

## Introduction

The latest routine international evaluation for females fertility traits took place as scheduled at the Interbull Centre. Data from twentyone (21) countries were included in this evaluation.

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

Based on a decision made by Interbull Steering committee in August 2007, female fertility traits are classified as follows:

- T1 (HC): Maiden (H)eifer's ability to (C)onceive. A measure of confirmed conception, such as conception rate (CR), will be considered for this trait group. In the absence of confirmed conception an alternative measure, such as interval first-last insemination (FL), interval first insemination-conception (FC), number of inseminations (NI), or non-return rate (NR, preferably NR56) can be submitted;
- T2 (CR): Lactating (C)ow's ability to (R)ecycle after calving. The interval calving-first insemination (CF) is an example for this ability. In the absence of such a trait, a measure of the interval calving-conception, such as days open (DO) or calving interval (CI) can be submitted;
- T3 (C1): Lactating (C)ow's ability to conceive (1), expressed as a rate trait. Traits like conception rate (CR) and non-return rate (NR, preferably NR56) will be considered for this trait group;
- T4 (C2): Lactating (C)ow's ability to conceive (2), expressed as an interval trait. The interval first insemination-conception (FC) or interval first-last insemination (FL) will be considered for this trait group. As an alternative, number of inseminations (NI) can be submitted. In the absence of any of these traits, a measure of interval calving-conception such as days open (DO), or calving interval (CI) can be submitted. All countries are expected to submit data for this trait group, and as a last resort the trait submitted under T3 can be submitted for T4 as well.
- T5 (IT): Lactating cow's measurements of (I)nterval (T)raits calving-conception, such as days open (DO) and calving interval (CI).

Based on the above trait definitions the following traits have been submitted for international genetic evaluation of female fertility traits.

Country	Traits	Submitted traits and their definitions
AUS	T4=C2 T5=IT	Calving interval converted to 42 days pregnancy rate Calving interval converted to 42 days pregnancy rate
BEL	T2=CY T4=C2 T5=IT	PR=Pregnancy Rate ( $=\frac{21}{(DO-45+11)} \times 100$ , with DO=days open) PR=Pregnancy Rate ( $=\frac{21}{(DO-45+11)} \times 100$ , with DO=days open) PR=Pregnancy Rate ( $=\frac{21}{(DO-45+11)} \times 100$ , with DO=days open)
CAN	T1=HC T2=CY T3=C1 T4=C2 T5=IT	NR=Non Return Rate after 56 Days in heifers (NRR), % CF=Interval from Calving to First Service in cows (CF) NR=Non Return Rate after 56 Days in cows (NRR), % FC=Interval first insemination-conception in cows DO=Days open
CHE	T1=HC T2=CR T3=C1 T4=C2	CR=Heifers' Conception rate CF=Interval from Calving to First Service (ICF), days NR=Non Return Rate after 56 Days (NRR), % FL=Interval from first to last insemination cows
CZE	T1=HC	CR=Heifers' Conception rate (pregnant or not after 3 months)

	T3=C1	CR=Cows' Conception rate (pregnant or not after 3 months)
	T4=C2	CR=Cows' Conception rate (pregnant or not after 3 months)
AUT/DEU	T1=HC	NR=Heifers' Non Return Rate after 56 days
	T2=CY	CF=Interval from calving to first insemination cows (days)
	T3=C1	NR=Cows' Non Return Rate after 56 days
	T4=C2	FL=Interval from first to last insemination cows (days)
	T5=IT	DO=Days open (days)
DFS	T1=HC	CR=Heifers' Conception rate for maiden heifers
	T2=CY	CF=Interval from calving to first insemination cows (days)
	T3=C1	CR=Cows' conception rate for cows
	T4=C2	FL=Interval from first to last insemination cows (days)
	T5=IT	DO=Days open (days)
ESP	T2=CY	Interval from Calving to First Service (ICF)
	T3=C1	Conception rate
	T4=C2	Interval first insemination to conception
	T5=IT	Days Open
FRA	T1=HC	CR=Heifers' Conception rate (binary trait) for maiden heifers
	T2=CY	Interval between calving and first AI
	T3=C1	CR=Cows' Conception rate (binary trait)
	T4=C2	FL=Interval from first to last insemination cows (days)
	T5=IT	FL=Interval from first to last insemination cows (days)
GBR	T2=CY	CI=days between 1st and 2nd calvings
	T3=C1	NR=1st lactation non return at 56 days
	T4=C2	CI=days between 1st and 2nd calvings
	T5=IT	CI=days between 1st and 2nd calvings
IRL	T2=CY	CI=Calving interval
	T4=C2	CI=Calving interval
	T5=IT	CI=Calving interval
ISR	T3=C1	CR=Inverse of the number of insemination to conception (%)
	T4=C2	CR=Inverse of the number of insemination to conception (%)
ITA	T1=HC	NR= non-return rate 56 days (heifers)
	T2=CY	CF=Days to first service
	T3=C1	NR=Non-return rate at 56 days (%)
	T4=C2	FL=Interval from first to last insemination cows (days)
	T5=IT	DO=days open (days)
ITA(BSW)	T2=CY	CF=Interval calving to first insemination
	T4=C2	Days Open
	T5=IT	CI=Calving interval
NLD	T1=HC	CR=Heifers' Conception rate
	T2=CY	CF=Interval calving to first insemination (days)
	T3=C1	CR=Cows' Conception rate (binary trait) for cows
	T4=C2	FL=Interval from first to last insemination cows (days)
	T5=IT	CI=Days Open
NOR	T1=HC	NI=Number of inseminations (heifers)
	T2=CY	CF=Days from calving to first insemination (days)
	T3=C1	NI=Number of inseminations (cows)
	T4=C2	NI=Number of inseminations (cows)
	T5=IT	CF=Days from calving to first insemination (days)
NZL	T2=CY	PM=Lactating cow's ability to start cycling
	T4=C2	CR= Cow's conception rate at 42 days
	T5=IT	CR= Cow's conception rate at 42 days
POL	T1=HC	CR=Conception Rate (heifer)
	T2=CR	CF=Interval from calving to first insemination
	T3=C1	CR=Conception Rate (cow)
	T4=IT	DO=Days open
	T5=IT	DO=Days open

