

Introduction

The latest international evaluation for dairy **production traits** took place as scheduled at the Interbull Centre. Data from twenty nine (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, Uruguay and Mexico were computed. Brown Swiss, Guernsey, Holstein, Jersey, Red Dairy Cattle and Simmental breed data were included in this evaluation.

Changes in national procedures

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

SVN (HOL,BSW,SIM)	Changed the definition of genetic reference base. As genetic reference base we use population average. Genetic parameters were recalculated
MEX (HOL)	First time
LTU (HOL,RDC)	Base change
IRL (HOL,RDC,IRL)	Base change
USA (SIM)	Corrected some heterosis adjustments previously computed incorrectly
CHE (BSW,HOL,SIM)	Base change
FRA (HOL)	Inclusion of FRR population in HOLFRA, Base change
FRA (BSW,SIM)	Base change
FRM (SIM)	Base change
NLD (ALL)	Introduction of the 4th and 5th lactation
ITA (HOL)	Base change plus one year cut-off of data
DEU (HOL,RDC,JER)	Base change
NZL (ALL)	Continuous DNA parentage testing therefore daughter counts, herd counts, edc and reliability are subjected to changes
JPN (HOL)	Little changes in proofs caused by additional records and modification of pedigree.
DEA (BSW,SIM)	Base change
EST (HOL)	Pedigree updates for some cows
GBR (ALL)	New model with fixed lactation curves, age-season subclasses fitted within newly defined groups of calving years and breed of animals defined on the basis of breed proportion. In addition some data edits were done as well so some bulls will lose daughters/herds
CAN (ALL)	Base change
ITA (SIM)	Base change, inclusion of Interbull pedigree in national one's so to have a deeper pedigree structure; new updated reliability software (accf90) which causes decreases in reliability
AUS (HOL, JER)	Changing from old single trait model to RR test-day model and applying a base change

INTERBULL CHANGES COMPARED TO THE DECEMBER ROUTINE RUN

Sub-setting:

As decided by the ITC in Orlando, new sub-setting was introduced in the September test run. Sub-setting is necessary for operational purposes and restrictions of time scales. To minimize the effect of sub-setting, 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 conformation traits. It is anticipated that these low values may not have large impact on evaluations since there were very few countries combinations whose estimated correlations fell between the old limit of 0.30 and these new limits.

DATA AND METHOD OF ANALYSIS

Data were national genetic evaluations of AI sampled bulls with at least 10 daughters or 10 EDC (for clinical mastitis and maternal calving traits at least 50 daughters or 50 EDC, and for direct calving traits at least 50 calvings or 50 EDC) in at least 10 herds. Table 1 presents the amount of data included in this Interbull evaluation for all breeds.

National proofs were first de-regressed within country and then analysed jointly with a linear model including the effects of evaluation country, genetic group of bull and bull merit. Heritability estimates used in both the de-regression and international evaluation were as in each country's national evaluation.

Table 2 presents the date of evaluation as supplied by each country. Estimated genetic parameters and sire standard deviations are shown in APPENDIX I and the corresponding number of common bulls are listed in APPENDIX II.

SCIENTIFIC LITERATURE

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

International genetic evaluation computation:

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

Verification and Genetic trend validation:

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

Weighting factors:

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

De-regression:

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

Genetic parameter estimation:

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

Post-processing of estimated genetic correlations:

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

Time edits

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

International reliability estimation

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

NEXT ROUTINE INTERNATIONAL EVALUATION

Dates for the next routine evaluation can be found on <http://www.interbull.org/ib/servicecalendar>.

NEXT TEST INTERNATIONAL EVALUATION

Dates for the next test run can be found on <http://www.interbull.org/ib/servicecalendar>.

PUBLICATION OF INTERBULL TEST RUN

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

^LTable 1. National evaluation data considered in the Interbull evaluation for dairy production traits (April Routine Evaluation 2017).

Number of records for milk yield by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS	191	135	7639	1678	672	
BEL			1145			
CAN	203	94	11373	650	762	
CHE	2779		3109			3022
CZE			4010			
DEA	5712					22678
DEU			26370	165	408	
DFS			12478	2026	7378	
ESP			3333			
EST			1025		401	
FRA	361		16412			430
FRM						4378
GBR	138	318	6610	847	583	91
HUN			3022			204
IRL			2218	131	42	92
ISR			1295			
ITA	1996		8979	169		1539
JPN			5404			
KOR			1098			
LTU			713		410	
LVA			991		682	
NLD	167		14527	128	62	305
NOR					3937	
NZL	48	60	7033	4554	1299	
POL			9404			
PRT			2150			
SVK			1058			557
SVN	346		470			567
URY			956			
USA	1038	757	35542	4175	664	41
ZAF			1256	675	140	
HRV			673			764
MEX			599			
No. Records	12979	1364	190892	15198	17440	34668
Pub. Proofs	10615	1092	146925	12404	15631	31388

