86	0.85	0.85	0.85	0.85	0.85	0.81	0.85	0.75	0.85	0.85	0.85	0.85
0.85	0.85	0.75	0.82	0.85	0.85	0.85	0.85	0.85	0.85	0.50							
KOR	0.89	0.87	0.87	0.90	0.90	0.89	0.86	0.89	0.86	0.87	0.79	0.88	0.82	0.85	0.85	0.89	0.85
0.90	0.87	0.79	0.84	0.85	0.85	0.89	0.86	0.90	0.85	0.34							
SVN	0.85	0.85	0.85	0.86	0.88	0.85	0.86	0.85	0.85	0.86	0.77	0.85	0.77	0.85	0.85	0.86	0.85
0.86	0.85	0.76	0.85	0.86	0.86	0.85	0.86	0.86	0.86	0.85	10.99						

HOL	mas																
	CAN	CHE	DEU	DFS	EST	FRA	FRR	GBR	NLD	USA	ISR	ITA	AUS	CHR	HUN	BEL	JPN
	ZAF	NZL	IRL	CZE	SVK	POL	LTU	LVA	PRT	KOR	SVN						
ESP																	
CAN	0.27																
CHE	0.91	11.34															
DEU	0.92	0.96	0.49														
DFS	0.81	0.76	0.81	12.33													
EST	0.87	0.89	0.93	0.82	13.56												
FRA	0.82	0.76	0.79	0.94	0.80	1.21											
FRR	0.65	0.60	0.59	0.81	0.69	0.82	1.03										
GBR	0.93	0.95	0.94	0.78	0.91	0.76	0.59	12.84									
NLD	0.90	0.90	0.94	0.85	0.90	0.84	0.72	0.90	4.60								
USA	0.95	0.87	0.89	0.83	0.90	0.82	0.71	0.90	0.89	0.23							
ISR	0.84	0.82	0.82	0.70	0.84	0.75	0.69	0.80	0.80	0.88	0.24						
ITA	0.91	0.92	0.94	0.81	0.93	0.83	0.68	0.90	0.91	0.90	0.86	5.87					
AUS	0.83	0.93	0.87	0.64	0.83	0.60	0.48	0.93	0.80	0.78	0.75	0.80	30.00				
CHR	0.86	0.97	0.91	0.68	0.86	0.70	0.58	0.91	0.85	0.84	0.80	0.85	0.91	10.34			
HUN	0.89	0.90	0.92	0.82	0.90	0.79	0.69	0.89	0.90	0.93	0.87	0.93	0.80	0.87	1.28		
BEL	0.92	0.95	0.96	0.84	0.93	0.84	0.65	0.95	0.94	0.90	0.82	0.95	0.87	0.90	0.93	0.49	
JPN	0.87	0.85	0.85	0.71	0.85	0.72	0.63	0.86	0.80	0.87	0.78	0.85	0.82	0.85	0.85	0.85	0.42
ESP	0.92	0.93	0.95	0.85	0.94	0.87	0.69	0.93	0.92	0.91	0.87	0.95	0.83	0.88	0.93	0.95	0.85
11.23																	
ZAF	0.91	0.91	0.90	0.79	0.89	0.81	0.66	0.92	0.89	0.90	0.86	0.92	0.88	0.87	0.92	0.92	0.86
0.95	26.61																
NZL	0.77	0.87	0.82	0.62	0.82	0.56	0.52	0.88	0.76	0.76	0.74	0.76	0.97	0.87	0.76	0.83	0.82
0.77	0.85	0.40															
IRL	0.88	0.96	0.93	0.77	0.89	0.75	0.62	0.96	0.89	0.85	0.78	0.88	0.95	0.93	0.87	0.95	0.85
0.90	0.91	0.92	0.11														
CZE	0.87	0.86	0.89	0.77	0.90	0.78	0.74	0.85	0.87	0.86	0.83	0.91	0.76	0.85	0.90	0.89	0.85
0.90	0.88	0.75	0.85	16.39													
SVK	0.85	0.88	0.90	0.78	0.89	0.79	0.66	0.86	0.87	0.88	0.82	0.88	0.78	0.87	0.95	0.91	0.85
0.92	0.89	0.75	0.85	0.89	0.41												
POL	0.90	0.91	0.93	0.80	0.90	0.84	0.69	0.89	0.89	0.87	0.82	0.93	0.83	0.86	0.89	0.92	0.85
0.92	0.90	0.79	0.90	0.89	0.87	10.08											
LTU	0.85	0.88	0.88	0.76	0.86	0.77	0.63	0.85	0.81	0.85	0.78	0.85	0.78	0.86	0.85	0.87	0.85
0.88	0.84	0.76	0.83	0.85	0.87	0.85	0.37										
LVA	0.86	0.90	0.94	0.79	0.93	0.77	0.63	0.87	0.89	0.85	0.77	0.90	0.83	0.86	0.86	0.93	0.85
0.88	0.85	0.82	0.88	0.86	0.86	0.93	0.89	0.48									
PRT	0.85	0.85	0.85	0.72	0.86	0.76	0.66	0.85	0.79	0.85	0.81	0.85	0.75	0.85	0.85	0.85	0.85
0.85	0.85	0.75	0.82	0.85	0.85	0.85	0.85	0.85	0.50								
KOR	0.89	0.87	0.87	0.79	0.89	0.84	0.69	0.89	0.84	0.87	0.80	0.88	0.81	0.85	0.85	0.90	0.85
0.90	0.87	0.78	0.85	0.85	0.85	0.89	0.85	0.87	0.85	0.34							
SVN	0.85	0.85	0.85	0.76	0.87	0.75	0.60	0.85	0.78	0.86	0.76	0.85	0.77	0.85	0.85	0.85	0.85
0.86	0.84	0.75	0.84	0.85	0.86	0.85	0.86	0.86	0.85	0.84	10.99						