URY	T4=C2	Days open expressed as Daughter Pregnancy Rate
	T5=IT	Days open expressed as Daughter Pregnancy Rate
USA	T1=HC	CR=Conception rate (heifer)
	T2=CY	CF=Interval from calving to first insemination
	T3=C1	CR=Conception rate (cow)
	T4=C2	DP=Daughter Pregnancy Rate
	T5=IT	DP=Daughter Pregnancy Rate
ZAF	T4=IT	CI=Calving Interval
	T5=IT	CI=Calving Interval
JPN	T1=HC	CR=Heifers' Conception rate
	T3=C1	CR=Cows' Conception rate
	T4=C2	DO=Days open
	T5=IT	DO=Days open
SVN	T5=IT	CI=Calving interval (days)

-----  
 CHANGES IN NATIONAL PROCEDURES  
 -----

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

FRA (ALL)	Base change
DEA (BSW)	Base change
SVN (HOL, BSW)	Base change. Decrease in information due to changes in pedigree completeness as well as phenotypic data improvement.
JPN (HOL)	Some decrease in information due to pedigree changes
AUS (ALL)	Decrease in information due to pedigree updates, and status changes of some bulls which then leads to no longer being qualified for the >10 threshold.
ITA (HOL)	One year cut-off of data causing drops in information, base change
ITA (BSW)	Base change
USA (ALL)	Drops in information are due to pedigree corrections and herd-year minimum edits
ISR (HOL)	Drops in information due to edits and parentage corrections
CAN (ALL)	Base change
DEU (ALL)	Base change
POL (HOL)	Changes in the recording software by the national organisation of milk recording system. Most of the changes were caused by small revisions of herd registration numbers
NZL (ALL)	Changed pedigree extract so that Holstein and Friesian breed proportions re-balanced for all animals based on a more realistic assumption of Holstein and Friesian ancestry. Specifically, any HF animals from NZ, Australia or the UK in the pedigree which have one or both parents missing, instead of merely assuming the missing parent(s) to have no Holstein genetics, now assumes a mixture of Holstein and Friesian genetics equal to the average of their herd contemporaries. These changes are also carried down to all progeny in the pedigree. Updated days-in-milk to include all data collected up to 305 days of lactation. Excluded any records where a cow has not calved within 365 days of her last parturition.
CHE (ALL)	Improvements in recording of pedigree validity and handling of animals with uncertain parentage on the database as well as the recomputation of breed percentages for all animals born after 01.01.1990 led to (great) changes in all pedigrees and in consequences in all genetic evaluation results.
NLD (ALL)	Base change. In the past there were separate traits for Dutch and Flemish fertility traits which got combined at the end to one trait. This combination is now done at the beginning of the process.

-----  
 INTERBULL CHANGES COMPARED TO THE PREVIOUS ROUTINE RUN  
 -----

Post-processing Windows:

-----  
 According to the decision taken by ITC in Orlando (2015) to review the post-processing windows every 5 years, during the 2020 the relative working group has been re-activated and new windows have been identified.

As before, the upper bounds have been set to 0.99 as these were judged to have

very little effect on evaluations while the lower values have been reduced to the 10th percentile. This reduction would provide post-processed correlations to be closer to the real estimated ones. Over the past five years, in fact, the previous adopted lower value (25th percentile) had been found too high causing estimated and post-processed correlations to differ significantly from each other. The new lower values have been applied to all breeds and traits.