^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	608.14										
FRA	0.89	640.95									
USA	0.93	0.89	623.43								
CHE	0.90	0.89	0.87	488.36							
ITA	0.88	0.83	0.88	0.87	590.30						
DEA	0.88	0.83	0.86	0.93	0.90	462.53					
NLD	0.88	0.88	0.87	0.85	0.84	0.85	580.96				
SVN	0.83	0.81	0.82	0.81	0.81	0.81	0.82	9.80			
NZL	0.70	0.76	0.71	0.76	0.70	0.74	0.73	0.75	340.77		
GBR	0.85	0.87	0.85	0.86	0.82	0.83	0.87	0.84	0.71	252.53	
AUS	0.76	0.77	0.74	0.73	0.71	0.72	0.77	0.73	0.84	0.75	404.07

BSW fat

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	26.37										
FRA	0.89	27.38									
USA	0.91	0.89	23.50								
CHE	0.87	0.87	0.84	19.11							
ITA	0.89	0.83	0.85	0.87	22.69						
DEA	0.87	0.84	0.83	0.93	0.88	17.43					
NLD	0.87	0.87	0.86	0.85	0.84	0.86	25.02				
SVN	0.83	0.81	0.82	0.81	0.81	0.81	0.82	10.21			
NZL	0.71	0.74	0.71	0.74	0.70	0.83	0.71	0.75	14.86		
GBR	0.86	0.88	0.85	0.87	0.82	0.83	0.87	0.84	0.71	8.86	
AUS	0.75	0.76	0.73	0.71	0.71	0.72	0.74	0.73	0.83	0.74	15.76

BSW pro

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	22.61										
FRA	0.84	20.72									
USA	0.90	0.86	18.77								
CHE	0.86	0.85	0.82	15.26							
ITA	0.85	0.82	0.83	0.86	20.71						
DEA	0.87	0.82	0.82	0.91	0.89	14.41					
NLD	0.86	0.84	0.84	0.83	0.82	0.83	19.30				
SVN	0.83	0.81	0.82	0.81	0.81	0.81	0.82	9.72			
NZL	0.70	0.71	0.70	0.71	0.70	0.75	0.71	0.75	10.40		
GBR	0.84	0.86	0.83	0.84	0.81	0.83	0.86	0.84	0.71	7.32	
AUS	0.70	0.73	0.70	0.71	0.69	0.72	0.73	0.73	0.82	0.73	12.08

GUE mil

	CAN	USA	AUS	GBR	NZL
CAN	731.79				
USA	0.94	708.00			
AUS	0.82	0.78	486.64		
GBR	0.86	0.83	0.77	239.71	
NZL	0.70	0.70	0.84	0.70	325.40

GUE fat

	CAN	USA	AUS	GBR	NZL
CAN	30.18				
USA	0.93	25.29			
AUS	0.80	0.76	17.70		
GBR	0.86	0.84	0.76	10.18	
NZL	0.72	0.71	0.84	0.70	16.40

GUE pro

	CAN	USA	AUS	GBR	NZL
CAN	22.00				
USA	0.92	19.53			
AUS	0.74	0.70	13.88		
GBR	0.85	0.83	0.74	7.10	
NZL	0.70	0.69	0.82	0.69	10.79

SIM	fat											
	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV
USA												
CHE	22.48											
DEA	0.88	19.32										
FRM	0.94	0.91	24.77									
ITA	0.83	0.83	0.81	19.66								
SVN	0.84	0.82	0.84	0.82	9.17							
FRA	0.90	0.92	0.89	0.85	0.83	27.56						
HUN	0.82	0.83	0.89	0.88	0.84	0.87	14.74					
NLD	0.88	0.92	0.90	0.83	0.83	0.89	0.84	28.08				
IRL	0.75	0.72	0.76	0.72	0.74	0.85	0.71	0.78	5.30			
SVK	0.83	0.82	0.83	0.81	0.83	0.83	0.85	0.83	0.74	13.25		
GBR	0.91	0.88	0.87	0.83	0.82	0.89	0.83	0.87	0.77	0.83	8.06	
HRV	0.83	0.82	0.89	0.81	0.83	0.83	0.84	0.83	0.75	0.83	0.82	10.80
USA	0.86	0.84	0.85	0.90	0.81	0.92	0.91	0.89	0.79	0.81	0.86	0.81
20.05												

