

Introduction

The latest international evaluation for dairy **production traits** took place as scheduled at the Interbull Centre. Data from twenty nine (29) 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 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:

DEA BSW/SIM The base group is shifted by 4 month for all traits in every evaluation

NOR RDC The rolling definition of hys is causing the daughters to distribute somewhat differently over hys-classes at each evaluation. Therefore some bulls occasionally may lose EDC although the number of daughters stay the same. Reliability changes is a function of the EDC changes

DFS HOL/RDC Some bulls have lost EDC's or herds or daughters. But is is only very few animals and less than 1% even if number of animals is big.

JPN HOL Little changes in proofs caused by additional records and modification of pedigree

ZAF RDC Data since Dec 2011 has now been included for herds participating in Milk Recording at the ARC.

SVN HOL/BSW There are still some bulls losing informations (herds/daughters/EDC) from run to run, SIM but in most cases there are changes only for one or two herds, daughters or EDC. These changes are mostly consequences of changes in data base related to the pedigree completeness as well as phenotypic data improvement.

AUS ALL The decrease in number of daughters and herds in all production traits is due to either or both reasons: 1) daughters wrongly allocated to them or adjustments in some of the herd-year -seasons. 2) different cut off dates in previous and current run.

IRL HOL/RDC Introduced the new genetic base as tested in January.
SIM/JER

EST HOL/RDC Decrease in number of daughters/herds and reliability of some bulls is due to the pedigree check of cows and due to additional data check.

CHE HOL/BSW Decrease in information due to continuous work on the raw data by herd-book organizations. Some SIM bulls are missing in the current proof files. This is because the information changed based on which we define the publication criterion. Some bulls changed from TOP 12 to 11. This is related to changes in the database by the herdbook organizations resulting in a lower number of daughters of these bulls.

INTERBULL CHANGES COMPARED TO THE APRIL ROUTINE RUN

None

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 analyzed 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.

^aLTable 1. National evaluation data considered in the Interbull evaluation for dairy production traits (August Routine Evaluation 2016).
Number of records for milk yield by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS	178	128	7065	1581	643	
BEL			1111			
CAN	209	93	11065	616	750	
CHE	2733		3017			2963
CZE			3926			
DEA	5628					22303
DEU			25935	160	399	
DFS			12308	2001	7293	
ESP			3242			
EST			980		394	
FRA	351		15974			421
FRM						4287
FRR			215			
GBR	135	317	6440	843	539	89
HUN			2942			200
IRL			2203	130	42	91
ISR			1263			
ITA	1963		9073	166		1477
JPN			5297			
KOR			1132			
LTU			681		399	
LVA			946		677	
NLD	163		14263	121	58	292
NOR					3848	
NZL	44	58	6769	4380	1254	
POL			9049			
PRT			2092			
SVK			1025			549
SVN	326		440			544
URY			926			
USA	1014	751	34746	4035	648	37
ZAF		36	1235	656	140	
HRV			649			743
No. Records	12744	1383	186009	14689	17084	33996
Pub. Proofs	10415	1109	144799	12047	15392	30864

^aLAPPENDIX 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	610.82											
FRA	0.89	640.69										
USA	0.93	0.89	624.28									
CHE	0.90	0.89	0.87	487.06								
ITA	0.89	0.83	0.87	0.87	588.68							
DEA	0.87	0.84	0.86	0.93	0.90	463.00						
NLD	0.89	0.88	0.87	0.85	0.84	0.86	567.07					
SVN	0.83	0.84	0.82	0.81	0.81	0.84	0.84	10.02				
NZL	0.70	0.76	0.72	0.76	0.70	0.74	0.74	0.75	349.41			
GBR	0.85	0.87	0.85	0.85	0.82	0.84	0.87	0.85	0.71	256.28		
AUS	0.77	0.79	0.75	0.73	0.72	0.73	0.78	0.76	0.84	0.76	401.84	

BSW	fat	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	26.21											
FRA	0.89	27.31										
USA	0.91	0.89	23.48									
CHE	0.86	0.88	0.83	19.22								
ITA	0.89	0.83	0.85	0.88	22.49							
DEA	0.85	0.85	0.83	0.93	0.88	17.48						
NLD	0.87	0.87	0.87	0.85	0.84	0.87	24.86					
SVN	0.83	0.84	0.82	0.81	0.81	0.84	0.84	10.09				
NZL	0.71	0.74	0.71	0.74	0.70	0.84	0.71	0.75	14.94			
GBR	0.86	0.88	0.85	0.86	0.82	0.84	0.87	0.85	0.72	9.69		
AUS	0.75	0.77	0.74	0.71	0.71	0.73	0.75	0.76	0.84	0.74	14.76	

