## 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 conformation traits are as follows:

| | |
|---|---|
| NOR (RDC) | New models with: Regression on level of Heterozygosity; Fixed effect of milking-system within lactation; Fourth and fifth lactation included from 2009, New definition of genetic groups. Genetic parameters were re-estimated. Some daughters lost due to new criterion of phenotype being outside +- 4 std within lactation and calving year. 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 |
| IRL (HOL) | SCS: decrese in herd for some sires is due to a bug correction on the herd count by sire |
| BEL (HOL) | Some bulls with type of proof showing an unexpected change are due to the program used to determine the type of proof for bulls |
| AUS (ALL) | Drops of information due to data clean up such as pedigree changes or status changes leading to a good number of bulls no longer being qualified. Decreases in EDC are also due to rounding. |
| ITA (SIM) | Base change, some drops in information due to parentage verification. |
| ITA (HOL) | Base change plus 1 year cutoff data. |
| ZAF (HOL) | Clean-up done on the data resulting in some of the lactations' test-day records not conforming to the BLUP-specs and were therefore ommitted |
| DEU (ALL) | Decrease in infromation due to pedigree and phenotype corrections, Base change |
| CHE (ALL) | Base change. Decrease in information due to manual edits in the database |
| DEA (ALL) | Some pedigree corrections were done by partners' organisations leading to decrease in reliabilities. Changes in EDC, affecting mostly SIM, are due to the software used |
| ITA (BSW) | Base change |
| NZL (ALL) | Daughter counts: New Zealand has continuous DNA parentage testing so daughters will always change. Herd Count: Affected by continuous DNA parentage testing. EDCs: Affected by continuous DNA parentage testing. Reliability changes. |
| LVA (HOL,RDC) | New data for scs since 2013. Changes related to animals with missing parents now deleted |
| HRV (HOL,SIM) | Drops in information due to data checks and pedigree verification, affecting especially SIM bulls |
| KOR (HOL) | Data are provided by the institution collecting test data. Before only the last test day data were provided while now all the test date data for SCS were provided and used in the evaluation |
| URY (HOL) | Drop in information due to pedigree verification |
| CAN (ALL) | Base change |
| GBR (ALL) | Drop in information due to data clean up |
| LTU (HOL) | Based change |
| USA (ALL) | Pedigree corrections and herd-year minimum edits causing drops in information |
| FRA (ALL) | Base change, quite a lot of publication rules changed in relation with setting up of the single step EBV affecting HOL, SIM and MON breeds |

## 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

## 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 2022).
Number of records for milk somatic cells by breed

| Country | BSW | GUE | HOL | JER | RDC | SIM |
|---|---|---|---|---|---|---|
| AUS | | 146 | 8624 | 1723 | 806 | |
| BEL | | | 2220 | | | |
| CAN | 270 | 105 | 13486 | 845 | 861 | |
| CHE | 3129 | | 3268 | 97 | | 3502 |
| CZE | | | 4594 | | | |
| DEA | 5928 | | | | | 24096 |
| DEU | | | 23545 | | 288 | |
| DFS | | | 14029 | 2286 | 8068 | |
| ESP | | | 4324 | | | |
| EST | | | 1291 | | 470 | |
| FRA | 430 | | 17811 | | | 451 |
| FRM | | | | | | 4645 |
| GBR | 144 | 300 | 7323 | 750 | 561 | 85 |
| HUN | | | 3163 | | | 190 |
| IRL | | | 2813 | | | |
| ISR | | | 1623 | | | |
| ITA | 2081 | | 9425 | 73 | | 1711 |
| JPN | | | 6692 | | | |
| KOR | | | 1556 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| LTU | | | 1341 | | 436 | |
| LVA | | | 1262 | | 662 | |
| NLD | 219 | | 16718 | 228 | 98 | 482 |
| NOR | | | | | 4276 | |
| NZL | 71 | 57 | 8606 | 4945 | 1408 | |
| POL | | | 11985 | | | |
| PRT | | | 2468 | | | |
| SVK | | | 1162 | | | |
| SVN | 408 | | 684 | | | 730 |
| URY | | | 1981 | | | |
| USA | 1151 | 720 | 41066 | 5065 | 742 | 87 |
| ZAF | | | 1204 | 605 | 125 | |
| HRV | | | 909 | | | 1017 |
| CAM | | | | | 44 | |
| No.Records | 13831 | 1328 | 215173 | 16617 | 18845 | 36996 |
| Pub. Proofs | 11114 | 1029 | 155761 | 13540 | 17799 | 32370 |