The weight assigned to the magnitude of the changes tested by each country has also been revised. The new weight will allow post-processed correlations to take more in consideration the value of the new estimated ones even when no changes are applied by the countries.

The new weights are as follows:

No changes    :: 2  
Small changes:: 1  
Big changes   :: 0

More information can be read on [https://interbull.org/ib/rg\\_procedure](https://interbull.org/ib/rg_procedure)

#### 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 fertility (April Routine Evaluation 2023).  
Number of records for lactating cow's ability to conceive (cc2) by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS		145	8672	1846	782	
BEL			2084			
CAN	184	49	10211	639	593	
CHE	2978		3243			
CZE			3687			
DEA	4916					
DEU			25388		311	
DFS			17184	2486	10520	
ESP			6387			
EST						
FRA	432		17164			
FRM						
GBR	111	248	7560	616	456	
HUN						
IRL			3222	229	72	
ISR			1638			
ITA	1948		9225			
JPN			6489			
KOR						
LTU						
LVA						

NLD	221		16528	238	95
NOR					3099
NZL	55	49	8476	4881	1325
POL			8937		
PRT					
SVK					
SVN					
URY			1906		
USA	1188	793	41869	5265	791
ZAF			1276	746	158
HRV					
CAM					
=====					
No. Records	12033	1284	201146	16946	18202
Pub. Proofs	10608	1067	157677	14112	17998
					0
-----					

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

-----

BSW      hco

-----

	CAN	DEA	FRA	USA	CHE	NLD
CAN	9.46					
DEA	0.86	9.88				
FRA	0.77	0.86	0.89			
USA	0.78	0.80	0.88	2.63		
CHE	0.90	0.94	0.87	0.81	13.17	
NLD	0.79	0.65	0.74	0.75	0.67	4.71

-----

BSW      crc

-----

	CAN	CHE	DEA	NLD	NZL	USA	GBR	FRA	ITA
CAN	6.90								
CHE	0.82	11.37							
DEA	0.78	0.95	14.93						
NLD	0.83	0.87	0.86	3.56					
NZL	0.61	0.61	0.69	0.62	0.12				
USA	0.77	0.84	0.81	0.79	0.60	8.11			
GBR	0.71	0.70	0.63	0.74	0.64	0.73	3.82		
FRA	0.82	0.96	0.95	0.88	0.63	0.84	0.74	1.80	
ITA	0.82	0.78	0.79	0.80	0.65	0.78	0.74	0.81	16.30

-----

BSW      cc1

-----

	CAN	CHE	DEA	NLD	USA	GBR	FRA
CAN	7.56						
CHE	0.82	11.83					
DEA	0.79	0.94	11.42				
NLD	0.75	0.70	0.67	3.99			
USA	0.75	0.68	0.67	0.81	2.85		
GBR	0.77	0.81	0.78	0.71	0.68	0.03	
FRA	0.74	0.69	0.67	0.84	0.88	0.72	0.96

-----

BSW      cc2

-----

	CAN	CHE	DEA	NLD	NZL	USA	GBR	FRA	ITA
CAN	6.62								
CHE	0.78	11.10							
DEA	0.77	0.93	12.26						
NLD	0.83	0.80	0.79	3.31					
NZL	0.71	0.66	0.73	0.70	6.16				
USA	0.81	0.83	0.83	0.79	0.70	2.47			
GBR	0.71	0.81	0.81	0.73	0.70	0.81	3.82		
FRA	0.84	0.87	0.87	0.84	0.70	0.82	0.79	0.96	

ITA 0.80 0.70 0.78 0.80 0.67 0.80 0.77 0.76 21.52

-----  
BSW int  
-----

	CAN	DEA	NLD	NZL	USA	GBR	ITA	SVN
CAN	7.27							
DEA	0.80	14.25						
NLD	0.84	0.89	3.12					
NZL	0.68	0.81	0.69	6.16				
USA	0.91	0.83	0.79	0.68	2.47			
GBR	0.82	0.73	0.83	0.67	0.82	3.82		
ITA	0.85	0.92	0.86	0.68	0.79	0.82	17.56	
SVN	0.72	0.68	0.72	0.71	0.71	0.76	0.71	19.84

-----  
GUE crc  
-----

	CAN	GBR	NZL	USA	AUS
CAN	8.04				
GBR	0.74	4.78			
NZL	0.61	0.64	0.11		
USA	0.78	0.76	0.60	6.87	
AUS	0.68	0.79	0.89	0.66	6.97