BSW	pro	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN		22.34										
FRA		0.84	20.74									
USA		0.90	0.87	18.80								
CHE		0.85	0.85	0.82	15.29							
ITA		0.85	0.82	0.83	0.86	20.63						
DEA		0.84	0.83	0.82	0.91	0.89	14.40					
NLD		0.86	0.85	0.84	0.83	0.82	0.84	18.89				
SVN		0.83	0.84	0.82	0.81	0.81	0.84	0.84	9.97			
NZL		0.70	0.72	0.71	0.72	0.70	0.76	0.71	0.75	10.61		
GBR		0.85	0.86	0.83	0.83	0.81	0.84	0.87	0.85	0.71	7.43	
AUS		0.71	0.74	0.70	0.71	0.69	0.73	0.74	0.76	0.82	0.74	11.81

GUE	mil	CAN	USA	AUS	GBR	ZAF	NZL
CAN		733.23					
USA		0.94	713.79				
AUS		0.83	0.79	471.22			
GBR		0.86	0.83	0.78	238.78		
ZAF		0.85	0.85	0.82	0.84	349.31	
NZL		0.70	0.70	0.84	0.70	0.72	331.29

GUE	fat	CAN	USA	AUS	GBR	ZAF	NZL
CAN		30.52					
USA		0.93	25.37				
AUS		0.80	0.78	17.48			
GBR		0.86	0.84	0.77	10.03		
ZAF		0.81	0.81	0.74	0.84	13.48	
NZL		0.72	0.71	0.84	0.70	0.72	16.65

GUE	pro	CAN	USA	AUS	GBR	ZAF	NZL
CAN		22.26					
USA		0.92	19.63				
AUS		0.74	0.71	13.70			
GBR		0.85	0.83	0.75	6.50		
ZAF		0.81	0.81	0.76	0.84	10.49	
NZL		0.70	0.69	0.82	0.70	0.71	11.00

HOL	fat																									
	CAN		DEU		DFS		FRA		ITA		NLD		USA		CHE		GBR		NZL		AUS		BEL		IRL	
ESP	CZE	SVN	EST	ISR	FRR	ITB	HUN	NLD	POL	USA	ZAF	CHE	JPN	GBR	LVA	NZL	SVK	AUS	LTU	BEL	PRT	IRL	KOR			
URY	HRV																									
CAN	30.28																									
DEU	0.91	24.24																								
DFS	0.93	0.91	11.15																							
FRA	0.91	0.89	0.92	26.95																						
ITA	0.89	0.86	0.86	0.88	23.53																					
NLD	0.91	0.91	0.91	0.90	0.85	24.94																				
USA	0.93	0.90	0.91	0.92	0.92	0.89	24.87																			
CHE	0.88	0.88	0.91	0.91	0.85	0.90	0.87	23.53																		
GBR	0.85	0.85	0.89	0.89	0.84	0.88	0.86	0.89	9.66																	
NZL	0.68	0.70	0.71	0.73	0.72	0.70	0.70	0.73	0.70	12.67																
AUS	0.78	0.75	0.75	0.80	0.73	0.76	0.78	0.76	0.75	0.84	18.43															
BEL	0.84	0.86	0.83	0.85	0.82	0.85	0.82	0.83	0.83	0.72	0.78	19.74														
IRL	0.81	0.78	0.82	0.85	0.74	0.83	0.79	0.81	0.79	0.84	0.83	0.84	6.12													
ESP	0.90	0.89	0.88	0.91	0.90	0.89	0.93	0.87	0.84	0.70	0.77	0.84	0.79													
21.82	CZE	0.86	0.87	0.85	0.84	0.83	0.83	0.85	0.83	0.70	0.72	0.83	0.72													
	0.85	21.67	SVN	0.81	0.82	0.83	0.83	0.82	0.83	0.81	0.84	0.83	0.71	0.73	0.83	0.72										
	0.83	0.83	12.32	EST	0.87	0.85	0.89	0.86	0.87	0.85	0.87	0.85	0.83	0.79	0.78	0.87	0.83									
	0.85	0.85	0.84	23.64	ISR	0.83	0.80	0.80	0.81	0.81	0.80	0.85	0.81	0.80	0.65	0.70	0.80	0.67								
	0.82	0.80	0.81	0.81	14.14	FRR	0.84	0.84	0.84	0.87	0.83	0.83	0.84	0.84	0.84	0.77	0.80	0.90	0.81							
	0.88	0.90	0.85	0.88	0.83	25.44	HUN	0.86	0.85	0.84	0.88	0.91	0.84	0.91	0.83	0.83	0.70	0.72	0.82	0.71						
	0.89	0.85	0.83	0.84	0.82	0.84	0.82	0.84	24.68	POL	0.89	0.90	0.87	0.89	0.86	0.89	0.80	0.80	0.68	0.72	0.83	0.76				
	0.92	0.88	0.81	0.88	0.83	0.90	0.90	0.88	16.12	ZAF	0.80	0.82	0.82	0.82	0.80	0.82	0.82	0.70	0.72	0.82	0.71					
	0.82	0.82	0.83	0.83	0.81	0.84	0.82	0.82	0.80	17.27	JPN	0.93	0.89	0.92	0.90	0.85	0.90	0.89	0.83	0.72	0.75	0.84	0.80			
	0.86	0.84	0.83	0.88	0.80	0.84	0.82	0.82	0.87	24.21	LVA	0.80	0.82	0.82	0.82	0.82	0.87	0.82	0.82	0.71	0.72	0.82	0.71			
	0.82	0.82	0.83	0.85	0.81	0.84	0.82	0.82	0.80	18.78	SVK	0.80	0.82	0.83	0.83	0.80	0.84	0.83	0.71	0.73	0.83	0.71				
	0.83	0.83	0.84	0.85	0.82	0.85	0.84	0.84	0.80	15.07	LTU	0.81	0.82	0.83	0.84	0.82	0.83	0.83	0.72	0.73	0.84	0.73				
	0.83	0.83	0.85	0.84	0.81	0.88	0.83	0.80	0.80	15.79	PRT	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.70	0.68	0.80	0.70				
	0.80	0.80	0.81	0.81	0.83	0.82	0.82	0.83	0.80	26.66	KOR	0.84	0.82	0.83	0.82	0.80	0.83	0.83	0.80	0.81	0.81	0.80				
	0.85	0.83	0.84	0.85	0.81	0.88	0.82	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.81	0.80	0.80	0.83	0.84	0.80					
19.06	URY	0.80	0.80	0.80	0.82	0.82	0.80	0.80	0.80	0.77	0.80	0.76	0.81	0.81	0.80	0.80	0.77	0.76	0.81	0.78						
	0.80	0.80	0.82	0.85	0.83	0.87	0.80	0.80	0.80	0.81	0.80	0.81	0.81	0.81	0.80	0.81	0.81	0.82	0.82	0.80	0.80					
	0.80	6.81	HRV	0.81	0.82	0.83	0.83	0.82	0.83	0.80	0.80	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.77	0.83	0.75					
	0.83	0.83	0.84	0.84	0.81	0.85	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.84	0.84	0.80					
	0.85	0.81	12.69	0.85	0.84	0.84	0.81	0.85	0.82	0.80	0.80	0.80	0.83	0.83	0.82	0.82	0.84	0.84	0.84	0.84	0.80					

