

Introduction

The latest routine international evaluation for udder traits took place as scheduled at the Interbull Centre. Data from thirty-three (33) countries were included in this evaluation.

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

Countries sending real MAS data (other countries participate to the MAS evaluation using SCS data as predictor):

HOL : DFS, NLD, FRA, CAN, ITA, CHE, USA, DEU, GBR, AUS
RDC : DFS, NLD, CAN, GBR, AUS
BSW : NLD, FRA, CHE, GBR
JER : DFS, NLD, CAN, GBR, AUS, USA
SIM : NLD, CHE, GBR
GUE : No evaluation for MAS yet

Changes in national procedures

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

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 loose EDC although the number of daughters stay the same.

DEU (ALL) Base change. MAS: first time with clinical MAS data for HOL

SCS: performance data: phenotypic data from 2000 onwards pedigree: sire and maternal grandsire of animals having own performance must be known breed: breed of animal having own performance must be consistent with the breeds of parents

CAM (RDC) One newly proven bull added for SCS, Base change

CAN (ALL) Base change

AUS (HOL, JER, RDC) First time with MAS data, MAS is analysed in a multi-trait model including MAS, SCS and Udder Depth. The number of observations include daughters with at least one of those three traits observed, so it will include all animals with SCS plus those that have MAS and/or Udder Depth but no SCS. Changed the method for calculation of reliabilities. Pedigree corrections based on genotype information has caused drops in information

IRL (HOL) Clean ups to the database causing some bulls having the number of daughters/herds changing by 1 or 2 in most cases

USA (JER, HOL) Implementation of 700 overall DIM maximum for usable lactation record (increased from 400 DIM) - Implementation of minimum incidence levels for each event at 10% of the current incidence rate for herd-years with over 100 animals causing drops in information. MAS evaluations, now including JER and crossbred animals, was found to be inflated by the uneven distribution and reporting of herds. It was necessary to include a sire by herd interaction and changed the weights of the effects to protect the PTAs from being influenced by this and avoid bias.

USA (ALL) Base change

NZL (ALL) Results based on brand new models which are based on the most recent version of LICâ s genetic evaluation software based on a multiple trait models. The new multiple traits have caused a general drop in reliability. It contains a number of enhancements which result in more accurate genetic evaluations and reduces the time taken to compute genetic evaluations. Implementation of Parent Average Adjustment (PAA), changes to the daughter count for all traits. When the single trait models are combined into a multi trait BV the single trait daughter count that was the greatest (which is always the 2 year old daughter count) was taken into account. The old routine for Fertility and longevity were based on having a record for that trait or a production record, this is now changed so that it is a count of

NLD (ALL) Base change, now the cows born in 2015 are the base (it was 2010)

SVN (ALL) Until now the EBV were limited to the interval(52, 148). We used to reduce all EBV greater than 147 to not exceed 148. We reduced all EBv smaller than 53 to be no less than 52. From now on, we no longer apply such restriction to EBVs.

POL (HOL) Base change

PRT (HOL) Recent update on the Pedigree file as well as routine corrections on the test-day records of the daughters causes drops in information

JPN (HOL) Small decrease in information due to additional records and modification of pedigree.

BEL (HOL) Some change in type of proof due to changes in pedigree information and the fact that the program that determines the type of proof for bulls is based on pedigree information

ISR (HOL) Small decrease in information due to pedigree corrections.

ITA (HOL) Base change plus cut off of 1 year of data causing decreases in information.

ITA (SIM) Base change defined as average birth date of cows born within an interval of -7 and -5 years before evaluation.

ITA (BSW) Base change applied a rolling base including a cow born between 15 an 12 year before the evaluation date.

CHE (ALL) Base change, small drops in information due to manual editings. BSW: few bulls missing in this evaluation due to change in status of bulls.