SIM	pro											
	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV
USA												
CHE	16.58											
DEA	0.85	15.50										
FRM	0.93	0.88	19.52									
ITA	0.83	0.81	0.81	15.66								
SVN	0.84	0.82	0.84	0.82	9.10							
FRA	0.90	0.87	0.90	0.83	0.84	21.45						
HUN	0.83	0.83	0.89	0.86	0.84	0.86	12.43					
NLD	0.84	0.92	0.87	0.82	0.83	0.85	0.82	23.22				
IRL	0.75	0.72	0.78	0.71	0.74	0.81	0.70	0.75	4.63			
SVK	0.83	0.82	0.83	0.81	0.83	0.83	0.85	0.83	0.74	10.49		
GBR	0.86	0.89	0.89	0.82	0.83	0.87	0.82	0.87	0.76	0.83	6.98	
HRV	0.83	0.82	0.90	0.81	0.83	0.83	0.84	0.83	0.74	0.83	0.83	10.97
USA	0.86	0.83	0.86	0.87	0.81	0.89	0.87	0.87	0.75	0.81	0.84	0.81
16.00												

^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	73	146	107	99	115	45	25	19	59	74	
FRA	50	0	117	146	168	191	78	49	19	54	56	
USA	110	78	0	297	221	301	73	36	26	86	116	
CHE	68	109	280	0	398	525	84	67	21	69	102	
ITA	66	134	154	342	0	636	112	83	24	74	104	
DEA	75	143	264	422	540	0	126	93	29	74	113	
NLD	37	63	63	75	92	119	0	37	20	39	51	
SVN	19	48	28	64	82	86	38	0	6	21	25	
NZL	14	15	23	16	18	24	13	5	0	18	24	
GBR	46	43	77	51	52	50	30	15	15	0	53	
AUS	59	45	110	65	74	78	39	20	19	46	0	

BSW

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common bulls below diagonal
common three quarter sib group above diagonal
      CAN  FRA  USA  CHE  ITA  DEA  NLD  SVN  NZL  GBR  AUS
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CAN      0   73  146  107   99  115   45   25   19   59   74
FRA     50    0  117  146  168  191   78   49   19   54   56
USA    110   78    0  297  221  301   73   36   26   86  116
CHE     68  109  280    0  398  525   84   67   21   69  102
ITA     66  134  154  342    0  636  112   83   24   74  104
DEA     75  143  264  422  540    0  126   93   29   74  113
NLD     37   63   63   75   92  119    0   37   20   39   51
SVN     19   48   28   64   82   86   38    0    6   21   25
NZL     14   15   23   16   18   24   13    5    0   18   24
GBR     46   43   77   51   52   50   30   15   15    0   53
AUS     59   45  110   65   74   78   39   20   19   46    0
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BSW

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common bulls below diagonal
common three quarter sib group above diagonal
      CAN  FRA  USA  CHE  ITA  DEA  NLD  SVN  NZL  GBR  AUS
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CAN      0   73  146  107   99  115   45   25   19   59   74
FRA     50    0  117  146  168  191   78   49   19   54   56
USA    110   78    0  297  221  301   73   36   26   86  116
CHE     68  109  280    0  398  525   84   67   21   69  102
ITA     66  134  154  342    0  636  112   83   24   74  104
DEA     75  143  264  422  540    0  126   93   29   74  113
NLD     37   63   63   75   92  119    0   37   20   39   51
SVN     19   48   28   64   82   86   38    0    6   21   25
NZL     14   15   23   16   18   24   13    5    0   18   24
GBR     46   43   77   51   52   50   30   15   15    0   53
AUS     59   45  110   65   74   78   39   20   19   46    0
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GUE

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common bulls below diagonal
common three quarter sib group above diagonal
      CAN  USA  AUS  GBR  NZL
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CAN      0   62  43  27  14
USA     53    0  59  83  31
AUS     42   55    0  37  27
GBR     22   85   32    0  15
NZL     10   28   26   13    0
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GUE

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-----
common bulls below diagonal
common three quarter sib group above diagonal
      CAN  USA  AUS  GBR  NZL
-----
CAN      0   62  43  27  14
USA     53    0  59  83  31
AUS     42   55    0  37  27
GBR     22   85   32    0  15
NZL     10   28   26   13    0
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GUE