HOL pro

	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	BEL	IRL
ESP	CZE	SVN	EST	ISR	FRR	HUN	POL	ZAF	JPN	LVA	SVK	LTU	KOR
URY													
CAN	21.19												
DEU	0.88	17.79											
DFS	0.92	0.92	10.77										
FRA	0.87	0.84	0.91	18.39									
ITA	0.87	0.84	0.88	0.85	17.65								
NLD	0.88	0.90	0.90	0.86	0.83	18.47							
USA	0.92	0.87	0.92	0.89	0.89	0.86	17.43						
CHE	0.85	0.85	0.90	0.91	0.85	0.85	0.85	17.16					
GBR	0.85	0.83	0.88	0.87	0.82	0.87	0.84	0.87	7.20				
NZL	0.68	0.70	0.70	0.70	0.72	0.70	0.70	0.70	0.70	9.09			
AUS	0.72	0.72	0.74	0.75	0.71	0.74	0.71	0.75	0.75	0.82	10.57		
BEL	0.80	0.83	0.83	0.83	0.82	0.84	0.80	0.83	0.83	0.70	0.73	13.94	
IRL	0.74	0.73	0.77	0.81	0.73	0.79	0.75	0.77	0.78	0.83	0.83	0.75	4.76
ESP	0.90	0.87	0.90	0.88	0.86	0.87	0.90	0.86	0.84	0.70	0.74	0.83	0.77
15.84													
CZE	0.80	0.82	0.83	0.83	0.82	0.83	0.80	0.83	0.83	0.70	0.72	0.83	0.71
SVN	0.83	16.53											
0.83	0.81	0.82	0.83	0.83	0.82	0.83	0.81	0.84	0.83	0.72	0.73	0.84	0.72
0.83	0.83	11.59											
EST	0.81	0.83	0.86	0.83	0.83	0.83	0.81	0.84	0.83	0.72	0.73	0.84	0.72
0.83	0.83	0.84	18.61										
ISR	0.83	0.80	0.81	0.83	0.81	0.80	0.83	0.81	0.80	0.66	0.68	0.81	0.67
0.82	0.80	0.82	0.82	9.82									
FRR	0.83	0.82	0.84	0.85	0.83	0.83	0.82	0.84	0.84	0.76	0.76	0.86	0.75
0.84	0.87	0.86	0.88	0.84	18.81								
HUN	0.83	0.83	0.86	0.86	0.88	0.82	0.88	0.83	0.82	0.70	0.71	0.82	0.71
0.84	0.82	0.83	0.83	0.81	0.85	20.64							
POL	0.84	0.84	0.85	0.80	0.82	0.83	0.83	0.80	0.80	0.68	0.70	0.80	0.69
0.85	0.80	0.81	0.84	0.83	0.85	0.83	10.83						
ZAF	0.80	0.82	0.82	0.82	0.82	0.82	0.80	0.82	0.70	0.76	0.82	0.73	
0.82	0.82	0.83	0.83	0.83	0.86	0.82	0.80	13.54					
JPN	0.91	0.86	0.92	0.87	0.87	0.87	0.91	0.86	0.84	0.72	0.74	0.82	0.75
0.88	0.82	0.83	0.84	0.82	0.85	0.83	0.86	0.82	17.33				
LVA	0.80	0.82	0.82	0.82	0.82	0.82	0.80	0.83	0.82	0.71	0.72	0.82	0.71
0.82	0.82	0.83	0.83	0.81	0.84	0.82	0.80	0.83	0.82	13.02			
SVK	0.80	0.82	0.84	0.83	0.83	0.83	0.80	0.84	0.83	0.71	0.73	0.83	0.71
0.83	0.83	0.85	0.85	0.83	0.86	0.85	0.80	0.83	0.83	0.83	11.15		
LTU	0.81	0.82	0.83	0.84	0.82	0.83	0.81	0.85	0.83	0.72	0.74	0.84	0.72
0.83	0.83	0.85	0.85	0.83	0.90	0.83	0.81	0.84	0.83	0.83	0.85	10.65	
PRT	0.80	0.80	0.80	0.80	0.81	0.80	0.80	0.80	0.80	0.70	0.68	0.80	0.70
0.80	0.80	0.81	0.81	0.83	0.83	0.80	0.80	0.80	0.81	0.80	0.80	0.81	20.08
KOR	0.82	0.82	0.83	0.83	0.82	0.83	0.80	0.83	0.83	0.70	0.72	0.83	0.71
0.83	0.83	0.85	0.84	0.82	0.90	0.82	0.80	0.82	0.82	0.83	0.84	0.84	0.80
13.09													
URY	0.80	0.80	0.80	0.80	0.82	0.80	0.80	0.81	0.80	0.71	0.71	0.80	0.71
0.80	0.80	0.82	0.82	0.84	0.88	0.80	0.80	0.82	0.82	0.81	0.82	0.80	
0.80	5.39												
HRV	0.81	0.82	0.83	0.83	0.82	0.83	0.80	0.84	0.83	0.71	0.73	0.83	0.71
0.83	0.83	0.84	0.84	0.81	0.85	0.82	0.80	0.83	0.83	0.82	0.84	0.84	0.80
0.84	0.82	12.02											