JER scs								
	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL
CAN	0.23							
DFS	0.88	12.47						
GBR	0.91	0.92	11.42					
NLD	0.91	0.93	0.96	4.34				
USA	0.92	0.85	0.88	0.87	0.21			
AUS	0.78	0.87	0.88	0.91	0.78	29.05		
ZAF	0.87	0.85	0.89	0.91	0.86	0.89	20.66	
NZL	0.76	0.78	0.83	0.85	0.75	0.96	0.84	0.38

JER mas								
	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL
CAN	0.23							
DFS	0.75	12.51						
GBR	0.91	0.70	11.42					
NLD	0.86	0.82	0.89	3.85				
USA	0.92	0.77	0.88	0.86	0.21			
AUS	0.79	0.58	0.88	0.82	0.78	29.05		
ZAF	0.87	0.67	0.89	0.88	0.86	0.88	20.66	
NZL	0.76	0.46	0.83	0.76	0.75	0.96	0.84	0.38

RDC scs													
	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD
CAN	0.26												
DFS	0.92	12.67											
GBR	0.93	0.92	11.54										
NOR	0.91	0.90	0.88	11.74									
USA	0.94	0.89	0.89	0.87	0.25								
DEU	0.92	0.93	0.94	0.89	0.89	0.45							
AUS	0.87	0.92	0.91	0.88	0.79	0.88	31.20						
EST	0.88	0.93	0.91	0.89	0.90	0.94	0.88	11.61					
ZAF	0.87	0.83	0.89	0.90	0.88	0.90	0.81	0.91	25.45				
NZL	0.78	0.87	0.84	0.85	0.76	0.83	0.96	0.84	0.79	0.41			
LTU	0.87	0.85	0.89	0.87	0.87	0.87	0.82	0.91	0.89	0.80	0.35		
LVA	0.88	0.86	0.90	0.87	0.86	0.93	0.89	0.95	0.88	0.86	0.89	0.43	
NLD	0.91	0.93	0.96	0.93	0.87	0.95	0.91	0.91	0.89	0.87	0.87	0.89	4.11

RDC	mas												
	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD
CAN	0.26												
DFS	0.71	13.37											
GBR	0.92	0.70	11.54										
NOR	0.89	0.56	0.87	11.74									
USA	0.94	0.73	0.88	0.87	0.25								
DEU	0.91	0.73	0.93	0.88	0.88	0.45							
AUS	0.85	0.59	0.90	0.87	0.78	0.88	31.29						
EST	0.88	0.69	0.90	0.87	0.90	0.94	0.87	11.61					
ZAF	0.87	0.77	0.89	0.86	0.87	0.90	0.81	0.90	25.05				
NZL	0.79	0.62	0.85	0.83	0.76	0.83	0.96	0.84	0.79	0.41			
LTU	0.87	0.63	0.89	0.87	0.86	0.87	0.84	0.89	0.87	0.81	0.35		
LVA	0.87	0.64	0.89	0.88	0.86	0.94	0.88	0.96	0.86	0.85	0.89	0.43	
NLD	0.90	0.85	0.89	0.77	0.87	0.93	0.79	0.86	0.88	0.76	0.74	0.82	3.24