LTU (HOL) Base change

FRA (ALL) Base change

URY (HOL) Base change

GBR (ALL) Drops in daughters due to minor data editings. For RDC some daughters of these bulls were duplicated with some of them having eartag numbers and herd book numbers. Data providers have now correctly eliminated the eartag numbers of these cows, so that only the herd-book numbers are now included. Base change

INTERBULL CHANGES COMPARED TO THE PREVIOUS ROUTINE RUN

----- Subsetting: -----

As decided by the ITC in Orlando, new subsetting was introduced in the september test run. Sub-setting is necessary for operational purposes and restrictions of time scales. To minimize the effect of subsetting, larger subsets with 10-12 countries and with 4 link providing countries have been applied.

Window: -----

According to the decision taken by ITC in Orlando, the following changes have been introduced in regards to the windows used for post processing:

The upper bounds have been set to 0.99 as these were judged to have very little effect on evaluations. The lower values have been set to about the 25% percentile value. The largest changes are for the lower values for conformation traits, with the lowest window being 40% for OFL otherwise it is about 50% for all other confirmation traits. It is anticipated that these low values may not have large impact on evaluations since there were very few countries combinations whose estimated correlations fell between the old limit of 0.30 and these new limits.

The window so far applied for MAS evaluation have been found too high compared to the within-country genetic correlation between mastitis and SCS available from the literature. It has been an ITC recommendation to adjust the windows for MAS in this test run to make them more in line with the values available from the literature. The recommendation has been approved by the Steering committee. Also, according to the decision taken by ITC in Orlando (2015) to review all windows every five (5) years, an overall review of the windows for all traits will take place during the first half of 2020 with the aim of implementation set for the September 2020 test run.

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 ROUTINE RUN

Results were distributed by the Interbull Centre to designated representatives in each country. The international evaluation file comprised international proofs expressed on the base and unit of each country included in the analysis. Such records readily provide more information on bull performance in various countries, thereby minimizing the need to resort to conversions.

At the same time, all recipients of Interbull results are expected to honor the agreed code of practice, decided by the Interbull Steering Committee, and only publish international evaluations on their own country scale. Evaluations expressed on another country scale are confidential and may only be used internally for research and review purposes.

PUBLICATION OF INTERBULL TEST RUN

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

^LTable 1. National evaluation data considered in the Interbull evaluation for udder health (April Routine Evaluation 2020).
Number of records for milk somatic cells by breed

Country BSW GUE HOL JER RDC SIM

AUS		139	8301	1661	752	
BEL			2070			
CAN	241	101	12800	776	828	
CHE	3012		3498	88		3327
CZE			3999			
DEA	5692					22858
DEU			22219		270	
DFS			13272	2144	7861	
ESP			3956			
EST			1188		445	
FRA	398		17355			469
FRM						4415
GBR	128	292	6878	704	521	83
HUN			2942			181
IRL			2601			
ISR			1490			
ITA	1966		9652			1597
JPN			6257			
KOR			1370			
LTU			1210		435	
LVA			527		564	
NLD	199		15981	182	89	427
NOR					4192	
NZL	54	57	7982	4665	1339	
POL			10859			
PRT			2433			
SVK			1112			580
SVN	376		570			634
URY			1798			
USA	1096	708	39228	4706	693	68
ZAF			1195	587	124	
HRV			771			852
MEX						
CAM					43	
=====						
No. Records	13162	1297	203514	15513	18156	35491
Pub. Proofs	10673	1009	152568	12740	17474	31735
=====						

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

BSW	scs									
	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	6.15									
FRA	0.92	1.04								
NLD	0.90	0.92	4.17							
USA	0.91	0.91	0.88	0.21						
CHE	0.91	0.94	0.94	0.88	10.41					
DEA	0.92	0.96	0.92	0.88	0.97	11.90				
NZL	0.87	0.87	0.86	0.86	0.87	0.88	0.32			
ITA	0.89	0.90	0.89	0.89	0.95	0.91	0.87	16.45		
GBR	0.91	0.96	0.95	0.91	0.94	0.95	0.86	0.90	12.55	
SVN	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.89	0.89	10.43

BSW	mas									
	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	6.14									
FRA	0.90	1.04								
NLD	0.85	0.86	4.07							
USA	0.86	0.84	0.84	0.21						