JER mil

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	559.98										
DFS	0.94	9.26									
USA	0.92	0.93	614.67								
NZL	0.75	0.71	0.71	281.37							
AUS	0.85	0.78	0.78	0.85	486.24						
GBR	0.86	0.85	0.82	0.70	0.76	210.06					
NLD	0.93	0.93	0.90	0.72	0.80	0.86	594.66				
ZAF	0.89	0.88	0.84	0.78	0.83	0.82	0.83	371.76			
ITA	0.88	0.87	0.89	0.75	0.78	0.84	0.86	0.86	526.27		
DEU	0.89	0.90	0.88	0.71	0.78	0.83	0.91	0.83	0.88	485.03	
IRL	0.82	0.81	0.79	0.83	0.85	0.79	0.84	0.80	0.79	0.82	180.50

JER fat

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	25.44										
DFS	0.91	11.57									
USA	0.91	0.90	24.30								
NZL	0.69	0.71	0.74	12.02							
AUS	0.82	0.74	0.80	0.86	18.70						
GBR	0.83	0.85	0.82	0.70	0.73	8.45					
NLD	0.88	0.88	0.86	0.71	0.75	0.86	23.95				
ZAF	0.81	0.83	0.80	0.70	0.74	0.82	0.83	14.29			
ITA	0.88	0.86	0.86	0.71	0.75	0.84	0.85	0.83	25.55		
DEU	0.89	0.90	0.86	0.71	0.76	0.84	0.90	0.83	0.86	22.26	
IRL	0.80	0.80	0.78	0.80	0.81	0.77	0.82	0.74	0.75	0.78	6.07

JER pro

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	17.91										
DFS	0.91	10.53									
USA	0.90	0.92	18.31								
NZL	0.69	0.71	0.70	8.48							
AUS	0.77	0.73	0.72	0.83	11.83						
GBR	0.85	0.86	0.81	0.70	0.74	5.93					
NLD	0.88	0.89	0.86	0.71	0.75	0.86	18.78				
ZAF	0.84	0.83	0.80	0.70	0.74	0.82	0.83	11.27			
ITA	0.85	0.86	0.85	0.71	0.73	0.83	0.84	0.84	18.87		
DEU	0.86	0.91	0.86	0.71	0.73	0.83	0.88	0.83	0.85	16.54	
IRL	0.74	0.77	0.75	0.81	0.83	0.77	0.79	0.75	0.73	0.75	5.25