common bulls below diagonal

common three quarter sib group above diagonal

CAN USA AUS GBR NZL

CAN	0	61	43	27	13
USA	52	0	59	83	31
AUS	42	55	0	37	27
GBR	22	85	32	0	15
NZL	10	28	26	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	2076	1132	1229	1354	1161	2692	723	1359	617	1153	448	386	1072	917	164	199	88	805
1041	457	1114	362	379	186	858	538	416	228	351									
DEU	1246	0	2518	2329	2271	3069	3229	1026	1888	873	1510	740	673	1343	1729	257	353	133	1107
1991	566	1319	614	682	428	1108	509	440	531	345									
DFS	814	1480	0	1469	1380	1805	1766	616	1349	732	1113	533	572	871	1117	211	246	122	786
1307	478	836	396	380	257	818	393	370	334	281									
FRA	712	1083	675	0	1568	1748	2250	567	1368	714	1124	592	561	974	1122	171	217	111	822
1367	450	1060	341	381	193	806	416	355	236	291									
ITA	835	1246	873	697	0	1473	2245	621	1347	667	1051	503	487	1074	1132	207	226	107	867
1296	463	1026	406	366	227	878	479	392	306	321									
NLD	978	2609	1413	962	1015	0	2127	764	1513	906	1277	767	670	932	1309	208	303	126	832
1440	487	893	420	488	246	931	386	376	372	291									
USA	2645	1968	1167	1074	1211	1700	0	841	1859	950	1627	561	579	1321	1463	198	290	135	1113
1654	608	1680	503	490	274	1140	687	600	306	438									
CHE	560	868	531	486	531	738	742	0	602	341	521	387	302	481	481	124	136	50	391
567	248	398	232	209	100	452	215	184	173	168									
GBR	1477	1270	919	762	888	1218	1511	542	0	816	1220	532	707	931	929	183	210	109	745
1084	485	897	345	339	215	842	410	389	278	312									
NZL	604	654	492	386	445	815	873	284	682	0	1073	332	557	464	546	111	118	94	445
562	352	482	200	229	137	497	258	304	184	189									
AUS	1066	1016	726	698	664	1063	1507	452	979	1057	0	483	550	749	760	156	186	88	608
848	449	749	298	282	174	691	356	373	240	259									
BEL	402	682	456	545	409	823	446	365	475	254	397	0	298	420	413	122	111	53	339
469	237	335	179	187	93	419	183	169	171	154									
IRL	315	520	419	384	348	567	456	277	648	435	433	270	0	382	392	87	102	69	331
433	277	328	151	162	106	366	155	202	135	136									
ESP	600	826	613	674	722	807	792	387	718	345	515	394	341	0	751	159	167	90	651
862	424	776	294	287	176	726	373	326	234	273									
CZE	593	1258	666	642	714	1108	1062	331	588	361	452	299	259	506	0	184	225	104	811
1134	372	727	363	430	202	711	400	331	302	265									
SVN	114	242	175	118	168	176	148	92	129	76	110	94	63	116	140	0	74	38	139
204	89	141	93	71	44	141	80	61	85	60									
EST	102	240	141	96	119	217	185	75	116	60	83	66	50	76	140	44	0	42	166
260	94	164	151	103	65	166	86	89	102	66									
ISR	56	109	97	58	69	104	118	34	73	78	57	31	51	56	78	29	28	0	90
108	55	83	52	40	35	89	46	57	55	40									
HUN	695	842	586	519	704	660	1047	312	632	355	446	267	266	511	714	107	102	71	0
798	374	615	267	290	160	632	377	327	215	279									
POL	734	1594	951	777	887	1204	1401	448	816	402	578	400	313	580	865	180	178	86	679
0	389	809	480	389	269	865	452	358	380	305									
ZAF	388	429	353	301	339	407	579	198	414	287	381	189	224	372	244	60	47	39	305
281	0	397	147	169	89	403	246	253	133	205									
JPN	473	462	398	328	402	412	632	239	401	234	370	203	174	334	282	77	53	35	326
373	255	0	273	275	159	606	438	340	175	286									
LVA	195	480	251	154	254	275	410	119	206	115	146	105	87	159	249	64	101	36	203
379	88	116	0	152	138	334	173	154	208	132									
SVK	256	508	193	191	201	326	318	105	189	135	138	100	80	143	343	41	48	17	207
257	94	95	74	0	78	287	175	159	111	119									