-----  
GUE cc1  
-----

	CAN	GBR	USA
CAN	7.44		
GBR	0.77	0.03	
USA	0.81	0.73	3.46

-----  
GUE cc2  
-----

	CAN	GBR	NZL	USA	AUS
CAN	7.30				
GBR	0.70	4.78			
NZL	0.69	0.70	5.87		
USA	0.85	0.81	0.70	2.78	
AUS	0.68	0.68	0.69	0.72	9.85

-----  
GUE int  
-----

	CAN	GBR	NZL	USA	AUS
CAN	8.26				
GBR	0.82	4.78			
NZL	0.67	0.67	5.87		
USA	0.90	0.81	0.67	2.78	
AUS	0.73	0.70	0.72	0.73	9.85

-----  
HOL hco  
-----

	CAN	CZE	DEU	DFS	FRA	USA	POL	CHE	NLD	ITA	JPN
CAN	7.86										
CZE	0.77	17.89									
DEU	0.90	0.80	15.18								
DFS	0.79	0.84	0.84	13.54							
FRA	0.81	0.80	0.82	0.89	0.83						
USA	0.84	0.85	0.84	0.87	0.88	2.38					
POL	0.63	0.53	0.63	0.52	0.52	0.56	19.47				
CHE	0.96	0.79	0.93	0.79	0.84	0.86	0.55	13.63			
NLD	0.81	0.77	0.83	0.86	0.84	0.83	0.51	0.80	5.20		
ITA	0.80	0.77	0.92	0.73	0.75	0.80	0.63	0.87	0.73	0.04	
JPN	0.85	0.71	0.84	0.72	0.78	0.84	0.63	0.84	0.75	0.73	6.23







NZL	0.67	0.67	0.67	0.67	3.96					
USA	0.83	0.82	0.78	0.74	0.69	2.61				
ZAF	0.72	0.72	0.75	0.71	0.76	0.85	11.19			
AUS	0.70	0.69	0.69	0.67	0.66	0.69	0.73	6.39		
IRL	0.80	0.74	0.76	0.75	0.67	0.76	0.80	0.76	2.35	

-----  
RDC      hco  
-----

	CAN	DEU	DFS	NOR	USA	NLD				
CAN	7.63									
DEU	0.90	14.75								
DFS	0.73	0.80	12.25							
NOR	0.86	0.87	0.87	16.46						
USA	0.83	0.82	0.83	0.73	2.80					
NLD	0.81	0.83	0.78	0.66	0.78	5.82				

-----  
RDC      crc  
-----

	CAN	DEU	DFS	GBR	NOR	NZL	USA	NLD	IRL	
CAN	6.47									
DEU	0.83	10.24								
DFS	0.85	0.90	12.68							
GBR	0.77	0.71	0.70	4.12						
NOR	0.84	0.81	0.85	0.62	14.05					
NZL	0.59	0.59	0.55	0.65	0.58	0.11				
USA	0.77	0.81	0.80	0.76	0.77	0.69	8.31			
NLD	0.82	0.83	0.87	0.72	0.81	0.57	0.77	3.37		
IRL	0.61	0.60	0.63	0.81	0.62	0.57	0.61	0.60	2.83	

-----  
RDC      cc1  
-----

	CAN	DEU	DFS	GBR	NOR	NLD	USA			
CAN	7.25									
DEU	0.90	13.99								
DFS	0.71	0.80	13.00							
GBR	0.77	0.78	0.67	0.03						
NOR	0.78	0.85	0.93	0.77	13.93					
NLD	0.76	0.78	0.86	0.70	0.70	3.93				
USA	0.82	0.75	0.78	0.67	0.74	0.79	2.76			

-----  
RDC      cc2  
-----

	CAN	DEU	DFS	GBR	NOR	NZL	USA	ZAF	NLD	AUS	IRL
CAN	6.93										
DEU	0.92	11.38									
DFS	0.81	0.94	12.84								
GBR	0.72	0.77	0.76	4.12							
NOR	0.80	0.83	0.89	0.73	13.93						
NZL	0.70	0.70	0.70	0.72		5.70					
USA	0.87	0.89	0.81	0.79	0.73	0.70	2.51				
ZAF	0.71	0.81	0.74	0.71	0.78	0.65	0.81	17.24			
NLD	0.86	0.93	0.86	0.74	0.75	0.71	0.80	0.74	3.40		
AUS	0.66	0.68	0.64	0.67	0.65	0.63	0.68	0.67	0.65	7.66	
IRL	0.77	0.80	0.77	0.80	0.73	0.70	0.79	0.84	0.78	0.80	2.83

-----  
RDC      int  
-----

	CAN	DEU	DFS	GBR	NOR	NZL	USA	ZAF	NLD	AUS	IRL
CAN	6.67										
DEU	0.90	11.29									
DFS	0.88	0.94	13.16								
GBR	0.82	0.85	0.81	4.12							
NOR	0.78	0.77	0.70	0.71	14.05						
NZL	0.67	0.68	0.67	0.68	0.69	5.70					