RDC mas														
	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	7.66													
DFS	0.90	13.79												
GBR	0.88	0.88	2.15											
NOR	0.90	0.85	0.86	14.08										
USA	0.84	0.82	0.83	0.85	0.23									
DEU	0.90	0.86	0.87	0.90	0.87	13.58								
AUS	0.82	0.81	0.81	0.81	0.76	0.79	0.13							
EST	0.87	0.84	0.87	0.88	0.86	0.92	0.75	12.24						
ZAF	0.87	0.86	0.87	0.92	0.84	0.88	0.76	0.89	25.28					
NZL	0.67	0.66	0.70	0.80	0.71	0.78	0.79	0.81	0.78	0.38				
LTU	0.86	0.84	0.87	0.89	0.85	0.89	0.79	0.91	0.89	0.80	0.34			
LVA	0.86	0.84	0.87	0.89	0.84	0.92	0.76	0.95	0.88	0.85	0.91	0.44		
NLD	0.87	0.87	0.85	0.86	0.85	0.88	0.81	0.90	0.89	0.77	0.87	0.88	4.60	
CAM	0.91	0.91	0.91	0.92	0.87	0.93	0.83	0.93	0.92	0.87	0.92	0.93	0.90	6.53

SIM scs												
	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVK	SVN	GBR	HRV	USA
FRM	1.09											
FRA	0.93	1.01										
ITA	0.93	0.90	13.89									
NLD	0.91	0.93	0.88	4.36								
CHE	0.93	0.93	0.90	0.94	10.32							
DEA	0.92	0.93	0.88	0.90	0.89	12.20						
HUN	0.93	0.91	0.93	0.89	0.90	0.94	15.65					
SVK	0.89	0.89	0.89	0.90	0.90	0.88	0.94	0.38				
SVN	0.90	0.89	0.88	0.89	0.90	0.88	0.90	0.89	8.92			
GBR	0.91	0.96	0.90	0.95	0.91	0.93	0.89	0.89	0.88	11.56		
HRV	0.93	0.88	0.88	0.88	0.89	0.88	0.89	0.89	0.89	0.88	9.87	
USA	0.89	0.90	0.89	0.88	0.89	0.89	0.91	0.89	0.89	0.90	0.88	0.21

SIM mas												
	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVK	SVN	GBR	HRV	USA
FRM	1.08											
FRA	0.91	1.00										
ITA	0.95	0.87	13.89									
NLD	0.87	0.87	0.85	4.19								
CHE	0.91	0.92	0.90	0.92	11.18							
DEA	0.91	0.92	0.88	0.87	0.88	12.20						
HUN	0.92	0.87	0.90	0.90	0.90	0.93	15.65					
SVK	0.87	0.88	0.89	0.87	0.90	0.87	0.94	0.38				
SVN	0.89	0.87	0.88	0.84	0.89	0.87	0.88	0.87	8.92			
GBR	0.87	0.88	0.86	0.85	0.91	0.88	0.87	0.87	0.86	2.71		
HRV	0.91	0.87	0.87	0.82	0.87	0.86	0.88	0.87	0.87	0.85	9.87	
USA	0.86	0.87	0.85	0.86	0.86	0.86	0.82	0.85	0.81	0.84	0.81	0.21

^LAPPENDIX II. Number of common bulls

BSW										
common bulls below diagonal										
common three quarter sib group above diagonal										
	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0	83	51	168	133	140	23	123	60	34
FRA	72	0	83	120	160	213	21	188	52	56
NLD	48	68	0	80	95	149	25	127	40	44
USA	158	80	71	0	318	314	28	222	82	42

CHE	109	116	88	296	0	583	25	450	67	79
DEA	120	156	143	280	482	0	35	637	68	104
NZL	21	17	18	25	20	30	0	29	17	11
ITA	106	146	107	156	393	536	22	0	70	98
GBR	54	42	30	73	50	46	15	48	0	23
SVN	30	55	45	34	75	97	10	97	17	0