SIM	scs									
	FRM	FRA	ITA	NLD	CHE	DEA	HUN	CZE	SVK	SVN
FRM	1.08									
FRA	0.92	1.00								
ITA	0.96	0.91	14.80							
NLD	0.92	0.94	0.87	4.31						
CHE	0.92	0.93	0.90	0.92	10.14					
DEA	0.95	0.92	0.93	0.93	0.94	12.06				
HUN	0.91	0.91	0.92	0.88	0.91	0.91	16.33			
CZE	0.90	0.88	0.87	0.85	0.86	0.85	0.89	16.03		
SVK	0.87	0.88	0.90	0.86	0.87	0.85	0.92	0.88	0.38	
SVN	0.87	0.86	0.86	0.86	0.87	0.86	0.87	0.86	0.86	9.82

SIM	mas									
	FRM	FRA	ITA	NLD	CHE	DEA	HUN	CZE	SVK	SVN
FRM	1.08									
FRA	0.92	1.00								
ITA	0.96	0.88	14.80							
NLD	0.87	0.86	0.87	3.56						
CHE	0.92	0.82	0.90	0.85	10.14					
DEA	0.95	0.91	0.93	0.89	0.94	12.06				
HUN	0.91	0.85	0.92	0.88	0.90	0.90	16.33			
CZE	0.88	0.86	0.87	0.85	0.86	0.85	0.89	16.03		
SVK	0.87	0.86	0.90	0.81	0.87	0.85	0.92	0.90	0.38	
SVN	0.87	0.85	0.86	0.69	0.87	0.85	0.87	0.86	0.86	9.82

 ^LAPPENDIX II. Number of common bulls

BSW

 common bulls below diagonal

common three quarter sib group above diagonal

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0	70	42	133	99	104	18	89	52	24
FRA	63	0	67	112	129	169	16	144	42	41
NLD	39	54	0	63	68	115	16	95	28	33
USA	132	73	57	0	275	277	22	185	66	30
CHE	82	92	63	258	0	481	16	344	53	52
DEA	90	126	109	245	388	0	25	483	55	79
NZL	18	12	10	20	14	20	0	17	12	7
ITA	77	111	78	126	296	388	13	0	49	70
GBR	55	37	25	68	45	40	10	38	0	16
SVN	22	41	33	25	51	74	5	71	14	0

 BSW

 common bulls below diagonal

common three quarter sib group above diagonal

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0	61	38	133	99	104	18	89	52	24
FRA	55	0	47	96	125	150	12	130	38	36
NLD	33	38	0	55	56	88	15	75	26	29
USA	132	64	45	0	275	277	22	185	66	30
CHE	82	90	52	258	0	481	16	344	53	52
DEA	90	110	78	245	388	0	25	483	55	79
NZL	18	9	9	20	14	20	0	17	12	7
ITA	77	102	57	126	296	388	13	0	49	70
GBR	55	36	22	68	45	40	10	38	0	16
SVN	22	36	27	25	51	74	5	71	14	0

 GUE

 common bulls below diagonal

common three quarter sib group above diagonal

	CAN	GBR	USA	AUS	NZL	ZAF
CAN	0	26	60	41	12	1
GBR	21	0	69	32	13	3
USA	51	72	0	53	28	6
AUS	38	25	49	0	25	3
NZL	10	11	28	25	0	2
ZAF	0	2	3	2	0	0