^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 | 6.47 | | | | | | | | | |
| FRA | 0.92 | 1.02 | | | | | | | | |
| NLD | 0.89 | 0.91 | 3.94 | | | | | | | |
| USA | 0.90 | 0.90 | 0.85 | 0.21 | | | | | | |
| CHE | 0.90 | 0.94 | 0.94 | 0.82 | 10.49 | | | | | |
| DEA | 0.90 | 0.96 | 0.92 | 0.85 | 0.97 | 11.94 | | | | |
| NZL | 0.71 | 0.79 | 0.81 | 0.67 | 0.77 | 0.72 | 0.36 | | | |
| ITA | 0.88 | 0.89 | 0.88 | 0.84 | 0.95 | 0.91 | 0.69 | 15.88 | | |
| GBR | 0.92 | 0.96 | 0.95 | 0.91 | 0.93 | 0.95 | 0.82 | 0.89 | 11.72 | |
| SVN | 0.82 | 0.82 | 0.82 | 0.82 | 0.81 | 0.81 | 0.69 | 0.82 | 0.84 | 10.36 |

BSW mas

| | CAN | FRA | NLD | USA | CHE | DEA | NZL | ITA | GBR | SVN |
|---|---|---|---|---|---|---|---|---|---|---|
| CAN | 6.46 | | | | | | | | | |
| FRA | 0.83 | 1.05 | | | | | | | | |
| NLD | 0.81 | 0.76 | 3.89 | | | | | | | |
| USA | 0.84 | 0.78 | 0.82 | 0.21 | | | | | | |
| CHE | 0.89 | 0.84 | 0.88 | 0.79 | 11.47 | | | | | |
| DEA | 0.91 | 0.73 | 0.88 | 0.84 | 0.90 | 11.94 | | | | |
| NZL | 0.69 | 0.64 | 0.71 | 0.68 | 0.70 | 0.74 | 0.36 | | | |
| ITA | 0.85 | 0.75 | 0.82 | 0.77 | 0.88 | 0.92 | 0.70 | 15.88 | | |
| GBR | 0.84 | 0.85 | 0.83 | 0.79 | 0.87 | 0.76 | 0.63 | 0.77 | 2.26 | |
| SVN | 0.81 | 0.74 | 0.74 | 0.79 | 0.74 | 0.80 | 0.75 | 0.82 | 0.78 | 10.36 |

GUE scs

| | CAN | GBR | USA | AUS | NZL |
|---|---|---|---|---|---|
| CAN | 6.19 | | | | |
| GBR | 0.92 | 13.50 | | | |
| USA | 0.93 | 0.90 | 0.25 | | |
| AUS | 0.82 | 0.88 | 0.78 | 0.24 | |
| NZL | 0.77 | 0.82 | 0.72 | 0.89 | 0.62 |