BSW

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0	77	49	168	39	140	23	123	28	34
FRA	68	0	69	105	43	197	18	177	26	56
NLD	44	58	0	72	26	135	25	117	19	40
USA	158	72	62	0	39	313	28	220	36	42
CHE	34	34	25	28	0	120	7	101	9	35
DEA	120	148	128	280	114	0	35	632	32	104
NZL	21	15	18	25	7	30	0	29	10	11
ITA	106	141	97	156	94	535	22	0	34	98
GBR	26	21	15	33	5	23	8	25	0	12
SVN	30	55	41	34	34	97	10	97	10	0

GUE

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	GBR	USA	AUS	NZL
CAN	0	30	71	46	14
GBR	25	0	87	36	13
USA	62	89	0	64	29
AUS	45	31	60	0	26
NZL	11	11	29	26	0

GUE

HOL

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	CHE	DEU	DFS	EST	FRA	GBR	NLD	USA	ISR	ITA	AUS	HUN	BEL	JPN	ESP	ZAF	NZL	IRL	CZE	SVK	POL	LTU	LVA	PRT	KOR	SVN	HRV	URY
CAN	0	886	2280	1396	253	1475	1557	1531	3375	123	1718	1421	1033	809	1346	1282	502	736	483	1042	423	1388	299	207	1026	668	204	293	768
CHE	745	0	1120	706	163	678	679	901	1006	58	726	617	438	601	472	561	266	395	350	493	230	676	177	138	503	257	139	200	317
DEU	1675	992	0	2472	403	2313	1897	3163	3340	152	2522	1596	1230	1191	1380	1483	537	923	733	1702	667	2403	605	296	1196	596	301	597	748
DFS	1170	623	1752	0	282	1614	1489	2053	2014	141	1565	1268	891	855	958	1006	497	813	650	1160	405	1570	364	206	927	469	246	388	638
EST	150	89	285	168	0	252	240	356	340	47	272	210	199	191	205	200	105	134	114	245	114	315	113	87	193	109	94	120	134
FRA	978	588	1188	835	118	0	1490	1967	2473	123	1673	1262	933	931	1200	1142	469	787	630	1157	414	1639	294	186	924	501	202	284	598
GBR	1763	620	1410	1109	135	908	0	1687	2100	132	1500	1348	850	843	1013	1039	503	880	800	956	365	1294	299	180	926	471	207	320	658
NLD	1455	874	2901	1775	255	1210	1448	0	2497	151	1731	1464	972	1275	1058	1103	509	1017	766	1389	536	1841	397	227	1050	461	256	426	669
USA	3726	893	2306	1477	222	1291	1828	2169	0	175	2590	1889	1313	965	1945	1531	629	1052	677	1530	531	2060	404	260	1290	823	238	366	1096
ISR	89	36	122	108	29	64	89	119	161	0	136	107	109	82	99	107	63	106	85	112	47	136	56	28	99	57	46	65	90
ITA	1377	647	1662	1161	152	881	1134	1429	1775	93	0	1187	1027	812	1170	1253	472	719	557	1208	391	1616	335	223	1000	577	235	376	676
AUS	1417	531	1170	898	105	833	1152	1267	1857	69	867	0	735	755	894	885	476	1187	626	797	306	1028	258	167	781	427	176	286	665
HUN	964	352	966	707	121	628	745	821	1272	77	876	552	0	546	722	770	391	497	379	864	311	967	229	140	708	439	160	252	519
BEL	801	611	1232	795	117	914	836	1475	851	54	791	653	475	0	551	671	332	506	444	605	295	813	210	144	656	284	176	262	354
JPN	697	309	609	522	72	432	530	566	888	47	549	496	417	357	0	902	421	557	388	785	312	989	214	149	707	536	165	216	576
ESP	817	448	956	746	94	819	826	987	977	64	918	624	613	655	431	0	443	535	437	796	311	1043	234	167	827	464	187	276	520
ZAF	458	215	420	379	53	327	436	429	610	42	370	411	314	279	294	390	0	360	286	361	180	410	116	99	428	257	98	149	320
NZL	743	332	700	566	67	463	751	930	992	87	530	1190	385	410	302	408	291	0	625	559	250	641	181	114	560	302	129	212	511
IRL	429	327	584	497	57	448	752	670	561	60	441	509	309	421	234	395	232	500	0	415	186	520	148	94	407	186	105	159	325
CZE	738	329	1245	735	152	674	620	1207	1141	81	818	501	762	455	349	517	230	378	265	0	439	1269	310	182	743	450	206	340	522
SVK	301	118	496	211	53	222	211	374	354	20	237	153	222	182	117	157	96	151	91	341	0	448	134	96	317	199	82	140	237
POL	1163	551	2127	1251	226	1039	1073	1689	1928	107	1231	758	858	746	528	723	305	485	399	1023	310	0	438	251	1009	554	252	444	639