LTU	84	400	128	45	104	128	169	35	93	57	63	33	41	67	125	20	28	16	93
195	32	38	102	38	0	168	106	91	119	64									
PRT	842	994	693	654	780	913	1155	387	751	401	516	396	303	679	574	109	109	67	600
855	357	345	262	194	105	0	394	351	272	327									
KOR	492	337	271	234	385	264	812	146	300	189	257	114	99	267	286	48	44	31	320
370	186	253	106	109	49	331	0	262	106	240									
URY	389	310	265	205	283	292	753	137	325	239	276	119	150	265	245	35	50	31	281
299	214	199	99	113	52	316	221	0	111	222									
HRV	112	544	253	139	221	329	227	114	195	106	147	136	92	180	225	70	72	40	163
330	89	78	170	57	81	219	48	63	0	102									
MEX	352	283	233	225	293	241	523	147	280	149	212	138	110	248	218	45	49	25	267
286	192	216	88	74	29	340	228	211	69	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	2077	1132	1230	1357	1161	2693	723	1359	617	1153	448	386	1072	917	164	199	88	805
1042	457	1112	362	379	186	856	539	416	228	134									
DEU	1248	0	2518	2329	2275	3069	3229	1026	1887	873	1510	740	673	1343	1729	257	353	133	1107
1991	566	1316	614	682	428	1106	509	440	531	129									
DFS	815	1480	0	1469	1383	1805	1766	616	1348	732	1113	533	572	871	1117	211	246	122	786
1307	478	833	396	380	257	816	393	370	334	116									
FRA	713	1083	675	0	1571	1748	2250	567	1367	714	1124	592	561	974	1122	171	217	111	822
1367	450	1057	341	381	193	806	416	355	236	120									
ITA	838	1251	876	700	0	1476	2250	623	1348	670	1054	505	489	1077	1132	207	226	109	869
1299	464	1025	406	366	227	879	481	394	306	118									
NLD	979	2609	1413	962	1020	0	2127	764	1512	906	1277	767	670	932	1309	208	303	126	832
1440	487	890	420	488	246	931	386	376	372	120									
USA	2647	1968	1167	1074	1221	1700	0	841	1859	950	1627	561	579	1321	1463	198	290	135	1113
1654	608	1677	503	490	274	1139	687	600	306	141									
CHE	561	868	531	486	533	738	742	0	601	341	521	387	302	481	481	124	136	50	391
567	248	395	232	209	100	452	215	184	173	90									
GBR	1478	1270	919	762	889	1218	1511	542	0	815	1219	531	707	931	928	183	210	109	745
1083	485	894	344	339	215	841	410	389	277	124									
NZL	605	654	492	386	449	815	873	284	682	0	1073	332	557	464	546	111	118	94	445
562	352	481	200	229	137	497	258	304	184	96									
AUS	1066	1016	726	698	667	1063	1507	452	979	1057	0	483	550	749	760	156	186	88	608
848	449	746	298	282	174	691	356	373	240	114									
BEL	402	682	456	545	410	823	446	365	475	254	397	0	298	420	413	122	111	53	339
469	237	334	179	187	93	419	183	169	171	86									
IRL	315	520	419	384	350	567	456	277	648	435	433	270	0	382	392	87	102	69	331
433	277	327	151	162	106	366	155	202	135	72									
ESP	601	826	613	674	727	807	792	387	718	345	515	394	341	0	751	159	167	90	651
862	424	774	294	287	176	726	373	326	234	114									
CZE	593	1257	665	642	714	1107	1062	331	588	361	452	299	259	505	0	184	225	104	811
1134	372	726	363	430	202	710	400	331	302	91									
SVN	114	242	175	118	168	176	148	92	129	76	110	94	63	116	140	0	74	38	139
204	89	140	93	71	44	141	80	61	85	33									
EST	102	240	141	96	119	217	185	75	116	60	83	66	50	76	140	44	0	42	166
260	94	163	151	103	65	166	86	89	102	27									
ISR	56	109	97	58	71	104	118	34	73	78	57	31	51	56	78	29	28	0	90
108	55	83	52	40	35	89	46	57	55	14									
HUN	696	842	586	519	706	660	1047	312	632	355	446	267	266	511	714	107	102	71	0
798	374	613	267	290	160	632	377	327	215	106									
POL	735	1594	951	777	889	1204	1401	448	816	402	578	400	313	580	864	180	178	86	679
0	389	806	480	389	269	864	452	358	380	97									