RDC mil

RDC fat

RDC	pro	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL
NLD														
CAN	17.65													
NOR	0.87	11.41												
USA	0.90	0.84	19.06											
NZL	0.69	0.73	0.69	9.40										
AUS	0.70	0.79	0.71	0.80	11.95									
GBR	0.83	0.83	0.83	0.69	0.74	6.55								
DFS	0.89	0.88	0.89	0.69	0.74	0.86	10.37							
DEU	0.88	0.92	0.86	0.70	0.75	0.83	0.90	18.39						
ZAF	0.81	0.88	0.81	0.70	0.75	0.81	0.81	0.81	16.01					
EST	0.82	0.84	0.83	0.75	0.76	0.85	0.84	0.84	0.83	15.69				
LVA	0.82	0.83	0.82	0.73	0.73	0.84	0.83	0.83	0.83	0.84	8.46			
LTU	0.83	0.83	0.82	0.73	0.74	0.85	0.84	0.83	0.85	0.85	0.83	9.39		
IRL	0.74	0.73	0.76	0.82	0.83	0.78	0.78	0.74	0.74	0.76	0.76	0.79	4.02	
NLD	0.88	0.91	0.86	0.70	0.76	0.87	0.90	0.90	0.81	0.85	0.84	0.85	0.80	
	22.55													

SIM	mil	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	564.44													
DEA	0.86	510.17												
FRM	0.95	0.89	633.08											
ITA	0.86	0.82	0.82	499.89										
SVN	0.85	0.83	0.86	0.83	8.79									
FRA	0.93	0.90	0.90	0.87	0.84	687.26								
HUN	0.85	0.84	0.90	0.88	0.85	0.88	407.09							
NLD	0.89	0.93	0.90	0.84	0.84	0.90	0.86	710.39						
IRL	0.79	0.73	0.78	0.75	0.76	0.88	0.77	0.79	140.66					
SVK	0.84	0.83	0.84	0.83	0.85	0.84	0.86	0.84	0.77	338.94				
GBR	0.88	0.89	0.89	0.83	0.84	0.87	0.83	0.87	0.78	0.84	303.20			
HRV	0.84	0.83	0.90	0.82	0.84	0.84	0.84	0.84	0.75	0.84	0.83	10.58		
USA	0.90	0.83	0.88	0.89	0.82	0.92	0.90	0.90	0.82	0.85	0.85	0.81	553.84	

SIM	fat	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	22.64													
DEA	0.88	19.36												
FRM	0.94	0.91	24.92											
ITA	0.85	0.84	0.82	19.84										
SVN	0.85	0.83	0.86	0.83	9.26									
FRA	0.91	0.93	0.90	0.87	0.84	27.86								
HUN	0.83	0.84	0.89	0.89	0.85	0.88	15.23							
NLD	0.88	0.92	0.90	0.83	0.84	0.89	0.84	27.61						
IRL	0.75	0.73	0.76	0.73	0.75	0.85	0.72	0.79	5.23					
SVK	0.84	0.83	0.84	0.83	0.85	0.84	0.85	0.84	0.75	13.16				
GBR	0.90	0.88	0.87	0.83	0.84	0.89	0.83	0.87	0.77	0.84	10.72			
HRV	0.83	0.83	0.90	0.82	0.84	0.84	0.84	0.84	0.75	0.84	0.83	10.67		
USA	0.86	0.83	0.84	0.90	0.81	0.92	0.91	0.89	0.79	0.81	0.86	0.81	24.94	

SIM	pro	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	16.72													
DEA	0.85	15.56												
FRM	0.93	0.89	19.64											
ITA	0.83	0.82	0.82	15.94										
SVN	0.85	0.83	0.86	0.83	9.03									
FRA	0.90	0.87	0.90	0.84	0.84	21.88								
HUN	0.84	0.84	0.89	0.86	0.85	0.86	12.47							
NLD	0.84	0.92	0.88	0.83	0.84	0.85	0.83	22.61						
IRL	0.76	0.73	0.77	0.72	0.75	0.81	0.72	0.76	4.61					
SVK	0.84	0.83	0.84	0.83	0.85	0.84	0.86	0.84	0.75	10.24				
GBR	0.86	0.90	0.89	0.83	0.84	0.87	0.82	0.87	0.76	0.84	8.30			
HRV	0.84	0.83	0.90	0.82	0.84	0.84	0.84	0.84	0.75	0.84	0.84	10.75		
USA	0.86	0.83	0.84	0.87	0.81	0.89	0.88	0.86	0.76	0.81	0.84	0.81	15.12	