LTU	160	78	559	212	58	104	151	245	271	27	181	113	139	107	74	99	47	82	69	207	68	344	0	101	235	142	78	164	174
LVA	131	78	204	126	62	86	103	149	208	20	151	79	100	91	66	95	58	55	52	118	47	186	73	0	190	99	43	115	119
PRT	1071	443	1097	820	135	777	857	1053	1349	74	936	624	704	661	440	790	383	459	343	598	221	1008	150	143	0	452	164	309	549
KOR	636	179	398	333	53	286	344	326	926	35	465	308	360	210	326	322	192	219	122	315	122	460	62	59	382	0	98	136	373
SVN	148	100	291	202	55	142	153	221	181	36	198	125	123	145	94	141	70	92	79	149	47	226	43	26	130	60	0	106	105
HRV	171	127	611	296	87	168	227	384	275	45	284	176	188	214	102	209	98	124	106	240	68	392	113	90	247	58	82	0	180
URY	738	236	531	447	81	346	540	531	1358	49	486	511	424	279	328	410	281	413	244	349	144	531	99	80	487	291	63	109	0

HOL

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	CHE	DEU	DFS	EST	FRA	GBR	NLD	USA	ISR	ITA	AUS	HUN	BEL	JPN	ESP	ZAF	NZL	IRL	CZE	SVK	POL	LTU	LVA	PRT	KOR	SVN	HRV	URY
CAN	0	113	590	695	151	790	805	819	981	73	1066	763	643	501	773	810	246	376	277	653	226	932	184	107	612	452	148	191	431
CHE	100	0	108	103	29	104	108	134	104	9	114	109	59	103	82	90	38	79	65	78	31	113	28	9	74	59	38	30	47
DEU	414	98	0	726	183	652	621	908	522	68	797	523	465	478	440	564	182	319	263	565	186	965	240	118	435	242	192	322	267
DFS	665	91	584	0	254	1210	1217	1754	773	130	1217	1130	816	754	899	946	481	748	611	1054	329	1408	321	187	856	423	224	345	521
EST	95	12	129	151	0	212	217	342	184	46	245	203	193	183	199	195	102	129	112	238	98	298	103	83	185	104	93	117	122
FRA	574	93	406	642	104	0	1114	1494	759	104	1285	982	807	778	937	982	380	617	529	1011	309	1419	235	153	794	414	179	239	432
GBR	806	100	491	919	129	720	0	1524	902	131	1251	1192	800	780	916	972	461	795	748	905	316	1212	255	154	853	432	192	291	552
NLD	826	125	863	1395	247	941	1329	0	954	148	1445	1408	943	1228	1044	1086	499	1000	762	1357	482	1762	351	215	1017	441	248	396	581
USA	1111	92	414	745	131	582	973	971	0	114	1131	820	750	498	859	741	338	462	350	746	234	1051	211	149	698	528	157	183	577
ISR	50	2	49	94	29	57	88	118	108	0	122	105	106	82	97	107	61	105	85	112	46	134	50	28	99	56	46	61	82
ITA	845	102	560	922	145	707	995	1201	1097	81	0	997	935	709	1052	1122	397	586	463	1087	327	1447	280	189	892	527	213	305	552
AUS	805	102	395	761	105	668	1029	1218	877	67	770	0	711	720	880	872	455	1147	621	779	281	998	226	157	752	403	172	266	582
HUN	602	44	348	643	121	552	719	803	784	75	816	538	0	531	713	759	378	486	374	853	289	945	211	136	688	420	157	237	456