ZAF	389	429	353	301	341	407	579	198	414	287	381	189	224	372	244	60	47	39	305
281	0	396	147	169	89	403	246	253	133	99									
JPN	471	459	395	325	398	408	626	236	397	232	365	202	173	331	281	76	52	35	325
369	254	0	273	273	159	604	438	339	175	123									
LVA	195	480	251	154	254	275	410	119	206	115	146	105	87	159	249	64	101	36	203
379	88	116	0	152	138	334	173	154	208	41									
SVK	256	508	193	191	201	326	318	105	189	135	138	100	80	143	342	41	48	17	207
257	94	93	74	0	78	287	175	159	111	54									
LTU	84	400	128	45	104	128	169	35	93	57	63	33	41	67	125	20	28	16	93
195	32	38	102	38	0	168	106	91	119	23									
PRT	843	994	693	654	782	915	1157	387	752	401	516	397	304	681	574	109	109	67	601
856	358	343	262	195	105	0	393	351	272	119									
KOR	493	337	271	234	389	264	811	146	300	189	257	114	99	267	286	48	44	31	320
370	186	252	106	109	49	331	0	262	106	92									
URY	389	310	265	205	286	292	753	137	325	239	276	119	150	265	245	35	50	31	281
299	214	196	99	113	52	318	221	0	111	93									
HRV	112	544	253	139	221	329	227	114	195	106	147	136	92	180	225	70	72	40	163
330	89	78	170	57	81	219	48	63	0	41									
MEX	162	143	120	124	123	130	181	92	149	93	118	92	73	131	72	26	18	9	113
99	110	119	26	40	7	142	95	100	29	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	2076	1132	1229	1354	1161	2686	723	1359	617	1153	448	386	1072	917	164	199	88	805
1041	457	1110	362	379	186	858	538	416	228	133									
DEU	1246	0	2518	2329	2271	3069	3225	1026	1887	873	1510	740	673	1343	1729	257	353	133	1107
1991	566	1316	614	682	428	1108	509	440	531	128									
DFS	814	1480	0	1469	1380	1805	1764	616	1348	732	1113	533	572	871	1117	211	246	122	786
1307	478	833	396	380	257	818	393	370	334	115									
FRA	712	1083	675	0	1568	1748	2249	567	1367	714	1124	592	561	974	1122	171	217	111	822
1367	450	1057	341	381	193	805	416	355	236	119									
ITA	835	1246	873	697	0	1473	2245	621	1346	667	1051	503	487	1074	1132	207	226	107	867
1296	463	1024	406	366	227	877	479	392	306	117									
NLD	978	2609	1413	962	1015	0	2126	764	1512	906	1277	767	670	932	1309	208	303	126	832
1440	487	889	420	488	246	930	386	376	372	119									
USA	2642	1966	1167	1074	1211	1700	0	841	1858	950	1624	560	579	1320	1463	198	290	135	1113
1654	608	1674	503	489	274	1139	688	600	306	140									
CHE	560	868	531	486	531	738	742	0	601	341	521	387	302	481	481	124	136	50	391
567	248	394	232	209	100	452	215	184	173	89									
GBR	1477	1270	919	762	888	1218	1511	542	0	815	1219	531	707	931	928	183	210	109	745
1083	485	894	344	339	215	840	410	389	277	123									
NZL	604	654	492	386	445	815	873	284	682	0	1073	332	557	464	546	111	118	94	445
562	352	481	200	229	137	497	258	304	184	95									
AUS	1066	1016	726	698	664	1063	1505	452	979	1057	0	483	550	749	760	156	186	88	608
848	449	746	298	282	174	691	356	373	240	113									
BEL	402	682	456	545	409	823	445	365	475	254	397	0	298	420	413	122	111	53	339
469	237	334	179	187	93	419	183	169	171	85									
IRL	315	520	419	384	348	567	456	277	648	435	433	270	0	382	392	87	102	69	331
433	277	327	151	162	106	366	155	202	135	71									
ESP	600	826	613	674	722	807	792	387	718	345	515	394	341	0	751	159	167	90	651
862	424	774	294	287	176	725	373	326	234	113									
CZE	593	1257	665	642	714	1107	1062	331	588	361	452	299	259	505	0	184	225	104	811
1134	372	726	363	430	202	710	400	331	302	90									
SVN	114	242	175	118	168	176	148	92	129	76	110	94	63	116	140	0	74	38	139
204	89	140	93	71	44	141	80	61	85	33									