^APPENDIX 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	77	149	110	104	113	46	22	20	65	78
FRA	69	0	117	145	167	189	76	46	17	54	53
USA	145	78	0	296	219	294	72	32	24	87	114
CHE	89	108	278	0	394	514	83	57	19	69	98
ITA	91	133	152	339	0	620	111	73	22	74	97
DEA	95	142	258	408	524	0	125	83	26	74	108
NLD	42	62	63	74	91	117	0	35	18	38	49
SVN	20	46	25	58	74	76	36	0	4	19	21
NZL	20	13	21	14	16	21	11	3	0	17	22
GBR	64	43	78	53	52	51	30	14	15	0	52
AUS	77	41	104	59	65	73	37	17	17	41	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	77	149	110	104	113	46	22	20	65	78
FRA	69	0	117	145	167	189	76	46	17	54	53
USA	145	78	0	296	219	294	72	32	24	87	114
CHE	89	108	278	0	394	514	83	57	19	69	98
ITA	91	133	152	339	0	620	111	73	22	74	97
DEA	95	142	258	408	524	0	125	83	26	74	108
NLD	42	62	63	74	91	117	0	35	18	38	49
SVN	20	46	25	58	74	76	36	0	4	19	21
NZL	20	13	21	14	16	21	11	3	0	17	22
GBR	64	43	78	53	52	51	30	14	15	0	52
AUS	77	41	104	59	65	73	37	17	17	41	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	77	149	110	104	113	46	22	20	65	78
FRA	69	0	117	145	167	189	76	46	17	54	53
USA	145	78	0	296	219	294	72	32	24	87	114
CHE	89	108	278	0	394	514	83	57	19	69	98
ITA	91	133	152	339	0	620	111	73	22	74	97
DEA	95	142	258	408	524	0	125	83	26	74	108
NLD	42	62	63	74	91	117	0	35	18	38	49
SVN	20	46	25	58	74	76	36	0	4	19	21
NZL	20	13	21	14	16	21	11	3	0	17	22
GBR	64	43	78	53	52	51	30	14	15	0	52
AUS	77	41	104	59	65	73	37	17	17	41	0

GUE

common bulls below diagonal

common three quarter sib group above diagonal

	CAN	USA	AUS	GBR	ZAF	NZL
--	-----	-----	-----	-----	-----	-----

CAN	0	61	43	27	4	14
USA	52	0	55	83	10	31
AUS	40	50	0	34	5	27
GBR	22	85	29	0	4	15
ZAF	1	7	4	3	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	61	43	27	4	14
USA	52	0	55	83	10	31
AUS	40	50	0	34	5	27
GBR	22	85	29	0	4	15
ZAF	1	7	4	3	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	43	27	3	13
USA	51	0	55	83	10	31
AUS	40	50	0	34	5	27
GBR	22	85	29	0	4	15
ZAF	1	7	4	3	0	5
NZL	10	28	26	13	3	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 FRR HUN POL

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	FRR	HUN	POL															
ZAF	JPN	LVA	SVK	LTU	PRT	KOR	URY	HRV																													
		CAN	0	2004	1105	1182	1328	1116	2583	687	1313	595	999	433	381	1050	888	150	185	82	7	769	995														
444	1089	346	362	174	837	538	405	216																													
		DEU	1168	0	2464	2173	2255	2978	3139	989	1839	842	1311	722	666	1322	1685	241	335	124	113	1068	1915														
551	1283	588	660	405	1078	516	429	513																													
		DFS	776	1403	0	1410	1372	1743	1735	592	1316	710	972	520	561	862	1097	197	231	115	37	765	1264														
464	819	378	367	245	799	399	363	315																													
		FRA	672	952	627	0	1574	1650	2181	519	1319	689	987	559	551	950	1082	157	194	103	19	790	1251														
434	1031	315	353	182	783	421	343	218																													
		ITA	786	1218	844	685	0	1465	2249	599	1324	660	923	494	490	1070	1116	193	215	104	15	854	1256														
464	1023	391	354	220	872	490	392	295																													
		NLD	928	2490	1337	888	988	0	2066	739	1461	877	1101	746	661	919	1269	193	292	118	76	808	1382														
475	870	401	470	230	910	391	371	358																													
		USA	2477	1870	1115	1023	1165	1641	0	806	1802	924	1417	545	571	1292	1426	180	274	128	20	1078	1588														
595	1650	479	472	255	1108	701	584	293																													
		CHE	525	824	507	445	513	707	704	0	579	329	442	372	291	465	462	116	127	47	28	374	536														
240	378	218	196	95	440	209	178	167																													
		GBR	1420	1217	880	721	860	1168	1439	525	0	789	1055	516	696	909	902	174	196	103	18	725	1043														
474	873	328	326	202	824	410	382	267																													
		NZL	586	622	472	370	440	785	848	272	657	0	926	324	549	451	531	104	113	89	5	429	538														
343	469	187	220	130	487	257	294	174																													
		AUS	858	762	538	542	476	816	1178	341	747	849	0	424	481	654	647	124	153	77	11	521	694														
400	652	246	243	152	584	318	327	200																													
		BEL	382	653	434	507	392	797	426	346	451	246	312	0	290	407	404	118	105	50	28	331	454														
230	324	171	179	88	405	177	165	165																													
		IRL	307	505	406	371	351	555	448	266	636	429	346	256	0	377	388	84	99	66	4	324	427														
270	323	149	159	99	363	155	197	131																													
		ESP	578	792	595	646	710	776	767	363	692	333	389	370	329	0	739	149	158	87	10	633	840														
412	758	283	278	170	714	377	320	228																													
		CZE	566	1223	642	608	687	1058	1025	318	573	350	327	287	252	482	0	172	215	98	29	788	1105														
362	714	349	412	190	694	399	323	288																													
		SVN	107	225	163	107	154	163	139	82	123	72	75	91	60	106	132	0	69	33	12	133	190														
85	131	91	65	40	136	77	58	83																													
		EST	95	225	132	82	112	209	177	71	110	59	55	65	49	73	137	45	0	42	14	158	247														
87	154	146	97	59	158	84	88	94																													
		ISR	53	103	91	54	71	98	112	33	71	74	44	29	49	56	72	27	28	0	1	84	104														
55	78	51	37	33	88	44	56	52																													
		FRR	3	85	22	14	14	40	10	19	11	4	7	23	4	6	21	11	13	1	0	4	77														
7	2	22	19	0	9	1	1	12																													
		HUN	657	812	569	501	685	644	1002	301	611	342	327	259	261	493	689	102	98	68	4	0	766														
364	591	252	281	152	615	372	323	209																													
		POL	678	1507	905	663	846	1133	1309	425	768	377	371	378	302	552	828	169	169	83	82	644	0														
373	774	454	374	249	836	446	346	362																													
		ZAF	381	417	342	292	339	395	567	192	405	279	314	183	216	364	235	57	43	39	4	302	269														
0	386	144	163	88	393	240	248	128																													
		JPN	451	438	379	313	384	392	604	226	384	225	285	190	169	319	267	70	49	32	2	310	353														
251	0	264	262	152	594	445	331	168																													
		LVA	188	451	239	140	247	261	390	116	198	109	104	101	85	158	243	63	98	35	17	190	358														
86	114	0	146	134	317	172	149	204																													
		SVK	239	489	182	178	186	308	302	99	178	130	107	96	79	135	327	37	45	16	9	197	243														
92	84	73	0	75	279	168	158	107																													
		LTU	78	379	121	41	99	115	155	32	84	55	47	32	38	67	116	18	24	15	0	87	184														
32	35	99	36	0	162	105	85	114																													
		PRT	821	955	672	635	773	893	1118</td																												

