

Interbull Routine Genetic Evaluation for Production Traits

August 2014

Introduction

The latest international evaluation for dairy production traits took place as scheduled at the Interbull Centre. Data from thirty one (30) countries were included in this evaluation.

International genetic evaluations for milk, fat and protein yields of bulls from Australia, Austria-Germany, Belgium, Canada, 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, Argentina and Uruguay were computed. Brown Swiss, Guernsey, Holstein, Jersey, Red Dairy Cattle and Simmental breed data were included in this evaluation.

Changes in national procedures

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

CHE HOL/SIM	Breeding association for Holstein (mainly red&white) and Simmental revised their breed code assignment for Holstein X Simmental crossbreds.
DEA BSW/SIM	We have a rolling base change each evaluation, i.e. base animal group is moved by 4 month each evaluation
GBR BSW/GUE HOL/JER RDC/SIM	Base change
NOR RDC	Base change
NZL HOL/JER RDC/BSW GUE	Changed in herd/dtr numbers due to parentage verification

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 dairy production traits (August Routine Evaluation 2014). Number of records for milk yield by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
ARG			1313			
AUS		125	6618	1487	604	
BEL			994			
CAN	193	91	10196	544	700	
CHE	2780		1148			3122
CHR			1850			
CZE			3615			2936
DEA	5374					18711
DEU			24619	114	381	
DFS			11624	1892	6943	
ESP			2823			
EST			855		358	
FRA	322		15253			359
FRM						4043
FRR			165			
GBR	113	304	5979	792	508	81
HUN			2717			189
IRL			1957	98	34	80
ISR			1147			
ITA	1870		8909	156		1254
JPN			4814			
KOR			971			
LTU			550		362	
LVA			772		651	
NLD	145		13401	108	48	249
NOR					3603	
NZL	44	57	6263	4079	1166	
POL			7918			
PRT			2131			
SVK			962			521
SVN	345		370			546
URY			787			
USA	951	721	32285	3652	581	
ZAF		37	1171	633	135	
No. Records	12137	1335	174177	13555	16074	32091
Pub. Proofs	10030	1070	137237	11180	14567	28591

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

BSW mil

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR
CAN	657.94									
FRA	0.89	649.41								
USA	0.91	0.89	694.57							
CHE	0.90	0.91	0.86	475.11						
ITA	0.92	0.86	0.89	0.88	572.43					
DEA	0.86	0.86	0.86	0.93	0.90	461.98				
NLD	0.91	0.89	0.89	0.89	0.87	0.87	521.22			
SVN	0.87	0.86	0.87	0.86	0.86	0.86	0.87	10.31		
NZL	0.76	0.76	0.76	0.77	0.76	0.77	0.76	0.78	334.97	
GBR	0.86	0.87	0.86	0.88	0.86	0.86	0.89	0.87	0.76	260.88

BSW fat

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR
CAN	28.78									
FRA	0.89	27.45								
USA	0.90	0.89	26.43							
CHE	0.87	0.89	0.86	18.97						
ITA	0.91	0.86	0.88	0.88	22.08					
DEA	0.86	0.86	0.86	0.93	0.89	17.59				
NLD	0.90	0.88	0.88	0.88	0.85	0.87	24.13			
SVN	0.87	0.86	0.87	0.86	0.86	0.86	0.87	10.33		
NZL	0.76	0.76	0.76	0.77	0.76	0.80	0.76	0.78	14.65	
GBR	0.86	0.89	0.87	0.87	0.86	0.86	0.88	0.87	0.76	10.05

BSW pro

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR
CAN	23.72									
FRA	0.87	21.08								
USA	0.89	0.88	20.59							
CHE	0.87	0.88	0.85	14.86						
ITA	0.88	0.86	0.87	0.88	20.04					
DEA	0.86	0.85	0.85	0.91	0.89	14.41				
NLD	0.89	0.86	0.86	0.87	0.85	0.86	16.99			
SVN	0.87	0.86	0.87	0.86	0.86	0.86	0.87	9.56		
NZL	0.76	0.76	0.76	0.77	0.76	0.77	0.76	0.78	10.33	
GBR	0.86	0.87	0.86	0.87	0.86	0.86	0.88	0.87	0.76	7.57

GUE mil

	CAN	USA	AUS	GBR	ZAF	NZL
CAN	711.15					
USA	0.94	807.62				
AUS	0.85	0.78	633.99			
GBR	0.87	0.86	0.80	235.00		

ZAF	0.86	0.86	0.81	0.86	342.78	
NZL	0.76	0.76	0.87	0.76	0.76	331.35

GUE fat

	CAN	USA	AUS	GBR	ZAF	NZL
CAN	27.91					
USA	0.94	29.21				
AUS	0.81	0.76	19.52			
GBR	0.87	0.86	0.77	9.93		
ZAF	0.86	0.86	0.76	0.86	13.17	
NZL	0.77	0.76	0.87	0.76	0.76	16.51

GUE pro

	CAN	USA	AUS	GBR	ZAF	NZL
CAN	21.51					
USA	0.91	22.34				
AUS	0.78	0.75	14.04			
GBR	0.86	0.86	0.77	6.32		
ZAF	0.86	0.86	0.77	0.86	10.42	
NZL	0.76	0.76	0.87	0.76	0.76	11.01