EST	102	240	141	96	119	217	185	75	116	60	83	66	50	76	140	44	0	42	166
260	94	162	151	103	65	166	86	89	102	27									
ISR	56	109	97	58	69	104	118	34	73	78	57	31	51	56	78	29	28	0	90
108	55	83	52	40	35	89	46	57	55	14									
HUN	695	842	586	519	704	660	1047	312	632	355	446	267	266	511	714	107	102	71	0
798	374	613	267	290	160	631	377	327	215	105									
POL	734	1594	951	777	887	1204	1401	448	816	402	578	400	313	580	864	180	178	86	679
0	389	806	480	389	269	864	452	358	380	96									
ZAF	388	429	353	301	339	407	579	198	414	287	381	189	224	372	244	60	47	39	305
281	0	396	147	169	89	403	246	253	133	98									
JPN	469	459	395	325	398	407	625	236	397	232	365	202	173	331	281	76	51	35	325
369	254	0	273	273	159	603	438	339	175	122									
LVA	195	480	251	154	254	275	410	119	206	115	146	105	87	159	249	64	101	36	203
379	88	116	0	152	138	334	173	154	208	41									
SVK	256	508	193	191	201	326	317	105	189	135	138	100	80	143	342	41	48	17	207
257	94	93	74	0	78	286	175	159	111	54									
LTU	84	400	128	45	104	128	169	35	93	57	63	33	41	67	125	20	28	16	93
195	32	38	102	38	0	168	106	91	119	23									
PRT	844	994	694	653	779	914	1156	387	750	400	515	396	303	679	574	108	109	66	600
854	358	343	262	195	105	0	393	350	272	118									
KOR	492	337	271	234	385	264	813	146	300	189	257	114	99	267	286	48	44	31	320
370	186	252	106	109	49	331	0	262	106	92									
URY	389	310	265	205	283	292	753	137	325	239	276	119	150	265	245	35	50	31	281
299	214	196	99	113	52	317	221	0	111	92									
HRV	112	544	253	139	221	329	227	114	195	106	147	136	92	180	225	70	72	40	163
330	89	78	170	57	81	218	48	63	0	40									
MEX	159	141	119	123	122	129	179	91	147	92	117	91	72	130	70	26	17	9	112
98	109	117	26	40	7	141	95	98	28	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	70	342	156	220	139	29	134	68	60	7
DFS	55	0	143	115	113	135	76	119	96	101	17
USA	353	115	0	322	434	206	66	267	100	102	28
NZL	166	89	396	0	399	185	59	182	83	79	80
AUS	222	77	466	445	0	186	56	208	82	73	39
GBR	134	118	218	185	181	0	68	149	102	89	39
NLD	23	74	71	52	47	61	0	61	53	51	14
ZAF	128	95	275	188	194	149	57	0	90	82	22
ITA	65	93	107	81	77	103	52	83	0	72	11
DEU	57	94	103	74	63	87	47	79	74	0	12
IRL	4	14	28	87	34	40	14	21	12	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	70	342	156	220	138	29	134	68	60	7
DFS	55	0	143	115	113	134	76	119	96	101	17
USA	353	115	0	322	434	205	66	267	100	102	28
NZL	166	89	396	0	399	184	59	182	83	79	80
AUS	222	77	466	445	0	185	56	208	82	73	39
GBR	134	118	218	185	181	0	68	149	101	89	39
NLD	23	74	71	52	47	61	0	61	53	51	14
ZAF	128	95	275	188	194	149	57	0	90	82	22
ITA	65	93	107	81	77	103	52	83	0	72	11
DEU	57	94	103	74	63	87	47	79	74	0	12
IRL	4	14	28	87	34	40	14	21	12	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	70	342	156	220	138	29	134	68	60	7
DFS	55	0	143	115	113	134	76	119	96	101	17
USA	353	115	0	322	434	205	66	267	100	102	28
NZL	166	89	396	0	399	184	59	182	83	79	80
AUS	222	77	466	445	0	185	56	208	82	73	39
GBR	134	118	218	185	181	0	68	149	101	89	39
NLD	23	74	71	52	47	61	0	61	53	51	14
ZAF	128	95	275	188	194	149	57	0	90	82	22
ITA	65	93	107	81	77	103	52	83	0	72	11
DEU	57	94	103	74	63	87	47	79	74	0	12
IRL	4	14	28	87	34	40	14	21	12	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	184	75	93	73	122	13	73	1	9	15	2	4
NOR	4	0	60	40	54	35	106	18	0	16	20	25	39	29
USA	167	61	0	105	111	93	155	25	62	13	21	32	18	29
NZL	74	39	104	0	128	67	158	20	36	8	16	26	5	13
AUS	92	45	109	130	0	70	157	38	36	24	35	44	8	22