HOL scs

| | 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 | 5.70 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CHE | 0.90 | 10.70 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| DEU | 0.94 | 0.95 | 12.87 | | | | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DFS | 0.93 | 0.92 | 0.97 | 11.74 | | | | | | | | | | | | | | | | | | | | | | | | | |
| EST | 0.88 | 0.89 | 0.93 | 0.93 | 19.46 | | | | | | | | | | | | | | | | | | | | | | | | |
| FRA | 0.94 | 0.93 | 0.96 | 0.96 | 0.91 | 1.18 | | | | | | | | | | | | | | | | | | | | | | | |
| GBR | 0.94 | 0.94 | 0.95 | 0.94 | 0.90 | 0.95 | 12.80 | | | | | | | | | | | | | | | | | | | | | | |
| NLD | 0.91 | 0.94 | 0.96 | 0.94 | 0.91 | 0.93 | 0.96 | 4.61 | | | | | | | | | | | | | | | | | | | | | |
| USA | 0.94 | 0.85 | 0.89 | 0.87 | 0.90 | 0.90 | 0.91 | 0.87 | 0.20 | | | | | | | | | | | | | | | | | | | | |
| ISR | 0.85 | 0.84 | 0.85 | 0.82 | 0.86 | 0.84 | 0.81 | 0.81 | 0.87 | 0.24 | | | | | | | | | | | | | | | | | | | |
| ITA | 0.90 | 0.89 | 0.95 | 0.93 | 0.93 | 0.93 | 0.90 | 0.89 | 0.89 | 0.84 | 5.81 | | | | | | | | | | | | | | | | | | |
| AUS | 0.81 | 0.86 | 0.83 | 0.82 | 0.77 | 0.83 | 0.87 | 0.85 | 0.77 | 0.69 | 0.79 | 0.25 | | | | | | | | | | | | | | | | | |
| HUN | 0.88 | 0.89 | 0.93 | 0.90 | 0.91 | 0.90 | 0.89 | 0.88 | 0.91 | 0.88 | 0.94 | 0.77 | 1.36 | | | | | | | | | | | | | | | | |
| BEL | 0.92 | 0.92 | 0.97 | 0.96 | 0.95 | 0.95 | 0.93 | 0.94 | 0.89 | 0.83 | 0.95 | 0.81 | 0.92 | 0.51 | | | | | | | | | | | | | | | |
| JPN | 0.87 | 0.83 | 0.85 | 0.87 | 0.84 | 0.90 | 0.86 | 0.84 | 0.87 | 0.78 | 0.83 | 0.78 | 0.82 | 0.85 | 0.42 | | | | | | | | | | | | | | |
| ESP | 0.93 | 0.91 | 0.96 | 0.94 | 0.93 | 0.96 | 0.93 | 0.91 | 0.91 | 0.88 | 0.96 | 0.80 | 0.93 | 0.96 | 0.85 | 11.62 | | | | | | | | | | | | | |
| ZAF | 0.90 | 0.88 | 0.92 | 0.90 | 0.88 | 0.93 | 0.91 | 0.88 | 0.89 | 0.83 | 0.92 | 0.83 | 0.90 | 0.91 | 0.85 | 0.95 | 26.32 | | | | | | | | | | | | |
| NZL | 0.77 | 0.82 | 0.80 | 0.80 | 0.76 | 0.81 | 0.84 | 0.83 | 0.72 | 0.68 | 0.75 | 0.89 | 0.71 | 0.78 | 0.81 | 0.77 | 0.82 | 0.41 | | | | | | | | | | | |