USA	0.92	0.89	0.79	0.81	0.70	0.67	2.51				
ZAF	0.82	0.85	0.78	0.75	0.82	0.68	0.83	17.24			
NLD	0.87	0.89	0.91	0.83	0.78	0.67	0.79	0.79	3.22		
AUS	0.72	0.71	0.69	0.71	0.71	0.67	0.72	0.74	0.67	7.66	
IRL	0.82	0.82	0.78	0.80	0.71	0.68	0.79	0.85	0.79	0.81	2.83

-----  
^LAPPENDIX II. Number of common bulls  
-----

BSW

-----  
common bulls below diagonal  
common three quarter sib group above diagonal  
CAN DEA FRA USA CHE NLD

CAN	0	99	54	104	101	31
DEA	88	0	199	197	597	138
FRA	46	150	0	73	168	75
USA	95	154	55	0	208	54
CHE	85	503	127	173	0	100
NLD	28	129	61	50	94	0

BSW

-----  
common bulls below diagonal  
common three quarter sib group above diagonal  
CAN CHE DEA NLD NZL USA GBR FRA ITA

CAN	0	122	120	41	18	136	49	73	113
CHE	103	0	610	109	27	271	66	169	459
DEA	107	506	0	157	40	240	63	208	599
NLD	36	100	145	0	25	66	38	80	133
NZL	17	21	35	19	0	18	14	21	31
USA	133	236	190	61	15	0	68	94	173
GBR	46	50	47	33	11	66	0	48	72
FRA	62	126	156	64	16	64	40	0	190
ITA	99	392	484	108	25	121	53	145	0

BSW

-----  
common bulls below diagonal  
common three quarter sib group above diagonal  
CAN CHE DEA NLD USA GBR FRA

CAN	0	123	121	42	137	48	77
CHE	104	0	608	108	271	67	176
DEA	108	503	0	156	240	65	220
NLD	37	100	144	0	66	38	85
USA	134	236	190	61	0	69	99
GBR	46	52	49	33	68	0	53
FRA	66	132	167	70	70	46	0

BSW

-----  
common bulls below diagonal  
common three quarter sib group above diagonal  
CAN CHE DEA NLD NZL USA GBR FRA ITA

CAN	0	110	107	37	15	132	46	70	101
CHE	91	0	598	109	25	326	66	176	459
DEA	95	496	0	158	35	314	63	219	595
NLD	33	100	145	0	20	89	38	85	133
NZL	14	19	30	14	0	25	11	18	26
USA	124	302	271	78	21	0	78	119	220
GBR	42	50	47	33	8	76	0	51	72
FRA	61	132	166	70	13	84	44	0	202
ITA	89	392	482	108	22	153	53	156	0

BSW

```

-----
common bulls below diagonal
common three quarter sib group above diagonal
  CAN  DEA  NLD  NZL  USA  GBR  ITA  SVN
-----
CAN   0  112  39  15  137  48  109  26
DEA  99   0  157  35  313  63  694  78
NLD  35  145   0  20   89  38  138  38
NZL  14   30  14   0  25  11  27   7
USA 129  271  78  21   0  78  242  32
GBR  44  47  33   8  76   0  74  17
ITA  96  614 114  23 172  54   0  75
SVN  24  74  39   7  29  14  73   0
-----

```

```

GUE
-----
common bulls below diagonal
common three quarter sib group above diagonal
  CAN  GBR  NZL  USA  AUS
-----
CAN   0  17   2  40  18
GBR  14   0  14  53  28
NZL   1  12   0  10  25
USA  39  50   7   0  19
AUS  13  22  23  16   0
-----

```

```

GUE
-----
common bulls below diagonal
common three quarter sib group above diagonal
  CAN  GBR  USA
-----
CAN   0  18  40
GBR  14   0  58
USA  39  55   0
-----

```

```

GUE
-----
common bulls below diagonal
common three quarter sib group above diagonal
  CAN  GBR  NZL  USA  AUS
-----
CAN   0  13   0  40  23
GBR  10   0  13  83  33
NZL   0  11   0  24  23
USA  38  85  23   0  65
AUS  19  27  23  63   0
-----

```

```

GUE
-----
common bulls below diagonal
common three quarter sib group above diagonal
  CAN  GBR  NZL  USA  AUS
-----
CAN   0  13   0  40  23
GBR  10   0  13  83  33
NZL   0  11   0  24  23
USA  38  85  23   0  65
AUS  19  27  23  63   0
-----

```

```

HOL
-----
common bulls below diagonal
common three quarter sib group above diagonal
  CAN  CZE  DEU  DFS  FRA  USA  POL  CHE  NLD  ITA  JPN
-----
CAN   0 1113 2295 1396 1304 3026 1388  839 1440 1877 1167
-----