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 FRR HUN POL
 ZAF JPN LVA SVK LTU PRT KOR URY HRV

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	68	323	143	195	134	28	125	66	58	6
DFS	53	0	142	115	105	133	71	113	95	100	17
USA	331	114	0	310	400	202	66	254	97	98	28
NZL	155	89	384	0	354	178	59	175	83	77	80
AUS	192	69	421	393	0	166	53	194	75	65	32
GBR	131	116	216	181	156	0	66	143	100	86	35
NLD	22	69	71	52	40	59	0	57	52	50	14
ZAF	119	89	262	181	177	143	53	0	89	77	21
ITA	62	92	103	81	70	102	51	83	0	71	10
DEU	55	93	99	72	54	84	47	74	73	0	12
IRL	3	14	28	87	27	36	14	20	11	13	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	68	323	143	195	134	28	125	66	58	6
DFS	53	0	142	115	105	133	71	113	95	100	17
USA	331	114	0	310	400	202	66	254	97	98	28
NZL	155	89	384	0	354	178	59	175	83	77	80
AUS	192	69	421	393	0	166	53	194	75	65	32
GBR	131	116	216	181	156	0	66	143	100	86	35
NLD	22	69	71	52	40	59	0	57	52	50	14
ZAF	119	89	262	181	177	143	53	0	89	77	21
ITA	62	92	103	81	70	102	51	83	0	71	10
DEU	55	93	99	72	54	84	47	74	73	0	12
IRL	3	14	28	87	27	36	14	20	11	13	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	68	323	143	195	134	28	125	66	58	6
DFS	53	0	142	115	105	133	71	113	95	100	17
USA	331	114	0	310	400	202	66	254	97	98	28
NZL	155	89	384	0	354	178	59	175	83	77	80
AUS	192	69	421	393	0	166	53	194	75	65	32
GBR	131	116	216	181	156	0	66	143	100	86	35
NLD	22	69	71	52	40	59	0	57	52	50	14
ZAF	119	89	262	181	177	143	53	0	89	77	21
ITA	62	92	103	81	70	102	51	83	0	71	10
DEU	55	93	99	72	54	84	47	74	73	0	12
IRL	3	14	28	87	27	36	14	20	11	13	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	178	71	87	66	119	11	73	1	9	14	2	4
NOR	4	0	55	36	51	23	103	17	0	15	20	25	39	28
USA	162	56	0	96	103	75	147	21	62	13	21	30	18	27
NZL	70	35	95	0	118	50	148	15	36	5	14	24	5	11
AUS	86	42	103	120	0	49	147	36	35	22	33	42	8	21
GBR	64	24	68	47	49	0	59	5	35	2	9	13	8	16
DFS	117	76	143	145	125	56	0	58	50	83	115	109	12	31
DEU	10	17	21	15	35	5	48	0	2	23	33	32	5	14
ZAF	75	0	56	31	34	30	47	2	0	0	2	5	0	2
EST	1	15	12	4	21	2	72	22	0	0	46	23	0	9
LVA	9	18	18	12	31	8	79	28	2	41	0	48	3	11
LTU	13	20	24	20	38	12	93	30	5	22	43	0	4	11
IRL	2	38	18	5	7	8	10	5	0	0	3	4	0	9
NLD	4	27	26	11	19	15	30	14	2	8	10	10	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	178	71	87	66	119	11	73	1	9	14	2	4
NOR	4	0	55	36	51	23	104	18	0	16	21	25	39	28
USA	162	56	0	96	103	74	147	21	62	13	21	30	18	27
NZL	70	35	95	0	118	50	148	15	36	5	14	24	5	11
AUS	86	42	103	120	0	49	147	36	35	22	33	42	8	21
GBR	64	24	68	47	49	0	59	5	35	2	9	13	8	16
DFS	117	77	143	145	125	56	0	58	50	83	115	109	12	30
DEU	10	18	21	15	35	5	48	0	2	23	33	32	5	14