| IRL | 0.80 | 0.90 | 0.86 | 0.85 | 0.82 | 0.84 | 0.87 | 0.88 | 0.77 | 0.75 | 0.79 | 0.81 | 0.82 | 0.85 | 0.79 | 0.83 | 0.82 | 0.82 | 0.12 | | | | | | | | | | |
| CZE | 0.87 | 0.83 | 0.90 | 0.89 | 0.87 | 0.89 | 0.86 | 0.85 | 0.87 | 0.79 | 0.90 | 0.74 | 0.89 | 0.90 | 0.85 | 0.92 | 0.89 | 0.72 | 0.75 | 15.89 | | | | | | | | | |
| SVK | 0.86 | 0.88 | 0.92 | 0.90 | 0.88 | 0.90 | 0.86 | 0.86 | 0.86 | 0.82 | 0.91 | 0.75 | 0.95 | 0.92 | 0.81 | 0.91 | 0.88 | 0.69 | 0.82 | 0.89 | 0.41 | | | | | | | | |
| POL | 0.90 | 0.91 | 0.96 | 0.95 | 0.94 | 0.93 | 0.91 | 0.91 | 0.88 | 0.86 | 0.94 | 0.79 | 0.95 | 0.96 | 0.84 | 0.95 | 0.89 | 0.75 | 0.83 | 0.90 | 0.91 | 10.87 | | | | | | | |
| LTU | 0.82 | 0.87 | 0.90 | 0.88 | 0.91 | 0.86 | 0.84 | 0.85 | 0.80 | 0.81 | 0.86 | 0.75 | 0.86 | 0.92 | 0.80 | 0.88 | 0.85 | 0.72 | 0.78 | 0.84 | 0.87 | 0.91 | 0.35 | | | | | | |
| LVA | 0.86 | 0.90 | 0.94 | 0.94 | 0.94 | 0.90 | 0.91 | 0.91 | 0.85 | 0.80 | 0.91 | 0.81 | 0.91 | 0.95 | 0.80 | 0.91 | 0.89 | 0.80 | 0.85 | 0.87 | 0.88 | 0.95 | 0.89 | 480.03 | | | | | |
| PRT | 0.79 | 0.79 | 0.82 | 0.80 | 0.79 | 0.80 | 0.81 | 0.79 | 0.79 | 0.76 | 0.81 | 0.70 | 0.81 | 0.82 | 0.79 | 0.82 | 0.82 | 0.70 | 0.74 | 0.80 | 0.79 | 0.82 | 0.81 | 0.80 | 0.45 | | | | |
| KOR | 0.87 | 0.83 | 0.88 | 0.90 | 0.87 | 0.87 | 0.87 | 0.84 | 0.87 | 0.79 | 0.89 | 0.77 | 0.87 | 0.89 | 0.81 | 0.90 | 0.86 | 0.71 | 0.69 | 0.83 | 0.84 | 0.91 | 0.84 | 0.88 | 0.79 | 0.33 | | | |
| SVN | 0.81 | 0.83 | 0.87 | 0.87 | 0.83 | 0.85 | 0.84 | 0.84 | 0.80 | 0.79 | 0.84 | 0.78 | 0.84 | 0.88 | 0.80 | 0.85 | 0.81 | 0.72 | 0.85 | 0.81 | 0.83 | 0.88 | 0.83 | 0.89 | 0.80 | 0.81 | 10.34 | | |
| HRV | 0.80 | 0.80 | 0.83 | 0.81 | 0.87 | 0.80 | 0.81 | 0.81 | 0.81 | 0.80 | 0.82 | 0.73 | 0.85 | 0.85 | 0.80 | 0.82 | 0.81 | 0.67 | 0.75 | 0.81 | 0.81 | 0.85 | 0.84 | 0.84 | 0.79 | 0.81 | 0.81 | 11.71 | |
| URY | 0.80 | 0.82 | 0.84 | 0.82 | 0.81 | 0.82 | 0.80 | 0.82 | 0.80 | 0.78 | 0.80 | 0.80 | 0.81 | 0.82 | 0.80 | 0.81 | 0.83 | 0.77 | 0.74 | 0.80 | 0.82 | 0.82 | 0.80 | 0.78 | 0.79 | 0.80 | 0.81 | 0.80 | 0.20 |