HOL	mil																
	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	BEL	IRL	ESP	CZE	SVN	EST
	CHR	FRR	HUN	POL	ZAF	JPN	LVA	SVK	LTU	PRT	KOR	URY	ARG				
ISR																	
CAN	783.70																
DEU	0.91	621.74															
DFS	0.94	0.93	11.20														
FRA	0.92	0.89	0.92	673.62													
ITA	0.91	0.88	0.90	0.89	575.68												
NLD	0.93	0.93	0.94	0.92	0.88	653.01											
USA	0.93	0.90	0.93	0.92	0.92	0.91	746.63										
CHE	0.92	0.91	0.93	0.96	0.89	0.89	0.89	559.85									
GBR	0.87	0.85	0.89	0.87	0.85	0.89	0.86	0.90	269.14								
NZL	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	316.04							
AUS	0.82	0.78	0.80	0.85	0.77	0.83	0.78	0.86	0.81	0.86	468.93						
BEL	0.86	0.87	0.85	0.85	0.85	0.88	0.85	0.85	0.85	0.75	0.81	476.43					
IRL	0.85	0.82	0.84	0.91	0.80	0.87	0.84	0.88	0.82	0.85	0.86	0.83	169.89				
ESP	0.93	0.90	0.92	0.92	0.90	0.92	0.92	0.92	0.85	0.75	0.82	0.87	0.85	546.52			
CZE	0.85	0.86	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.85	0.75	0.85	535.58		
SVN	0.86	0.85	0.86	0.85	0.85	0.85	0.86	0.86	0.86	0.76	0.76	0.86	0.77	0.85	0.86	11.95	
EST	0.86	0.85	0.89	0.86	0.86	0.85	0.86	0.86	0.86	0.76	0.76	0.86	0.78	0.86	0.86	0.87	681.41
ISR	0.78	0.79	0.80	0.79	0.79	0.81	0.80	0.80	0.76	0.76	0.76	0.76	0.76	0.82	0.76	0.77	0.77
353.53																	
CHR	0.90	0.89	0.91	0.93	0.88	0.91	0.88	0.97	0.88	0.76	0.84	0.85	0.86	0.89	0.85	0.86	0.87
0.79	528.18																
FRR	0.87	0.90	0.89	0.90	0.86	0.87	0.86	0.90	0.87	0.80	0.84	0.89	0.81	0.88	0.92	0.88	0.88
0.80	0.89	683.67															
HUN	0.87	0.85	0.88	0.88	0.90	0.86	0.90	0.85	0.85	0.75	0.75	0.85	0.78	0.87	0.85	0.86	0.86
0.77	0.85	0.88	644.88														
POL	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.85	0.75	0.85	0.85	0.86	0.86
0.76	0.85	0.88	0.85	440.33													
ZAF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.84	0.85	0.77	0.85	0.85	0.86	0.86
0.83	0.85	0.88	0.85	0.85	525.34												
JPN	0.88	0.87	0.88	0.85	0.85	0.86	0.89	0.86	0.85	0.75	0.78	0.85	0.80	0.87	0.85	0.86	0.86
0.84	0.87	0.87	0.85	0.85	0.85	0.85	783.76										
LVA	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.76	0.76	0.85	0.76	0.85	0.85	0.87	0.86
0.77	0.86	0.87	0.86	0.85	0.86	0.85	426.75										
SVK	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.75	0.76	0.85	0.77	0.85	0.85	0.87	0.87
0.79	0.86	0.88	0.86	0.85	0.86	0.85	0.86	407.19									
LTU	0.86	0.85	0.86	0.86	0.86	0.86	0.86	0.87	0.86	0.76	0.77	0.86	0.76	0.85	0.86	0.87	0.87
0.78	0.87	0.90	0.86	0.86	0.86	0.86	0.86	0.87	338.53								
PRT	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.85	0.75	0.85	0.85	0.86	0.86
0.76	0.85	0.86	0.85	0.85	0.85	0.85	0.85	0.85	0.86	621.34							
KOR	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.75	0.77	0.85	0.76	0.85	0.85	0.87	0.87
0.77	0.86	0.90	0.85	0.85	0.85	0.85	0.86	0.86	0.87	0.85	473.03						
URY	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.77	0.79	0.85	0.77	0.85	0.85	0.87	0.87
0.78	0.86	0.90	0.85	0.85	0.85	0.85	0.86	0.86	0.87	0.85	0.85	160.40					
ARG	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.75	0.76	0.85	0.75	0.85	0.85	0.87	0.87
0.78	0.86	0.90	0.85	0.85	0.85	0.85	0.86	0.86	0.87	0.85	0.85	0.85	181.01				