GBR	71	36	85	63	70	0	86	18	36	6	16	24	13	25
DFS	122	79	150	155	133	83	0	63	50	86	117	112	12	34
DEU	12	18	25	20	37	17	53	0	2	24	34	37	5	14
ZAF	75	0	56	31	35	31	47	2	0	0	2	5	0	2
EST	1	16	12	7	22	5	75	23	0	0	47	24	0	12
LVA	9	18	18	13	31	15	79	29	2	41	0	51	3	11
LTU	14	20	26	22	39	22	95	34	5	23	46	0	4	12
IRL	2	38	18	5	7	12	10	5	0	0	3	4	0	9
NLD	4	28	28	13	20	23	33	14	2	11	10	11	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	184	75	93	73	122	13	73	1	9	15	2	4
NOR	4	0	60	40	54	35	107	19	0	17	21	25	39	29
USA	167	61	0	105	111	92	155	25	62	13	21	32	18	29
NZL	74	39	104	0	128	67	158	20	36	8	16	26	5	13
AUS	92	45	109	130	0	70	157	38	36	24	35	44	8	22
GBR	71	36	85	63	70	0	86	18	36	6	16	24	13	25
DFS	122	80	150	155	133	83	0	63	50	86	117	112	12	34
DEU	12	19	25	20	37	17	53	0	2	24	34	37	5	14
ZAF	75	0	56	31	35	31	47	2	0	0	2	5	0	2
EST	1	17	12	7	22	5	75	23	0	0	47	24	0	12
LVA	9	19	18	13	31	15	79	29	2	41	0	51	3	11
LTU	14	20	26	22	39	22	95	34	5	23	46	0	4	12
IRL	2	38	18	5	7	12	10	5	0	0	3	4	0	9
NLD	4	28	28	13	20	23	33	14	2	11	10	11	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	184	75	93	73	122	13	73	1	9	15	2	4
NOR	4	0	60	40	54	35	107	19	0	17	21	25	39	29
USA	167	61	0	105	111	92	155	25	62	13	21	32	18	29
NZL	74	39	104	0	128	67	158	20	36	8	16	26	5	13
AUS	92	45	109	130	0	70	157	38	36	24	35	44	8	22
GBR	71	36	85	63	70	0	86	18	36	6	16	24	13	25
DFS	122	80	150	155	133	83	0	63	50	86	117	111	12	34
DEU	12	19	25	20	37	17	53	0	2	24	34	37	5	14
ZAF	75	0	56	31	35	31	47	2	0	0	2	5	0	2
EST	1	17	12	7	22	5	75	23	0	0	47	24	0	12
LVA	9	19	18	13	31	15	79	29	2	41	0	51	3	11
LTU	14	20	26	22	39	22	94	34	5	23	46	0	4	12
IRL	2	38	18	5	7	12	10	5	0	0	3	4	0	9
NLD	4	28	28	13	20	23	33	14	2	11	10	11	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	291	168	80	6	11	2	76	52	30	55	1	17
DEA	258	0	233	780	167	230	44	214	54	351	53	470	16
FRM	217	275	0	150	17	3	3	106	65	56	72	2	26
ITA	80	684	184	0	94	130	19	152	53	132	48	203	19
SVN	6	153	17	90	0	53	10	43	1	44	0	67	0
FRA	9	191	1	116	49	0	11	52	1	51	0	83	0
HUN	1	30	1	15	8	8	0	4	1	12	0	17	0
NLD	77	220	128	148	41	52	4	0	48	56	51	79	14
IRL	48	47	70	51	1	1	1	43	0	11	37	3	12
SVK	22	358	55	111	43	44	10	47	4	0	10	82	3
GBR	63	55	91	52	0	0	0	52	32	5	0	0	18
HRV	1	495	1	194	57	77	16	78	2	65	0	0	0
USA	18	23	41	26	0	0	0	17	12	3	25	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	291	168	80	6	11	2	76	52	30	55	1	17
DEA	258	0	233	780	167	230	44	214	54	351	53	468	16
FRM	217	275	0	150	17	3	3	106	65	56	72	2	26
ITA	80	684	184	0	94	130	19	152	53	132	48	201	19
SVN	6	153	17	90	0	53	10	43	1	44	0	67	0
FRA	9	191	1	116	49	0	11	52	1	51	0	83	0
HUN	1	30	1	15	8	8	0	4	1	12	0	17	0
NLD	77	220	128	148	41	52	4	0	48	56	51	79	14
IRL	48	47	70	51	1	1	1	43	0	11	37	3	12
SVK	22	358	55	111	43	44	10	47	4	0	10	80	3
GBR	63	55	91	52	0	0	0	52	32	5	0	0	18
HRV	1	493	1	192	57	77	16	78	2	63	0	0	0
USA	18	23	41	26	0	0	0	17	12	3	25	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	291	168	80	6	11	2	76	52	30	55	1	17
DEA	258	0	233	780	167	230	44	214	54	351	53	469	16
FRM	217	275	0	150	17	3	3	106	65	56	72	2	26
ITA	80	684	184	0	94	130	19	152	53	132	48	202	19
SVN	6	153	17	90	0	53	10	43	1	44	0	67	0
FRA	9	191	1	116	49	0	11	52	1	51	0	83	0
HUN	1	30	1	15	8	8	0	4	1	12	0	17	0
NLD	77	220	128	148	41	52	4	0	48	56	51	79	14
IRL	48	47	70	51	1	1	1	43	0	11	37	3	12
SVK	22	358	55	111	43	44	10	47	4	0	10	81	3
GBR	63	55	91	52	0	0	0	52	32	5	0	0	18
HRV	1	494	1	193	57	77	16	78	2	64	0	0	0
USA	18	23	41	26	0	0	0	17	12	3	25	0	0