HOL

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	CHE	DEU	DFS	EST	FRA	FRR	GBR	NLD	USA	ISR	ITA	AUS	CHR	HUN	BEL	JPN	ESP	ZAF	NZL	IRL	CZE	SVK	POL	LTU	LVA	PRT	KOR	SVN
CAN	0	417	1815	970	150	1041	13	1132	988	2278	67	1244	956	362	659	354	996	932	393	523	334	725	312	800	122	188	748	427	112
CHE	280	0	524	357	57	349	11	372	390	451	34	369	318	401	244	229	248	319	182	225	209	262	100	294	56	87	306	139	65
DEU	904	420	0	2300	287	2028	122	1650	2775	2904	111	2229	1322	595	964	613	1208	1207	496	771	613	1423	599	1597	298	307	1044	424	195
DFS	607	292	1182	0	188	1329	44	1183	1587	1599	100	1333	985	326	686	426	751	773	418	650	520	915	330	1072	184	210	784	339	166
EST	78	25	194	106	0	162	19	158	257	235	38	181	147	70	131	79	133	125	77	95	86	172	84	198	40	87	141	67	56
FRA	551	310	850	547	66	0	22	1226	1556	2061	93	1552	990	279	701	481	970	850	397	638	514	913	314	1084	136	177	763	346	125
FRR	7	9	98	30	16	18	0	22	81	28	4	25	21	35	9	31	6	14	10	10	10	31	23	60	1	22	21	2	14
GBR	1184	334	1038	753	87	645	16	0	1329	1614	92	1242	1044	313	652	433	783	806	427	700	632	742	285	879	143	176	788	340	143
NLD	753	371	2234	1160	182	791	51	1021	0	1936	108	1450	1137	488	726	647	811	838	429	808	609	1068	423	1180	162	223	898	326	165
USA	1973	352	1573	964	148	928	15	1228	1482	0	111	2196	1401	477	953	465	1562	1165	539	847	527	1192	424	1326	183	260	1036	586	150
ISR	39	23	91	80	26	48	3	63	87	90	0	101	74	25	73	40	72	79	51	78	61	78	33	87	23	27	84	38	34
ITA	672	293	1225	805	98	662	21	796	996	1101	74	0	972	338	789	428	980	989	435	625	460	975	332	1117	165	225	857	419	164
AUS	816	271	816	596	61	581	16	806	912	1208	53	582	0	286	534	400	659	644	399	942	491	617	233	689	124	159	640	288	119
CHR	299	441	515	279	37	258	25	292	459	453	14	291	245	0	206	243	197	253	145	193	181	243	127	286	41	99	265	109	65
HUN	534	193	732	514	79	453	8	552	591	866	57	628	385	172	0	269	532	564	322	385	294	663	248	660	116	138	578	311	106
BEL	295	207	507	330	45	418	27	355	667	340	24	325	296	219	205	0	257	334	199	273	252	292	142	353	61	94	357	129	88
JPN	390	147	400	346	44	290	4	337	364	580	33	368	312	139	303	134	0	687	343	422	289	603	237	664	108	147	554	371	104
ESP	458	262	718	531	61	574	8	628	716	674	54	685	434	208	448	299	286	0	370	412	343	608	237	703	132	164	674	308	122
ZAF	325	158	374	308	39	264	6	369	364	507	38	322	334	121	266	156	229	330	0	313	243	288	148	315	67	92	371	205	71
NZL	512	195	546	407	49	334	7	567	715	763	65	422	914	160	306	201	198	305	251	0	488	433	196	456	101	110	479	212	86
IRL	255	196	443	357	39	333	7	560	487	396	44	326	373	164	238	216	143	304	200	366	0	315	144	370	77	94	365	125	73
CZE	415	160	949	497	104	468	25	424	838	784	56	570	332	167	571	186	224	377	181	269	179	0	335	892	129	182	592	324	132
SVK	200	51	442	163	41	157	12	153	272	264	12	174	108	67	175	76	79	116	84	119	73	245	0	313	53	95	256	140	57
POL	512	215	1185	749	134	545	56	612	945	1027	67	766	441	231	555	265	302	471	226	304	248	647	193	0	173	238	747	361	144
LTU	47	17	287	91	13	27	0	58	79	98	12	83	37	13	60	18	21	58	20	43	29	77	26	119	0	67	131	72	29
LVA	107	49	208	130	62	78	19	100	146	208	19	151	75	66	99	53	62	91	54	54	51	118	45	182	47	0	192	97	45
PRT	754	280	991	694	96	676	19	759	955	1081	70	818	504	250	575	341	323	706	357	413	333	484	187	749	82	152	0	342	120
KOR	367	84	257	217	33	177	0	239	202	642	21	317	195	70	251	67	204	206	155	146	74	226	85	276	34	59	288	0	62
SVN	79	44	171	137	34	88	13	105	141	118	28	140	86	45	84	71	57	94	54	62	53	99	37	127	15	28	102	30	0