HOL	fat																	
	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	BEL	IRL	ESP	CZE	SVN	EST	
	CHR	FRR	HUN	POL	ZAF	JPN	LVA	SVK	LTU	PRT	KOR	URY	ARG					
ISR																		
CAN	30.49																	
DEU	0.91	24.21																
DFS	0.93	0.91	11.26															
FRA	0.93	0.89	0.92	27.08														
ITA	0.91	0.86	0.86	0.88	23.53													
NLD	0.91	0.92	0.91	0.90	0.85	24.83												
USA	0.94	0.89	0.91	0.92	0.92	0.89	27.68											
CHE	0.90	0.88	0.93	0.92	0.85	0.91	0.88	21.19										
GBR	0.86	0.86	0.88	0.89	0.85	0.89	0.87	0.88	9.72									
NZL	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	12.75								
AUS	0.79	0.75	0.76	0.83	0.75	0.77	0.76	0.80	0.77	0.85	18.43							
BEL	0.85	0.87	0.85	0.85	0.85	0.87	0.85	0.85	0.85	0.75	0.80	19.81						
IRL	0.80	0.76	0.83	0.87	0.75	0.84	0.78	0.83	0.78	0.85	0.85	0.85	6.09					
ESP	0.92	0.89	0.88	0.91	0.90	0.90	0.92	0.89	0.85	0.75	0.79	0.85	0.80	21.65				
CZE	0.87	0.87	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.85	0.75	0.86	21.51			
SVN	0.86	0.85	0.86	0.86	0.85	0.85	0.86	0.86	0.86	0.76	0.76	0.86	0.76	0.85	0.86	11.94		
EST	0.87	0.86	0.91	0.87	0.86	0.86	0.86	0.87	0.86	0.78	0.79	0.86	0.83	0.86	0.86	0.87	24.77	
ISR	0.76	0.76	0.76	0.76	0.78	0.76	0.81	0.77	0.76	0.76	0.76	0.76	0.76	0.78	0.76	0.77	0.77	
13.99																		
CHR	0.88	0.88	0.90	0.91	0.85	0.89	0.87	0.96	0.87	0.75	0.76	0.85	0.82	0.86	0.85	0.86	0.88	
0.78	21.58																	
FRR	0.88	0.86	0.86	0.88	0.87	0.86	0.87	0.87	0.86	0.79	0.83	0.90	0.79	0.89	0.90	0.88	0.88	
0.79	0.86	24.27																
HUN	0.88	0.86	0.85	0.89	0.92	0.85	0.92	0.85	0.85	0.75	0.75	0.85	0.75	0.89	0.85	0.86	0.86	
0.77	0.85	0.88	23.30															
POL	0.87	0.87	0.85	0.86	0.86	0.85	0.85	0.85	0.85	0.75	0.75	0.85	0.75	0.90	0.86	0.86	0.86	
0.76	0.85	0.88	0.85	16.43														
ZAF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.85	0.75	0.85	0.85	0.86	0.86	
0.76	0.85	0.89	0.85	0.85	18.39													
JPN	0.89	0.85	0.89	0.86	0.85	0.86	0.88	0.87	0.85	0.75	0.75	0.85	0.79	0.85	0.85	0.86	0.87	
0.76	0.89	0.87	0.85	0.85	0.85	27.22												
LVA	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.76	0.76	0.86	0.76	0.85	0.85	0.87	0.86	
0.77	0.86	0.87	0.86	0.85	0.86	0.86	18.10											
SVK	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.76	0.76	0.85	0.76	0.85	0.85	0.87	0.87	
0.79	0.86	0.88	0.85	0.85	0.86	0.86	0.86	15.13										
LTU	0.86	0.85	0.86	0.86	0.86	0.86	0.86	0.87	0.86	0.76	0.76	0.86	0.76	0.86	0.86	0.87	0.88	
0.78	0.88	0.92	0.86	0.86	0.87	0.87	0.86	0.87	14.38									
PRT	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.85	0.75	0.85	0.85	0.86	0.86	
0.76	0.85	0.87	0.85	0.85	0.85	0.85	0.85	0.85	0.86	25.40								
KOR	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.75	0.77	0.86	0.76	0.85	0.85	0.87	0.87	
0.79	0.86	0.92	0.85	0.85	0.85	0.85	0.86	0.86	0.87	0.85	19.05							
URY	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.76	0.80	0.85	0.78	0.85	0.85	0.87	0.87	
0.78	0.86	0.89	0.85	0.85	0.85	0.85	0.86	0.86	0.87	0.85	0.85	6.18						
ARG	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.75	0.75	0.85	0.75	0.85	0.85	0.87	0.87	
0.78	0.86	0.91	0.85	0.85	0.85	0.85	0.86	0.86	0.87	0.85	0.85	0.85	5.92					