```

```

CZE 828 0 1855 1250 1219 1500 1214 494 1510 1324 827
DEU 1883 1424 0 2646 2354 3027 2341 1140 3146 2673 1338
DFS 1319 849 2026 0 1686 1750 1447 735 2238 1651 982
FRA 982 754 1348 993 0 1687 1506 714 1966 1657 1134
USA 3500 1225 2437 1605 1026 0 1992 896 1940 2537 1492
POL 1273 980 2088 1208 1047 2105 0 561 1660 1628 844
CHE 763 349 1070 688 658 829 457 0 918 770 468
NLD 1420 1313 2809 1959 1310 1737 1508 914 0 1783 1076
ITA 1670 993 1958 1407 1028 2167 1349 724 1539 0 1166
JPN 671 370 613 523 425 798 464 304 554 571 0

```

HOL

-----

common bulls below diagonal  
common three quarter sib group above diagonal

	BEL	CAN	CHE	DEU	DFS	ESP	GBR	IRL	ITA	NLD	NZL	USA	POL	FRA
BEL	0	793	625	1249	890	925	889	533	816	1278	532	849	600	987
CAN	795	0	875	2457	1482	1607	1691	583	1915	1596	741	3221	1275	1407
CHE	631	804	0	1181	742	740	771	441	773	963	445	961	524	729
DEU	1276	1961	1121	0	2824	2328	2318	962	2690	3658	1065	3289	2104	2601
DFS	835	1399	700	2108	0	1556	1672	792	1638	2289	895	1905	1316	1701
ESP	996	1411	690	2054	1385	0	1549	732	1702	1799	763	1893	1237	1788
GBR	872	1776	741	1801	1337	1419	0	1047	1674	1969	1002	2142	1113	1640
IRL	526	579	453	845	671	750	1094	0	641	962	778	706	428	781
ITA	824	1706	726	1975	1392	1543	1396	591	0	1863	713	2636	1435	1659
NLD	1459	1602	961	3406	2070	1881	1754	915	1640	0	1162	2206	1549	2096
NZL	430	676	372	819	647	629	862	675	571	1051	0	894	481	831
USA	810	3778	896	2549	1702	1668	2114	696	2202	2013	835	0	1800	1889
POL	513	1152	407	1784	1072	1014	881	332	1129	1370	366	1825	0	1411
FRA	973	1069	663	1486	987	1705	1081	637	1024	1387	512	1130	932	0

HOL

-----

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	CHE	CZE	DEU	DFS	FRA	GBR	ISR	ITA	NLD	USA	POL	JPN
CAN	0	876	1069	2450	1486	1414	1740	132	1923	1602	3260	1321	1303
CHE	806	0	448	1175	742	733	781	60	773	963	961	550	496
CZE	831	319	0	1667	1110	1064	963	119	1228	1398	1476	1169	759
DEU	1951	1115	1327	0	2828	2613	2365	170	2679	3644	3273	2263	1531
DFS	1404	700	835	2105	0	1707	1701	153	1638	2288	1909	1414	1042
FRA	1087	670	661	1499	997	0	1673	122	1660	2110	1898	1470	1268
GBR	1827	754	679	1832	1359	1102	0	154	1715	2020	2214	1182	1135
ISR	98	36	92	136	115	68	113	0	144	161	178	114	109
ITA	1714	726	946	1963	1388	1032	1427	106	0	1861	2633	1502	1195
NLD	1610	961	1280	3385	2069	1407	1802	128	1636	0	2206	1670	1146
USA	3829	896	1220	2527	1702	1144	2193	172	2199	2013	0	1864	1680
POL	1207	439	967	2016	1191	997	956	85	1198	1531	1906	0	860
JPN	780	342	390	698	593	494	607	48	632	644	940	490	0

HOL

-----

common bulls below diagonal  
common three quarter sib group above diagonal

	BEL	CAN	CHE	CZE	DEU	DFS	ESP	FRA	GBR	IRL	ISR	ITA	NLD	NZL	USA	POL	ZAF	AUS	URY	JPN
BEL	0	781	625	554	1242	891	925	985	891	535	77	814	1280	512	1001	593	334	769	352	536
CAN	782	0	868	1055	2385	1458	1593	1379	1662	571	128	1875	1567	684	3362	1243	445	1348	744	1211
CHE	631	791	0	448	1167	743	740	726	771	441	61	770	963	423	1058	514	263	667	314	464
CZE	442	809	319	0	1661	1109	1062	1057	949	431	119	1226	1398	484	1525	1090	281	718	468	728
DEU	1268	1877	1105	1319	0	2819	2330	2573	2310	957	171	2653	3612	1013	3823	2052	559	1773	815	1446
DFS	835	1370	701	835	2097	0	1564	1699	1676	792	155	1626	2292	857	2296	1298	512	1350	654	982
ESP	996	1381	690	853	2044	1392	0	1791	1552	733	139	1698	1804	736	2208	1217	517	1237	667	1135
FRA	969	1038	659	654	1447	977	1696	0	1640	785	125	1636	2087	814	2588	1386	481	1344	608	1209
GBR	872	1739	741	669	1780	1337	1420	1074	0	1048	153	1665	1972	967	2518	1099	505	1515	698	1073
IRL	526	560	453	330	837	671	750	634	1094	0	103	639	965	761	871	419	338	786	387	463
ISR	47	90	36	92	135	115	103	67	110	80	0	142	163	112	204	108	60	116	89	107