BEL	517	97	475	690	116	754	800	1428	478	54	716	641	474	0	537	657	327	492	441	593	272	787	190	136	640	274	174	252	330
JPN	508	67	251	470	72	382	517	558	667	47	526	490	417	357	0	902	416	549	388	781	287	973	192	144	684	511	162	201	495
ESP	511	76	377	684	94	721	805	965	577	64	795	615	612	655	431	0	437	532	436	791	285	1027	214	161	814	451	181	262	461
ZAF	229	32	141	362	53	284	419	423	375	42	327	399	313	279	294	390	0	358	284	354	170	401	106	95	418	243	97	138	295
NZL	337	72	250	501	66	385	656	918	431	87	470	1142	383	408	302	408	290	0	623	550	238	633	165	109	548	291	128	199	459
IRL	276	63	235	445	57	405	722	665	339	60	395	504	309	421	234	395	232	500	0	413	176	516	139	92	403	180	103	154	300
CZE	486	58	408	639	150	551	605	1182	675	81	751	487	752	454	349	517	228	373	265	0	408	1238	280	172	725	427	205	317	458
SVK	164	10	105	179	51	173	203	361	158	20	213	149	220	179	117	157	95	149	91	336	0	404	110	88	299	183	78	127	210
POL	844	92	934	1082	221	915	1040	1629	1161	107	1145	744	848	736	528	721	304	480	399	1007	297	0	405	235	970	525	244	418	563
LTU	116	13	201	194	57	94	145	236	152	27	159	111	138	106	74	99	47	81	69	204	65	332	0	95	209	121	74	146	150
LVA	72	4	103	114	62	76	96	146	122	20	124	78	99	91	66	95	58	54	52	116	47	178	73	0	182	95	43	107	105
PRT	621	69	384	752	134	690	821	1038	757	74	866	609	698	659	440	790	380	458	343	597	217	990	146	142	0	432	161	284	494
KOR	433	48	171	301	53	254	331	320	576	35	449	297	356	210	326	322	191	215	122	311	118	449	58	59	379	0	96	120	326
SVN	112	29	182	182	55	132	151	219	124	36	179	122	123	144	94	141	70	92	79	149	47	224	43	26	130	60	0	102	99
HRV	119	14	307	266	87	155	224	369	143	45	231	171	187	211	102	209	98	123	106	236	68	384	112	88	245	57	81	0	163
URY	420	33	190	392	81	283	507	515	632	48	457	503	412	277	328	410	277	408	244	341	142	514	98	76	476	282	63	108	0

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE
CAN	0	77	153	38	431	254	150	172	36
DFS	62	0	140	109	152	124	126	119	54
GBR	154	127	0	83	226	209	160	206	67
NLD	34	106	75	0	84	71	71	73	39
USA	451	122	245	91	0	480	277	355	63
AUS	260	88	213	63	525	0	221	426	51
ZAF	145	102	159	67	292	212	0	194	54
NZL	179	91	207	66	425	470	201	0	49
CHE	29	49	64	33	63	42	47	40	0

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE
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CAN	0	32	65	16	68	112	65	75	21
DFS	26	0	89	86	40	109	114	108	52
GBR	63	82	0	55	66	141	117	139	60
NLD	10	79	50	0	26	65	68	66	36
USA	62	32	66	22	0	129	99	93	30
AUS	101	71	145	59	138	0	213	417	48
ZAF	58	88	117	64	110	209	0	190	52
NZL	69	77	140	58	95	460	199	0	46
CHE	18	48	55	31	23	41	46	39	0