HOL	pro																	
	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	BEL	IRL	ESP	CZE	SVN	EST	
ISR	CHR	FRR	HUN	POL	ZAF	JPN	LVA	SVK	LTU	PRT	KOR	URY	ARG					
CAN	21.78																	
DEU	0.88	17.87																
DFS	0.92	0.92	10.86															
FRA	0.89	0.85	0.91	18.54														
ITA	0.88	0.85	0.89	0.86	17.79													
NLD	0.90	0.90	0.90	0.86	0.85	18.06												
USA	0.91	0.87	0.92	0.90	0.90	0.86	19.60											
CHE	0.89	0.86	0.91	0.93	0.86	0.89	0.86	15.57										
GBR	0.86	0.85	0.89	0.87	0.85	0.89	0.86	0.88	7.23									
NZL	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	9.15								
AUS	0.75	0.75	0.75	0.77	0.75	0.75	0.75	0.81	0.77	0.85	10.63							
BEL	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	13.95						
IRL	0.77	0.75	0.78	0.84	0.75	0.80	0.78	0.82	0.78	0.85	0.85	0.76	4.71					
ESP	0.90	0.86	0.90	0.87	0.87	0.87	0.89	0.87	0.85	0.75	0.75	0.85	0.80	15.87				
CZE	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.85	0.75	0.85	16.36			
SVN	0.86	0.85	0.86	0.86	0.85	0.86	0.86	0.86	0.86	0.76	0.76	0.86	0.76	0.85	0.86	11.44		
EST	0.86	0.85	0.87	0.86	0.86	0.85	0.85	0.86	0.86	0.76	0.76	0.86	0.77	0.86	0.86	0.87	20.59	
ISR	0.77	0.76	0.78	0.81	0.78	0.77	0.79	0.79	0.76	0.76	0.76	0.76	0.76	0.80	0.76	0.77	0.78	
9.20																		
CHR	0.86	0.85	0.89	0.91	0.85	0.86	0.85	0.97	0.87	0.75	0.77	0.85	0.79	0.85	0.85	0.86	0.88	
0.78	14.56																	
FRR	0.87	0.85	0.86	0.86	0.86	0.86	0.87	0.87	0.86	0.78	0.79	0.86	0.77	0.86	0.87	0.88	0.89	
0.80	0.86	19.04																
HUN	0.85	0.85	0.86	0.87	0.89	0.85	0.88	0.85	0.85	0.75	0.75	0.85	0.75	0.85	0.85	0.86	0.86	
0.77	0.85	0.88	19.62															
POL	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.85	0.75	0.85	0.85	0.86	0.86	
0.76	0.85	0.86	0.85	11.74														
ZAF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.78	0.85	0.75	0.85	0.85	0.86	0.86	
0.82	0.85	0.89	0.85	0.85	14.33													
JPN	0.86	0.85	0.86	0.85	0.85	0.85	0.87	0.85	0.85	0.75	0.75	0.85	0.75	0.85	0.85	0.86	0.86	
0.78	0.86	0.88	0.85	0.85	0.85	21.40												
LVA	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.76	0.76	0.86	0.76	0.85	0.85	0.87	0.86	
0.77	0.86	0.87	0.86	0.85	0.86	0.86	12.60											
SVK	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.76	0.76	0.85	0.76	0.85	0.85	0.87	0.87	
0.79	0.86	0.88	0.87	0.85	0.86	0.86	0.86	11.47										
LTU	0.86	0.85	0.86	0.86	0.86	0.86	0.86	0.87	0.86	0.76	0.76	0.86	0.76	0.86	0.86	0.87	0.88	
0.78	0.88	0.91	0.86	0.86	0.87	0.87	0.86	0.87	10.15									
PRT	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.85	0.75	0.85	0.85	0.86	0.86	
0.76	0.85	0.87	0.85	0.85	0.85	0.85	0.85	0.85	0.86	20.15								
KOR	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.75	0.75	0.86	0.76	0.85	0.85	0.87	0.87	
0.78	0.86	0.91	0.85	0.85	0.85	0.85	0.86	0.86	0.87	0.85	13.20							
URY	0.85	0.85	0.86	0.85	0.85	0.85	0.85	0.86	0.85	0.76	0.76	0.86	0.76	0.85	0.86	0.88	0.88	
0.79	0.86	0.91	0.85	0.86	0.85	0.85	0.87	0.86	0.88	0.85	0.86	4.75						
ARG	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85	0.75	0.75	0.85	0.75	0.85	0.85	0.87	0.87	
0.78	0.86	0.91	0.85	0.85	0.85	0.85	0.86	0.86	0.87	0.85	0.85	0.85	5.40					

JER mil

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	579.35										
DFS	0.94	9.25									
USA	0.92	0.93	651.89								
NZL	0.78	0.76	0.75	282.83							
AUS	0.87	0.80	0.79	0.86	483.12						
GBR	0.86	0.87	0.85	0.75	0.77	212.25					
NLD	0.93	0.94	0.90	0.76	0.80	0.88	615.98				
ZAF	0.88	0.89	0.85	0.79	0.84	0.85	0.86	374.92			
ITA	0.91	0.88	0.89	0.79	0.81	0.85	0.87	0.88	534.22		
DEU	0.90	0.89	0.88	0.76	0.79	0.86	0.91	0.86	0.87	451.03	
IRL	0.86	0.86	0.85	0.83	0.82	0.84	0.87	0.84	0.83	0.83	181.69

JER fat

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	25.94										
DFS	0.93	11.68									
USA	0.92	0.92	26.03								
NZL	0.75	0.76	0.75	12.00							
AUS	0.84	0.76	0.80	0.86	18.95						
GBR	0.86	0.86	0.86	0.75	0.76	8.48					
NLD	0.90	0.89	0.88	0.76	0.77	0.88	24.86				
ZAF	0.85	0.86	0.85	0.75	0.75	0.85	0.86	14.96			
ITA	0.89	0.87	0.89	0.76	0.76	0.85	0.86	0.86	26.04		
DEU	0.89	0.90	0.88	0.76	0.76	0.86	0.91	0.86	0.86	21.13	
IRL	0.82	0.85	0.82	0.79	0.81	0.81	0.84	0.82	0.79	0.79	6.74