ZAF	75	0	56	31	34	30	47	2	0	0	2	5	0	2
EST	1	16	12	4	21	2	72	22	0	0	46	23	0	9
LVA	9	19	18	12	31	8	79	28	2	41	0	48	3	11
LTU	13	20	24	20	38	12	93	30	5	22	43	0	4	11
IRL	2	38	18	5	7	8	10	5	0	0	3	4	0	9
NLD	4	27	26	11	19	15	30	14	2	8	10	10	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	178	71	87	66	119	11	73	1	9	14	2	4
NOR	4	0	55	36	51	23	104	18	0	16	21	25	39	28
USA	162	56	0	96	103	74	147	21	62	13	21	30	18	27
NZL	70	35	95	0	118	50	148	15	36	5	14	24	5	11
AUS	86	42	103	120	0	49	147	36	35	22	33	42	8	21
GBR	64	24	68	47	49	0	59	5	35	2	9	13	8	16
DFS	117	77	143	145	125	56	0	58	50	83	115	109	12	30
DEU	10	18	21	15	35	5	48	0	2	23	33	32	5	14
ZAF	75	0	56	31	34	30	47	2	0	0	2	5	0	2
EST	1	16	12	4	21	2	72	22	0	0	46	23	0	9
LVA	9	19	18	12	31	8	79	28	2	41	0	48	3	11
LTU	13	20	24	20	38	12	93	30	5	22	43	0	4	11
IRL	2	38	18	5	7	8	10	5	0	0	3	4	0	9
NLD	4	27	26	11	19	15	30	14	2	8	10	10	8	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	282	161	77	6	12	2	73	51	31	54	1	17
DEA	251	0	228	738	157	223	44	206	54	346	52	451	16
FRM	210	274	0	148	17	3	3	104	65	55	70	2	23
ITA	79	644	182	0	87	125	18	145	52	129	46	196	19
SVN	6	143	17	82	0	50	9	40	1	43	0	64	0
FRA	10	184	1	112	47	0	11	49	1	50	0	83	0
HUN	1	29	1	14	7	8	0	3	1	12	0	15	0
NLD	74	211	125	140	38	49	3	0	47	51	50	75	14
IRL	48	47	70	49	1	1	1	42	0	11	37	3	12
SVK	23	353	55	110	42	43	10	42	4	0	10	81	3
GBR	62	54	89	52	0	0	0	50	32	5	0	0	17
HRV	1	474	1	187	53	77	15	75	2	64	0	0	0
USA	18	22	37	26	0	0	0	17	12	3	24	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	282	161	77	6	12	2	73	51	31	54	1	17
DEA	251	0	228	738	157	223	44	206	54	346	52	449	16
FRM	210	274	0	148	17	3	3	104	65	55	70	2	23
ITA	79	644	182	0	87	125	18	145	52	129	46	194	19
SVN	6	143	17	82	0	50	9	40	1	43	0	64	0
FRA	10	184	1	112	47	0	11	49	1	50	0	83	0
HUN	1	29	1	14	7	8	0	3	1	12	0	15	0
NLD	74	211	125	140	38	49	3	0	47	51	50	75	14
IRL	48	47	70	49	1	1	1	42	0	11	37	3	12
SVK	23	353	55	110	42	43	10	42	4	0	10	79	3
GBR	62	54	89	52	0	0	0	50	32	5	0	0	17
HRV	1	472	1	185	53	77	15	75	2	62	0	0	0
USA	18	22	37	26	0	0	0	17	12	3	24	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	282	161	77	6	12	2	73	51	31	54	1	17
DEA	251	0	228	738	157	223	44	206	54	346	52	450	16
FRM	210	274	0	148	17	3	3	104	65	55	70	2	23
ITA	79	644	182	0	87	125	18	145	52	129	46	195	19
SVN	6	143	17	82	0	50	9	40	1	43	0	64	0
FRA	10	184	1	112	47	0	11	49	1	50	0	83	0
HUN	1	29	1	14	7	8	0	3	1	12	0	15	0
NLD	74	211	125	140	38	49	3	0	47	51	50	75	14
IRL	48	47	70	49	1	1	1	42	0	11	37	3	12
SVK	23	353	55	110	42	43	10	42	4	0	10	80	3
GBR	62	54	89	52	0	0	0	50	32	5	0	0	17
HRV	1	473	1	186	53	77	15	75	2	63	0	0	0
USA	18	22	37	26	0	0	0	17	12	3	24	0	0