HOL

common bulls below diagonal

common three quarter sib group above diagonal

	CAN	CHE	DEU	DFS	EST	FRA	FRR	GBR	NLD	USA	ISR	ITA	AUS	CHR	HUN	BEL	JPN	ESP	ZAF	NZL	IRL	CZE	SVK	POL	LTU	LVA	PRT	KOR	SVN
CAN	0	417	1815	899	150	723	6	1132	895	2278	67	1244	956	362	659	354	996	932	393	523	334	725	309	800	122	188	748	427	112
CHE	280	0	524	346	57	297	8	372	373	451	34	369	318	401	244	229	248	319	182	225	209	262	99	294	56	87	306	139	65
DEU	904	420	0	2175	287	1480	63	1650	2610	2902	111	2229	1322	595	964	613	1208	1207	495	771	613	1423	595	1596	298	307	1044	424	195
DFS	518	280	1033	0	176	973	24	1125	1400	1495	96	1266	929	298	649	410	716	743	407	619	509	861	307	1000	178	200	747	314	159
EST	78	25	194	96	0	125	14	158	246	235	38	181	147	70	131	79	133	125	77	95	86	172	84	198	40	87	141	67	56
FRA	419	256	559	402	54	0	9	915	1101	1368	78	1178	731	236	588	396	707	690	314	475	411	773	241	926	110	144	625	277	104
FRR	4	8	48	21	13	8	0	14	47	18	3	16	13	22	5	20	1	9	7	5	6	23	17	45	0	17	15	1	12
GBR	1184	334	1038	684	87	491	11	0	1266	1614	92	1242	1044	313	652	433	783	806	426	700	632	742	281	879	143	176	788	340	143
NLD	636	348	2018	916	174	521	34	933	0	1823	105	1359	1090	460	691	628	772	790	411	788	596	1015	404	1124	155	210	848	315	161
USA	1973	352	1573	822	148	513	11	1228	1311	0	111	2196	1401	477	953	465	1562	1165	538	847	527	1192	421	1325	183	260	1035	586	150
ISR	39	23	91	72	26	43	3	63	85	90	0	101	74	25	73	40	72	79	51	78	61	78	32	87	23	27	84	38	34
ITA	672	293	1225	726	98	474	15	796	865	1101	74	0	972	338	789	428	980	989	434	625	460	975	328	1116	165	225	857	419	164
AUS	816	271	816	526	61	440	11	806	841	1208	53	582	0	286	534	400	659	844	398	942	491	617	231	689	124	159	640	288	119
CHR	299	441	515	253	37	217	20	292	418	453	14	291	245	0	206	243	197	253	145	193	181	243	126	286	41	99	265	109	65
HUN	534	193	732	477	79	379	5	552	533	866	57	628	385	172	0	269	532	564	322	385	294	663	247	660	116	138	578	311	106
BEL	295	207	507	310	45	334	19	355	632	340	24	325	296	219	205	0	257	334	199	273	252	292	141	353	61	94	357	129	88
JPN	390	147	400	316	44	242	1	337	334	580	33	368	312	139	303	134	0	687	343	422	289	603	235	664	108	147	554	371	104
ESP	458	262	718	494	61	485	7	628	646	674	54	685	434	208	448	299	286	0	370	412	343	608	236	703	132	164	674	308	122
ZAF	325	158	374	294	39	224	5	369	336	507	38	322	334	121	266	156	229	330	0	313	243	288	147	315	67	92	371	205	71
NZL	512	195	546	380	49	263	4	567	682	763	65	422	914	160	306	201	198	305	251	0	488	433	195	456	101	110	479	212	86
IRL	255	196	443	340	39	288	5	560	462	396	44	326	373	164	238	216	143	304	200	366	0	315	143	369	77	94	365	125	73
CZE	415	160	949	447	104	356	19	424	765	784	56	570	332	167	571	186	224	377	181	269	179	0	333	892	129	182	592	324	132
SVK	200	51	442	146	41	115	10	153	256	264	12	174	108	67	175	76	79	116	84	119	73	245	0	311	52	94	255	139	57
POL	512	215	1185	669	134	461	47	612	869	1027	67	766	441	231	555	265	302	471	226	304	248	647	193	0	173	238	747	361	144
LTU	47	17	287	81	13	22	0	58	69	98	12	83	37	13	60	18	21	58	20	43	29	77	26	119	0	67	131	72	29
LVA	107	49	208	120	62	67	15	100	127	208	19	151	75	66	99	53	62	91	54	54	51	118	45	182	47	0	192	97	45
PRT	754	280	991	646	96	569	15	759	889	1081	70	818	504	250	575	341	323	706	357	413	333	484	187	749	82	152	0	342	120
KOR	367	84	257	194	33	146	0	239	183	642	21	317	195	70	251	67	204	206	155	146	74	226	85	276	34	59	288	0	62
SVN	79	44	171	128	34	76	11	105	137	118	28	140	86	45	84	71	57	94	54	62	53	99	37	127	15	28	102	30	0