JER pro

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	18.46										
DFS	0.92	10.58									
USA	0.89	0.92	19.39								
NZL	0.75	0.76	0.75	8.51							
AUS	0.80	0.76	0.75	0.85	11.83						
GBR	0.86	0.87	0.85	0.75	0.76	5.98					
NLD	0.89	0.89	0.86	0.76	0.76	0.88	18.67				
ZAF	0.85	0.86	0.85	0.75	0.76	0.85	0.86	11.78			
ITA	0.87	0.87	0.88	0.76	0.76	0.85	0.86	0.87	19.39		
DEU	0.88	0.90	0.87	0.76	0.76	0.85	0.89	0.86	0.86	16.20	
IRL	0.79	0.81	0.82	0.81	0.82	0.82	0.82	0.82	0.79	0.78	5.66

RDC	mil													
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD
CAN	577.40													
NOR	0.91	10.23												
USA	0.93	0.88	668.24											
NZL	0.76	0.77	0.76	317.36										
AUS	0.80	0.79	0.79	0.86	449.13									
GBR	0.86	0.87	0.86	0.76	0.81	231.69								
DFS	0.91	0.91	0.89	0.75	0.82	0.88	10.05							
DEU	0.91	0.92	0.90	0.76	0.79	0.85	0.92	597.73						
ZAF	0.86	0.91	0.86	0.76	0.78	0.86	0.86	0.85	544.41					
EST	0.87	0.90	0.87	0.78	0.80	0.86	0.92	0.87	0.88	546.43				
LVA	0.87	0.87	0.86	0.77	0.77	0.87	0.86	0.86	0.87	0.87	293.13			
LTU	0.88	0.87	0.87	0.77	0.77	0.87	0.86	0.86	0.89	0.87	0.86	302.66		
IRL	0.85	0.86	0.85	0.85	0.86	0.83	0.86	0.83	0.80	0.83	0.81	0.84	132.61	
NLD	0.92	0.91	0.91	0.76	0.83	0.89	0.94	0.93	0.85	0.87	0.87	0.87	0.88	667.36

RDC	fat													
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD
CAN	21.58													
NOR	0.91	9.86												
USA	0.93	0.87	24.65											
NZL	0.76	0.77	0.76	13.41										
AUS	0.78	0.78	0.78	0.86	19.31									
GBR	0.86	0.87	0.87	0.76	0.78	8.24								
DFS	0.91	0.89	0.88	0.75	0.81	0.87	10.02							
DEU	0.90	0.89	0.89	0.76	0.77	0.86	0.90	23.84						
ZAF	0.86	0.90	0.86	0.76	0.76	0.86	0.86	0.85	19.70					
EST	0.88	0.88	0.87	0.79	0.79	0.86	0.89	0.87	0.88	18.67				
LVA	0.87	0.87	0.86	0.77	0.77	0.87	0.86	0.86	0.87	0.87	13.37			
LTU	0.88	0.87	0.87	0.77	0.77	0.87	0.86	0.86	0.89	0.87	0.86	14.20		
IRL	0.81	0.86	0.80	0.85	0.84	0.79	0.84	0.77	0.77	0.85	0.81	0.84	5.40	
NLD	0.90	0.88	0.89	0.76	0.78	0.88	0.92	0.91	0.85	0.87	0.87	0.87	0.83	25.49

RDC	pro													
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD
CAN	17.10													
NOR	0.90	10.04												
USA	0.91	0.87	18.88											
NZL	0.76	0.77	0.76	9.37										
AUS	0.76	0.83	0.76	0.85	11.11									
GBR	0.86	0.88	0.86	0.76	0.78	6.30								
DFS	0.89	0.89	0.88	0.75	0.75	0.87	10.41							
DEU	0.88	0.90	0.87	0.76	0.76	0.85	0.90	18.50						
ZAF	0.86	0.91	0.86	0.76	0.76	0.86	0.86	0.85	16.15					
EST	0.87	0.88	0.87	0.78	0.80	0.87	0.86	0.87	0.88	16.94				
LVA	0.87	0.87	0.86	0.77	0.77	0.87	0.86	0.86	0.87	0.87	8.37			
LTU	0.88	0.87	0.87	0.77	0.77	0.87	0.86	0.86	0.89	0.87	0.86	9.09		
IRL	0.78	0.86	0.80	0.85	0.84	0.80	0.80	0.76	0.77	0.80	0.81	0.84	3.37	
NLD	0.89	0.89	0.87	0.76	0.76	0.88	0.92	0.90	0.85	0.87	0.87	0.87	0.81	22.46