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HOL mas

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| | 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 | 7.56 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CHE | 0.92 | 10.70 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| DEU | 0.92 | 0.88 | 9.78 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| DFS | 0.94 | 0.88 | 0.91 | 12.56 | | | | | | | | | | | | | | | | | | | | | | | | | |
| EST | 0.81 | 0.85 | 0.83 | 0.85 | 19.46 | | | | | | | | | | | | | | | | | | | | | | | | |
| FRA | 0.96 | 0.92 | 0.91 | 0.94 | 0.83 | 1.18 | | | | | | | | | | | | | | | | | | | | | | | |
| GBR | 0.88 | 0.90 | 0.82 | 0.84 | 0.78 | 0.88 | 2.40 | | | | | | | | | | | | | | | | | | | | | | |
| NLD | 0.85 | 0.90 | 0.81 | 0.86 | 0.84 | 0.86 | 0.82 | 4.98 | | | | | | | | | | | | | | | | | | | | | |
| USA | 0.85 | 0.81 | 0.85 | 0.81 | 0.77 | 0.86 | 0.80 | 0.80 | 2.37 | | | | | | | | | | | | | | | | | | | | |
| ISR | 0.74 | 0.76 | 0.74 | 0.77 | 0.84 | 0.75 | 0.70 | 0.76 | 0.71 | 0.24 | | | | | | | | | | | | | | | | | | | |
| ITA | 0.81 | 0.88 | 0.74 | 0.79 | 0.84 | 0.81 | 0.78 | 0.88 | 0.69 | 0.78 | 6.08 | | | | | | | | | | | | | | | | | | |
| AUS | 0.68 | 0.68 | 0.68 | 0.68 | 0.69 | 0.68 | 0.68 | 0.67 | 0.68 | 0.65 | 0.68 | 0.12 | | | | | | | | | | | | | | | | | |
| HUN | 0.84 | 0.86 | 0.78 | 0.82 | 0.90 | 0.81 | 0.82 | 0.87 | 0.74 | 0.87 | 0.89 | 0.69 | 1.36 | | | | | | | | | | | | | | | | |
| BEL | 0.88 | 0.93 | 0.85 | 0.88 | 0.93 | 0.87 | 0.84 | 0.89 | 0.74 | 0.82 | 0.88 | 0.70 | 0.93 | 0.51 | | | | | | | | | | | | | | | |
| JPN | 0.74 | 0.83 | 0.70 | 0.74 | 0.78 | 0.73 | 0.72 | 0.80 | 0.69 | 0.77 | 0.84 | 0.70 | 0.82 | 0.85 | 0.42 | | | | | | | | | | | | | | |
| ESP | 0.86 | 0.91 | 0.80 | 0.85 | 0.90 | 0.86 | 0.84 | 0.87 | 0.73 | 0.86 | 0.87 | 0.70 | 0.93 | 0.96 | 0.86 | 11.62 | | | | | | | | | | | | | |
| ZAF | 0.83 | 0.88 | 0.78 | 0.78 | 0.83 | 0.82 | 0.79 | 0.84 | 0.72 | 0.81 | 0.85 | 0.70 | 0.90 | 0.93 | 0.86 | 0.94 | 26.05 | | | | | | | | | | | | |
| NZL | 0.63 | 0.70 | 0.63 | 0.63 | 0.72 | 0.63 | 0.63 | 0.64 | 0.62 | 0.72 | 0.66 | 0.66 | 0.71 | 0.78 | 0.80 | 0.77 | 0.82 | 0.41 | | | | | | | | | | | |
| IRL | 0.77 | 0.85 | 0.75 | 0.77 | 0.85 | 0.76 | 0.77 | 0.78 | 0.65 | 0.78 | 0.80 | 0.67 | 0.86 | 0.93 | 0.84 | 0.92 | 0.91 | 0.90 | 0.11 | | | | | | | | | | |
| CZE | 0.83 | 0.86 | 0.75 | 0.81 | 0.86 | 0.82 | 0.80 | 0.84 | 0.71 | 0.79 | 0.88 | 0.69 | 0.90 | 0.92 | 0.85 | 0.92 | 0.90 | 0.72 | 0.84 | 15.89 | | | | | | | | | |
| SVK | 0.83 | 0.85 | 0.80 | 0.80 | 0.88 | 0.83 | 0.80 | 0.86 | 0.76 | 0.81 | 0.88 | 0.69 | 0.94 | 0.92 | 0.80 | 0.91 | 0.89 | 0.71 | 0.84 | 0.89 | 0.40 | | | | | | | | |
| POL | 0.85 | 0.89 | 0.81 | 0.86 | 0.93 | 0.84 | 0.84 | 0.86 | 0.73 | 0.84 | 0.85 | 0.69 | 0.95 | 0.97 | 0.84 | 0.95 | 0.89 | 0.74 | 0.91 | 0.91 | 0.90 | 10.82 | | | | | | | |
| LTU | 0.81 | 0.80 | 0.80 | 0.82 | 0.88 | 0.82 | 0.77 | 0.76 | 0.69 | 0.76 | 0.78 | 0.69 | 0.87 | 0.91 | 0.78 | 0.86 | 0.83 | 0.71 | 0.83 | 0.84 | 0.87 | 0.90 | 0.35 | | | | | | |
| LVA | 0.78 | 0.82 | 0.73 | 0.81 | 0.91 | 0.78 | 0.79 | 0.84 | 0.70 | 0.78 | 0.82 | 0.68 | 0.91 | 0.94 | 0.78 | 0.90 | 0.88 | 0.78 | 0.91 | 0.87 | 0.88 | 0.95 | 0.89 | 479.46 | | | | | |
| PRT | 0.73 | 0.80 | 0.70 | 0.74 | 0.79 | 0.74 | 0.71 | 0.76 | 0.69 | 0.76 | 0.74 | 0.69 | 0.82 | 0.85 | 0.78 | 0.83 | 0.82 | 0.71 | 0.82 | 0.82 | 0.78 | 0.82 | 0.82 | 0.82 | 0.45 | | | | |
| KOR | 0.83 | 0.83 | 0.72 | 0.84 | 0.84 | 0.83 | 0.79 | 0.79 | 0.73 | 0.76 | 0.78 | 0.69 | 0.86 | 0.89 | 0.81 | 0.90 | 0.83 | 0.71 | 0.81 | 0.84 | 0.83 | 0.92 | 0.84 | 0.88 | 0.78 | 0.33 | | | |
| SVN | 0.79 | 0.81 | 0.76 | 0.83 | 0.81 | 0.79 | 0.79 | 0.79 | 0.69 | 0.75 | 0.78 | 0.69 | 0.82 | 0.89 | 0.78 | 0.86 | 0.81 | 0.71 | 0.88 | 0.82 | 0.80 | 0.88 | 0.85 | 0.89 | 0.82 | 0.79 | 10.37 | | |
| HRV | 0.71 | 0.74 | 0.71 | 0.72 | 0.85 | 0.72 | 0.75 | 0.77 | 0.69 | 0.77 | 0.76 | 0.69 | 0.85 | 0.85 | 0.78 | 0.82 | 0.81 | 0.71 | 0.79 | 0.81 | 0.80 | 0.84 | 0.84 | 0.86 | 0.78 | 0.78 | 0.81 | 11.41 | |
| URY | 0.72 | 0.74 | 0.75 | 0.72 | 0.79 | 0.72 | 0.72 | 0.71 | 0.69 | 0.76 | 0.74 | 0.70 | 0.79 | 0.83 | 0.79 | 0.80 | 0.83 | 0.77 | 0.84 | 0.79 | 0.82 | 0.82 | 0.78 | 0.81 | 0.78 | 0.79 | 0.78 | 0.78 | 0.20 |