ITA	823	1652	723	941	1933	1380	1539	1000	1393	590	105	0	1852	674	2760	1403	438	1190	675	1133
NLD	1461	1565	961	1280	3330	2071	1884	1371	1755	916	128	1630	0	1094	2768	1509	505	1555	697	1083
NZL	409	622	354	363	765	610	608	490	834	660	92	542	987	0	1132	444	355	1233	531	571
USA	891	3852	991	1244	2787	1837	1936	1420	2357	798	191	2249	2451	1071	0	1805	636	2059	1176	1982
POL	496	1101	392	856	1699	1045	986	899	863	322	74	1089	1314	332	1789	0	231	817	480	786
ZAF	281	409	222	201	429	379	475	336	444	297	39	361	422	283	612	159	0	476	315	411
AUS	666	1376	592	504	1339	992	1009	920	1340	680	73	953	1353	1224	2099	606	416	0	679	920
URY	263	704	240	318	581	452	584	358	565	299	48	510	545	435	1444	376	267	535	0	570
JPN	337	653	295	351	596	515	546	426	528	286	40	549	555	279	814	407	260	490	289	0

HOL

common bulls below diagonal  
common three quarter sib group above diagonal

	BEL	CAN	DEU	DFS	ESP	GBR	IRL	ITA	NLD	NZL	USA	POL	ZAF	AUS	URY	FRA	JPN	SVN
BEL	0	783	1240	891	925	891	535	813	1280	512	1001	592	334	769	352	985	536	152
CAN	786	0	2390	1466	1600	1671	577	1881	1576	689	3375	1245	449	1356	750	1387	1216	196
DEU	1267	1886	0	2817	2329	2310	957	2649	3610	1013	3819	2045	559	1773	815	2573	1446	302
DFS	835	1380	2094	0	1564	1676	792	1624	2290	857	2295	1296	512	1350	654	1699	982	232
ESP	996	1397	2044	1392	0	1552	733	1697	1802	736	2206	1216	517	1236	667	1790	1134	216
GBR	872	1752	1780	1337	1420	0	1048	1665	1972	967	2518	1098	505	1515	697	1640	1073	191
IRL	526	568	837	671	750	1094	0	638	964	761	871	419	338	786	387	785	463	103
ITA	823	1664	1930	1379	1538	1393	590	0	1852	674	2759	1397	438	1190	675	1636	1133	234
NLD	1461	1578	3329	2070	1884	1755	916	1630	0	1094	2767	1506	505	1555	697	2086	1082	245
NZL	409	625	765	610	608	834	660	542	987	0	1132	444	355	1233	531	814	571	108
USA	891	3881	2787	1837	1936	2357	798	2249	2451	1071	0	1802	636	2059	1176	2588	1982	225
POL	496	1107	1695	1044	986	863	322	1088	1314	332	1789	0	231	817	480	1386	785	229
ZAF	281	416	429	379	475	444	297	361	422	283	612	159	0	476	315	481	411	67
AUS	666	1381	1339	992	1009	1340	680	953	1353	1224	2099	606	416	0	679	1344	920	150
URY	263	710	581	452	584	565	299	510	545	435	1444	376	267	535	0	608	570	79
FRA	969	1046	1447	977	1696	1074	634	1000	1371	490	1420	899	336	920	358	0	1209	187
JPN	337	656	596	515	546	528	286	549	555	279	814	407	260	490	289	426	0	148
SVN	118	149	297	181	191	140	80	198	214	76	179	191	47	104	42	137	79	0

JER

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DFS	USA	NLD
CAN	0	98	334	34
DFS	93	0	148	88
USA	323	135	0	71
NLD	27	85	71	0

JER

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	NZL	USA	IRL
CAN	0	104	154	41	168	397	14
DFS	97	0	175	153	161	167	55
GBR	155	171	0	94	220	222	78
NLD	35	151	88	0	87	95	37
NZL	170	138	227	79	0	298	140
USA	400	154	242	98	323	0	44
IRL	13	51	81	36	157	46	0