SIM mil												
	CHE	DEA	FRM	ITA	SVN	FRA	CZE	HUN	NLD	IRL	SVK	GBR
CHE	515.18											
DEA	0.90	511.28										
FRM	0.95	0.94	639.53									
ITA	0.87	0.86	0.85	475.02								
SVN	0.88	0.86	0.87	0.86	8.28							
FRA	0.94	0.92	0.92	0.89	0.86	699.42						
CZE	0.86	0.85	0.85	0.85	0.86	0.86	390.97					
HUN	0.86	0.86	0.91	0.89	0.88	0.88	0.86	360.97				
NLD	0.91	0.94	0.92	0.87	0.87	0.92	0.85	0.86	691.45			
IRL	0.79	0.77	0.76	0.78	0.78	0.91	0.76	0.80	0.82	148.07		
SVK	0.87	0.85	0.86	0.86	0.86	0.86	0.86	0.87	0.86	0.78	336.87	
GBR	0.91	0.89	0.90	0.86	0.86	0.87	0.86	0.85	0.88	0.80	0.86	321.91

SIM fat												
	CHE	DEA	FRM	ITA	SVN	FRA	CZE	HUN	NLD	IRL	SVK	GBR
CHE	20.97											
DEA	0.90	19.47										
FRM	0.94	0.95	25.13									
ITA	0.86	0.87	0.85	18.73								
SVN	0.88	0.86	0.87	0.86	8.77							
FRA	0.91	0.93	0.92	0.90	0.86	27.92						
CZE	0.86	0.85	0.85	0.85	0.86	0.86	16.69					
HUN	0.86	0.86	0.91	0.90	0.88	0.89	0.86	13.29				
NLD	0.89	0.93	0.91	0.85	0.87	0.89	0.85	0.85	27.19			
IRL	0.78	0.77	0.76	0.76	0.77	0.86	0.76	0.75	0.79	5.42		
SVK	0.87	0.85	0.86	0.86	0.86	0.86	0.86	0.87	0.86	0.77	13.27	
GBR	0.91	0.88	0.89	0.86	0.86	0.89	0.86	0.85	0.88	0.77	0.86	11.65

SIM pro												
	CHE	DEA	FRM	ITA	SVN	FRA	CZE	HUN	NLD	IRL	SVK	GBR
CHE	14.70											
DEA	0.87	15.58										
FRM	0.94	0.93	19.87									
ITA	0.86	0.85	0.85	15.09								
SVN	0.88	0.86	0.87	0.86	8.24							
FRA	0.92	0.89	0.91	0.86	0.86	22.12						
CZE	0.86	0.85	0.85	0.85	0.86	0.86	12.49					
HUN	0.86	0.86	0.91	0.88	0.88	0.87	0.86	10.59				
NLD	0.88	0.93	0.89	0.85	0.87	0.87	0.85	0.85	21.84			
IRL	0.78	0.77	0.76	0.76	0.77	0.84	0.76	0.75	0.78	4.75		
SVK	0.87	0.85	0.86	0.86	0.86	0.86	0.86	0.88	0.86	0.77	10.13	
GBR	0.91	0.88	0.88	0.86	0.86	0.87	0.86	0.85	0.88	0.78	0.86	9.21

^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
CAN	0	72	137	99	97	107	41	25	20	59
FRA	64	0	113	132	154	173	65	44	17	45
USA	134	74	0	278	209	286	62	31	24	78
CHE	82	95	261	0	382	493	67	57	18	60
ITA	85	122	147	329	0	587	95	76	21	63
DEA	90	130	253	394	489	0	110	84	26	65
NLD	38	54	58	62	80	105	0	34	16	29
SVN	23	44	26	56	77	77	34	0	7	17
NZL	20	13	21	15	16	21	10	5	0	16
GBR	61	39	74	49	48	46	25	14	14	0

BSW

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR
CAN	0	72	137	99	97	107	41	25	20	59
FRA	64	0	113	132	154	173	65	44	17	45
USA	134	74	0	278	209	286	62	31	24	78
CHE	82	95	261	0	382	493	67	57	18	60
ITA	85	122	147	329	0	587	95	76	21	63
DEA	90	130	253	394	489	0	110	84	26	65
NLD	38	54	58	62	80	105	0	34	16	29
SVN	23	44	26	56	77	77	34	0	7	17
NZL	20	13	21	15	16	21	10	5	0	16
GBR	61	39	74	49	48	46	25	14	14	0

BSW

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR
CAN	0	72	137	99	97	107	41	25	20	59
FRA	64	0	113	132	154	173	65	44	17	45
USA	134	74	0	278	209	286	62	31	24	78
CHE	82	95	261	0	382	493	67	57	18	60
ITA	85	122	147	329	0	587	95	76	21	63
DEA	90	130	253	394	489	0	110	84	26	65
NLD	38	54	58	62	80	105	0	34	16	29
SVN	23	44	26	56	77	77	34	0	7	17
NZL	20	13	21	15	16	21	10	5	0	16
GBR	61	39	74	49	48	46	25	14	14	0