RDC

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	0	156	76	6	199	13	101	2	70	84	17	7	7	0
DFS	159	0	97	128	180	49	181	103	51	161	103	91	54	0
GBR	76	90	0	50	102	14	82	7	38	77	26	11	34	0
NOR	6	101	52	0	70	14	66	21	0	39	25	17	43	0
USA	185	176	97	72	0	20	128	18	59	115	34	14	39	24
DEU	12	40	14	13	20	0	36	21	1	16	29	28	14	0
AUS	101	155	77	56	129	36	0	30	34	138	43	28	31	12
EST	2	92	6	21	17	21	28	0	0	7	25	36	16	0
ZAF	72	48	34	0	53	1	33	0	0	34	5	1	4	0
NZL	82	159	72	39	117	16	137	6	30	0	27	13	20	12
LTU	16	98	24	22	29	28	42	25	5	25	0	36	16	0
LVA	7	59	11	15	10	22	25	28	1	10	32	0	9	0
NLD	7	53	33	43	38	14	29	15	4	20	14	8	0	0
CAM	0	0	0	0	24	0	12	0	0	12	0	0	0	0

RDC

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	0	71	26	3	72	8	31	0	35	32	13	4	3	0
DFS	70	0	70	129	168	73	195	103	46	159	102	92	53	0
GBR	25	65	0	46	71	17	50	5	24	54	21	9	25	0
NOR	3	101	48	0	70	20	64	21	0	39	25	17	37	0
USA	72	165	70	72	0	28	115	18	54	113	34	14	36	24
DEU	8	62	17	19	28	0	43	27	2	22	38	30	18	0
AUS	30	171	48	54	118	42	0	30	31	129	40	27	28	10
EST	0	92	5	21	17	26	28	0	0	7	25	36	16	0
ZAF	36	46	23	0	52	2	33	0	0	32	5	1	3	0
NZL	32	155	52	39	117	22	129	6	30	0	27	13	18	12
LTU	12	97	19	22	29	35	40	25	5	25	0	36	15	0
LVA	4	59	9	15	10	24	25	28	1	10	32	0	8	0
NLD	3	51	25	37	36	18	26	15	3	18	13	7	0	0
CAM	0	0	0	0	24	0	10	0	0	12	0	0	0	0

SIM

common bulls below diagonal
common three quarter sib group above diagonal

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVK	SVN	GBR	HRV	USA
FRM	0	3	167	119	201	243	2	62	17	65	2	51
FRA	1	0	148	70	12	264	6	55	55	0	92	1
ITA	200	134	0	211	93	872	16	146	116	44	237	28
NLD	144	68	206	0	88	315	7	68	56	48	107	21
CHE	252	9	96	92	0	323	2	32	5	51	2	26
DEA	274	223	776	327	282	0	34	386	191	47	548	26
HUN	0	5	13	7	1	22	0	10	9	0	17	0
SVK	57	45	123	58	26	392	9	0	46	11	94	7

SVN	17	52	111	54	5	177	8	45	0	0	78	0
GBR	82	0	48	48	58	50	0	6	0	0	0	19
HRV	1	83	223	103	2	572	15	74	65	0	0	2
USA	66	1	33	23	25	28	0	5	0	26	2	0

SIM

common bulls below diagonal

common three quarter sib group above diagonal

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVK	SVN	GBR	HRV	USA
FRM	0	2	159	104	4	217	2	58	17	25	2	35
FRA	1	0	85	31	1	159	3	39	34	0	58	1
ITA	192	75	0	197	4	871	16	146	116	18	237	27
NLD	126	30	191	0	4	288	7	66	50	18	101	21
CHE	4	1	4	4	0	43	0	0	0	1	0	2
DEA	261	122	776	298	38	0	34	386	191	19	548	25
HUN	0	2	13	7	0	22	0	10	9	0	17	0
SVK	57	31	123	56	0	392	9	0	46	5	94	7
SVN	17	29	111	48	0	177	8	45	0	0	78	0
GBR	33	0	22	20	1	24	0	5	0	0	0	16
HRV	1	51	223	97	0	572	15	74	65	0	0	2
USA	50	1	32	23	2	28	0	5	0	21	2	0