JER

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA
CAN	0	104	156	41	402
DFS	97	0	176	152	166
GBR	157	172	0	93	224

NLD	35	150	88	0	94
USA	405	154	245	98	0

JER

```

common bulls below diagonal
common three quarter sib group above diagonal
  CAN  DFS  GBR  NLD  NZL  USA  ZAF  AUS  IRL
-----
CAN    0  101  152  40  157  403  133  227  14
DFS   94    0  176  153  157  216  157  167  55
GBR  151  171    0  94  218  249  175  231  78
NLD   33  151  88    0  82  109  77  77  37
NZL  156  133  225  75    0  384  213  444  140
USA  405  191  276  115  458    0  321  514  52
ZAF  131  139  179  73  223  334    0  251  43
AUS  221  137  239  70  492  559  239    0  64
IRL   13   51   81  36  157  54  44  62  0

```

JER

```

common bulls below diagonal
common three quarter sib group above diagonal
  CAN  DFS  GBR  NLD  NZL  USA  ZAF  AUS  IRL
-----
CAN    0  103  153  40  159  407  135  229  14
DFS   96    0  176  153  157  216  157  167  55
GBR  153  171    0  94  218  249  175  231  78
NLD   34  151  88    0  82  109  77  77  37
NZL  160  133  225  75    0  384  213  444  140
USA  412  191  276  115  458    0  321  514  52
ZAF  134  139  179  73  223  334    0  251  43
AUS  225  137  239  70  492  559  239    0  64
IRL   13   51   81  36  157  54  44  62  0

```

RDC

```

common bulls below diagonal
common three quarter sib group above diagonal
  CAN  DEU  DFS  NOR  USA  NLD
-----
CAN    0  10  176  7  103  6
DEU   10  0  61  15  18  11
DFS  183  52  0  130  164  57
NOR   6  14  108  0  70  40
USA   97  17  156  70  0  39
NLD   6  11  54  40  37  0

```

RDC

```

common bulls below diagonal
common three quarter sib group above diagonal
  CAN  DEU  DFS  GBR  NOR  NZL  USA  NLD  IRL
-----
CAN    0  13  180  78  7  71  148  6  4
DEU   12  0  66  15  15  21  20  14  5
DFS  187  54  0  117  147  181  194  59  19
GBR   79  14  113  0  63  78  104  39  26
NOR   6  14  119  66  0  48  81  46  60
NZL   71  21  177  77  47  0  106  23  15
USA  143  19  189  100  81  109  0  43  31
NLD   6  14  56  38  46  23  41  0  14
IRL   4  5  14  25  59  15  31  14  0

```

RDC

```

common bulls below diagonal
common three quarter sib group above diagonal
  CAN  DEU  DFS  GBR  NOR  NLD  USA

```

CAN	0	13	180	79	7	6	148
DEU	12	0	65	15	15	13	20
DFS	187	53	0	118	135	59	194
GBR	80	14	114	0	67	39	105
NOR	6	14	111	71	0	44	81
NLD	6	13	56	38	44	0	43
USA	143	19	189	101	81	41	0

RDC

-----

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DEU	DFS	GBR	NOR	NZL	USA	ZAF	NLD	AUS	IRL
CAN	0	13	178	74	7	63	171	77	6	75	4
DEU	12	0	64	15	15	17	22	3	13	44	5
DFS	184	53	0	117	135	164	217	62	59	223	19
GBR	74	14	113	0	62	72	118	47	39	86	26
NOR	6	14	111	65	0	41	86	0	44	70	60
NZL	64	17	160	70	40	0	111	39	18	139	15
USA	174	20	216	116	86	113	0	77	46	138	32
ZAF	81	3	59	43	0	37	72	0	3	46	3
NLD	6	13	56	38	44	18	44	3	0	33	14
AUS	77	42	200	84	59	140	139	48	31	0	19
IRL	4	5	14	25	59	15	32	3	14	18	0

RDC

-----

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DEU	DFS	GBR	NOR	NZL	USA	ZAF	NLD	AUS	IRL
CAN	0	13	178	75	7	63	171	77	6	75	4
DEU	12	0	64	15	15	17	22	3	13	44	5
DFS	184	53	0	117	147	164	217	62	59	223	19
GBR	75	14	113	0	63	72	118	47	39	86	26
NOR	6	14	119	66	0	42	86	0	46	74	60
NZL	64	17	160	70	41	0	111	39	18	139	15
USA	174	20	216	116	86	113	0	77	46	138	32
ZAF	81	3	59	43	0	37	72	0	3	46	3
NLD	6	13	56	38	46	18	44	3	0	33	14
AUS	77	42	200	84	63	140	139	48	31	0	19
IRL	4	5	14	25	59	15	32	3	14	18	0

SIM

-----

SIM

-----

SIM

-----

SIM

-----

SIM

-----