GUE

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

CAN 0 60 44 28 4 12
USA 51 0 56 74 11 30
AUS 40 49 0 38 6 26
GBR 23 77 30 0 5 15
ZAF 2 8 5 4 0 5
NZL 10 28 26 13 3 0

GUE

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

CAN 0 60 44 28 4 12
USA 51 0 56 74 11 30
AUS 40 49 0 38 6 26
GBR 23 77 30 0 5 15
ZAF 2 8 5 4 0 5
NZL 10 28 26 13 3 0

GUE

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

CAN 0 60 44 28 4 12
USA 51 0 56 74 11 30
AUS 40 49 0 38 6 26
GBR 23 77 30 0 5 15
ZAF 2 8 5 4 0 5
NZL 10 28 26 13 3 0

LVA	153	364	199	112	198	222	306	62	159	85	85	79	72	131	190	46	78	26	78	15	146	280	73	86	0	120	90	268
129	68	154																										
SVK	208	452	164	155	162	276	271	54	156	122	92	81	76	119	289	37	41	12	63	8	179	198	89	72	60	0	58	259
149	82	148																										
LTU	49	298	92	29	81	80	105	17	60	43	31	23	30	55	85	18	15	12	13	0	62	121	21	21	71	26	0	135
78	39	83																										
PRT	766	995	687	662	779	945	1086	278	767	419	372	369	333	704	557	102	96	72	231	13	579	753	369	294	220	191	85	0
354	183	441																										
KOR	395	269	223	180	322	213	689	87	249	157	147	80	80	217	247	30	35	24	69	0	259	284	166	198	77	90	36	299
0	130	300																										
URY	189	147	125	104	138	137	305	58	151	106	105	64	79	132	100	20	18	11	46	0	137	106	124	96	40	54	18	177
108	0	186																										
ARG	417	306	250	196	305	277	821	109	313	180	189	105	115	279	240	31	42	20	76	0	291	300	249	205	111	85	35	421
257	185	0																										

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	0	64	274	132	164	119	28	112	62	41	5
DFS	49	0	135	110	97	124	60	112	91	77	12
USA	284	108	0	292	357	179	64	239	90	70	21
NZL	142	82	362	0	333	162	57	168	79	57	60
AUS	165	63	378	366	0	152	50	181	68	44	27
GBR	120	108	193	160	147	0	59	135	93	64	28
NLD	22	58	68	50	39	53	0	57	49	41	8
ZAF	109	87	251	170	166	132	52	0	85	61	18
ITA	59	88	97	76	63	93	46	80	0	56	8
DEU	37	72	69	51	36	62	37	56	55	0	8
IRL	3	9	22	66	22	28	8	18	9	8	0

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	0	64	274	132	164	119	28	112	62	41	5
DFS	49	0	135	110	97	124	60	112	91	77	12
USA	284	108	0	292	357	178	64	239	90	70	21
NZL	142	82	362	0	333	162	57	168	79	57	60
AUS	165	63	378	366	0	151	50	181	68	44	27
GBR	120	108	193	160	147	0	59	135	93	64	28
NLD	22	58	68	50	39	53	0	57	49	41	8
ZAF	109	87	251	170	166	132	52	0	85	61	18
ITA	59	88	97	76	63	93	46	80	0	56	8
DEU	37	72	69	51	36	62	37	56	55	0	8
IRL	3	9	22	66	22	28	8	18	9	8	0

 JER

common bulls below diagonal

	common three quarter			sib group			above diagonal					
	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	
CAN	0	64	274	132	164	119	28	112	62	41	5	
DFS	49	0	135	110	97	124	60	112	91	77	12	
USA	284	108	0	292	357	179	64	239	90	70	21	
NZL	142	82	362	0	333	162	57	168	79	57	60	
AUS	165	63	378	366	0	152	50	181	68	44	27	
GBR	120	108	193	160	147	0	59	135	93	64	28	
NLD	22	58	68	50	39	53	0	57	49	41	8	
ZAF	109	87	251	170	166	132	52	0	85	61	18	
ITA	59	88	97	76	63	93	46	80	0	56	8	
DEU	37	72	69	51	36	62	37	56	55	0	8	
IRL	3	9	22	66	22	28	8	18	9	8	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
CAN	0	4	160	65	83	60	100	11	70	1	9	13	2	3
NOR	4	0	40	29	43	11	89	16	0	12	20	22	33	24
USA	145	39	0	74	89	66	120	16	58	8	16	24	11	21
NZL	64	28	74	0	110	44	134	12	33	4	14	22	3	6
AUS	82	36	89	112	0	45	130	29	34	17	32	40	6	16
GBR	59	12	59	41	45	0	46	5	32	1	9	10	5	10
DFS	96	69	118	132	108	44	0	55	47	73	108	100	8	23
DEU	10	15	16	12	27	5	45	0	1	20	31	29	3	13
ZAF	72	0	53	29	33	27	44	1	0	0	2	5	0	2
EST	1	11	6	3	16	1	61	18	0	0	42	21	0	8
LVA	9	18	15	12	30	8	76	27	2	36	0	44	2	10
LTU	12	17	17	18	36	9	82	28	5	20	39	0	2	10
IRL	2	33	11	3	5	5	6	3	0	0	2	2	0	7
NLD	3	23	19	6	14	10	22	12	2	7	9	9	6	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
CAN	0	4	160	65	83	60	100	11	70	1	9	13	2	3
NOR	4	0	40	29	43	11	90	17	0	13	21	22	33	24
USA	145	39	0	74	89	65	120	16	58	8	16	24	11	21
NZL	64	28	74	0	110	44	134	12	33	4	14	22	3	6
AUS	82	36	89	112	0	45	130	29	34	17	32	40	6	16
GBR	59	12	59	41	45	0	46	5	32	1	9	10	5	10
DFS	96	70	118	132	108	44	0	55	47	73	108	99	8	22
DEU	10	16	16	12	27	5	45	0	1	20	31	29	3	13
ZAF	72	0	53	29	33	27	44	1	0	0	2	5	0	2
EST	1	12	6	3	16	1	61	18	0	0	42	21	0	8
LVA	9	19	15	12	30	8	76	27	2	36	0	44	2	10
LTU	12	17	17	18	36	9	82	28	5	20	39	0	2	10
IRL	2	33	11	3	5	5	6	3	0	0	2	2	0	7
NLD	3	23	19	6	14	10	22	12	2	7	9	9	6	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
CAN	0	4	160	65	83	60	100	11	70	1	9	13	2	3
NOR	4	0	40	29	43	11	90	17	0	13	21	22	33	24
USA	145	39	0	74	89	65	120	16	58	8	16	24	11	21
NZL	64	28	74	0	110	44	134	12	33	4	14	22	3	6
AUS	82	36	89	112	0	45	130	29	34	17	32	40	6	16
GBR	59	12	59	41	45	0	46	5	32	1	9	10	5	10
DFS	96	70	118	132	108	44	0	55	47	73	108	99	8	22
DEU	10	16	16	12	27	5	45	0	1	20	31	29	3	13
ZAF	72	0	53	29	33	27	44	1	0	0	2	5	0	2
EST	1	12	6	3	16	1	61	18	0	0	42	21	0	8
LVA	9	19	15	12	30	8	76	27	2	36	0	44	2	10
LTU	12	17	17	18	36	9	82	28	5	20	39	0	2	10
IRL	2	33	11	3	5	5	6	3	0	0	2	2	0	7
NLD	3	23	19	6	14	10	22	12	2	7	9	9	6	0