JER

common bulls below diagonal

common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL
CAN	0	64	114	28	272	174	106	130
DFS	48	0	118	60	136	104	109	106
GBR	118	106	0	58	171	158	129	157
NLD	22	58	53	0	64	53	56	57
USA	282	108	190	68	0	370	220	289
AUS	180	68	164	46	401	0	175	330
ZAF	103	85	128	51	233	168	0	159
NZL	140	76	157	49	357	366	163	0

JER

 common bulls below diagonal

common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL
CAN	0	57	114	22	272	174	106	130
DFS	41	0	112	43	126	95	101	98
GBR	118	100	0	43	171	158	129	157
NLD	16	36	39	0	50	45	47	46
USA	282	88	190	54	0	370	220	289
AUS	180	57	164	41	401	0	175	330
ZAF	103	75	128	43	233	168	0	159
NZL	140	65	157	38	357	366	163	0

RDC

 common bulls below diagonal

common three quarter sib group above diagonal

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD
CAN	0	102	57	4	153	11	80	1	65	65	12	7	4
DFS	98	0	45	87	121	55	133	68	46	127	94	89	29
GBR	58	44	0	11	63	5	43	1	30	43	10	5	11
NOR	4	67	12	0	40	16	42	10	0	28	20	16	24
USA	140	119	59	39	0	16	83	7	53	70	23	9	22
DEU	10	45	5	15	16	0	31	20	1	12	29	28	13
AUS	80	109	41	35	83	29	0	15	28	105	39	26	17
EST	1	57	1	9	5	18	15	0	0	3	21	33	8
ZAF	67	43	26	0	48	1	28	0	0	29	5	1	3
NZL	63	125	40	27	71	12	107	2	25	0	22	12	7
LTU	12	78	9	15	17	28	35	20	5	18	0	36	11
LVA	7	59	5	14	8	23	25	27	1	10	32	0	9
NLD	4	29	11	23	20	12	15	7	3	7	10	8	0

RDC

 common bulls below diagonal

common three quarter sib group above diagonal

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD
CAN	0	94	57	4	153	11	80	1	26	65	12	7	3
DFS	88	0	43	89	115	55	151	68	15	125	94	90	28
GBR	58	41	0	11	63	5	43	1	16	43	10	5	9
NOR	4	68	12	0	40	16	42	10	0	28	20	16	22
USA	140	113	59	39	0	16	83	7	23	70	23	9	20
DEU	10	45	5	15	16	0	31	20	1	12	29	28	13
AUS	80	130	41	35	83	29	0	15	12	105	39	26	16
EST	1	57	1	9	5	18	15	0	0	3	21	33	8
ZAF	19	13	14	0	18	1	12	0	0	12	2	1	0
NZL	63	121	40	27	71	12	107	2	11	0	22	12	6
LTU	12	78	9	15	17	28	35	20	2	18	0	36	10
LVA	7	59	5	14	8	23	25	27	1	10	32	0	7
NLD	3	28	9	21	18	12	14	7	0	6	9	6	0

SIM

common bulls below diagonal

common three quarter sib group above diagonal

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	CZE	SVK	SVN
FRM	0	2	140	100	149	95	2	139	52	20
FRA	1	0	83	30	11	160	3	39	38	40
ITA	165	72	0	122	72	542	9	177	111	74
NLD	123	29	120	0	69	132	2	104	44	28
CHE	192	6	74	73	0	233	1	64	27	12
DEA	106	122	445	136	206	0	24	347	299	149
HUN	0	2	6	2	0	13	0	3	6	5
CZE	149	29	143	98	53	308	3	0	75	44
SVK	52	30	95	37	19	302	5	66	0	44
SVN	20	36	70	27	12	130	4	42	43	0

SIM

common bulls below diagonal

common three quarter sib group above diagonal

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	CZE	SVK	SVN
FRM	0	2	140	88	149	95	2	139	52	20
FRA	1	0	81	29	11	158	3	38	38	39
ITA	165	71	0	104	72	542	9	177	111	74
NLD	107	27	104	0	63	110	2	95	40	24
CHE	192	6	74	66	0	233	1	64	27	12
DEA	106	121	445	112	206	0	24	347	299	149
HUN	0	2	6	2	0	13	0	3	6	5
CZE	148	29	143	90	53	308	3	0	75	44
SVK	52	30	95	34	19	302	5	66	0	44
SVN	20	35	70	23	12	130	4	42	43	0