SIM

common bulls below diagonal

common	three	quarter	sib	group	above	diagonal						
CHE	DEA	FRM	ITA	SVN	FRA	CZE	HUN	NLD	IRL	SVK	GBR	
CHE	0	231	144	71	12	14	93	1	69	45	27	50
DEA	203	0	95	562	150	167	432	42	129	32	305	22
FRM	185	106	0	139	20	2	174	3	100	59	52	65
ITA	73	461	164	0	76	86	215	18	119	47	112	43
SVN	12	132	20	71	0	42	54	10	28	1	45	0
FRA	10	132	1	77	38	0	49	10	30	0	39	0
CZE	82	394	194	176	52	38	0	13	117	35	97	42
HUN	0	27	1	14	8	7	11	0	3	1	12	0
NLD	71	133	120	115	27	29	113	3	0	42	45	49
IRL	43	26	64	42	1	0	24	1	37	0	10	34
SVK	19	309	52	96	44	31	86	10	38	3	0	8
GBR	55	18	81	45	0	0	37	0	47	30	3	0

SIM

common bulls below diagonal

common	three	quarter	sib	group	above	diagonal						
CHE	DEA	FRM	ITA	SVN	FRA	CZE	HUN	NLD	IRL	SVK	GBR	
CHE	0	231	144	71	12	14	93	1	69	45	27	50
DEA	203	0	95	562	150	167	432	42	129	32	305	22
FRM	185	106	0	139	20	2	174	3	100	59	52	65
ITA	73	461	164	0	76	86	215	18	119	47	112	43
SVN	12	132	20	71	0	42	54	10	28	1	45	0
FRA	10	132	1	77	38	0	49	10	30	0	39	0
CZE	82	394	194	176	52	38	0	13	117	35	97	42
HUN	0	27	1	14	8	7	11	0	3	1	12	0
NLD	71	133	120	115	27	29	113	3	0	42	45	49
IRL	43	26	64	42	1	0	24	1	37	0	10	34
SVK	19	309	52	96	44	31	86	10	38	3	0	8
GBR	55	18	81	45	0	0	37	0	47	30	3	0

SIM

common bulls below diagonal

common	three	quarter	sib	group	above	diagonal						
CHE	DEA	FRM	ITA	SVN	FRA	CZE	HUN	NLD	IRL	SVK	GBR	
CHE	0	229	144	71	12	14	93	1	69	45	27	50
DEA	201	0	95	562	150	167	432	42	129	32	305	22
FRM	185	106	0	139	20	2	174	3	100	59	52	65
ITA	73	461	164	0	76	86	215	18	119	47	112	43
SVN	12	132	20	71	0	42	54	10	28	1	45	0
FRA	10	132	1	77	38	0	49	10	30	0	39	0
CZE	82	394	194	176	52	38	0	13	117	35	97	42
HUN	0	27	1	14	8	7	11	0	3	1	12	0
NLD	71	133	120	115	27	29	113	3	0	42	45	49
IRL	43	26	64	42	1	0	24	1	37	0	10	34
SVK	19	309	52	96	44	31	86	10	38	3	0	8
GBR	55	18	81	45	0	0	37	0	47	30	3	0