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JER scs

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| | CAN | DFS | GBR | NLD | USA | AUS | ZAF | NZL | CHE | ITA |
|---|---|---|---|---|---|---|---|---|---|---|
| CAN | 6.08 | | | | | | | | | |
| DFS | 0.91 | 12.41 | | | | | | | | |
| GBR | 0.92 | 0.91 | 11.39 | | | | | | | |
| NLD | 0.91 | 0.95 | 0.94 | 4.38 | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| USA | 0.90 | 0.83 | 0.89 | 0.85 | 0.17 | | | | | |
| AUS | 0.78 | 0.83 | 0.83 | 0.86 | 0.74 | 0.23 | | | | |
| ZAF | 0.85 | 0.87 | 0.86 | 0.88 | 0.84 | 0.81 | 21.23 | | | |
| NZL | 0.70 | 0.73 | 0.78 | 0.79 | 0.69 | 0.89 | 0.76 | 0.39 | | |
| CHE | 0.88 | 0.87 | 0.86 | 0.90 | 0.83 | 0.76 | 0.83 | 0.70 | 12.69 | |
| ITA | 0.87 | 0.92 | 0.86 | 0.87 | 0.85 | 0.71 | 0.83 | 0.65 | 0.85 | 7.20 |

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JER mas

| | CAN | DFS | GBR | NLD | USA | AUS | ZAF | NZL | CHE | ITA |
|---|---|---|---|---|---|---|---|---|---|---|
| CAN | 7.48 | | | | | | | | | |
| DFS | 0.92 | 12.19 | | | | | | | | |
| GBR | 0.81 | 0.85 | 1.87 | | | | | | | |
| NLD | 0.84 | 0.82 | 0.77 | 4.25 | | | | | | |
| USA | 0.77 | 0.77 | 0.74 | 0.75 | 2.47 | | | | | |
| AUS | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.11 | | | | |
| ZAF | 0.73 | 0.72 | 0.72 | 0.80 | 0.71 | 0.70 | 21.20 | | | |
| NZL | 0.63 | 0.63 | 0.63 | 0.64 | 0.63 | 0.63 | 0.77 | 0.39 | | |
| CHE | 0.84 | 0.82 | 0.74 | 0.77 | 0.75 | 0.71 | 0.80 | 0.73 | 12.63 | |
| ITA | 0.76 | 0.73 | 0.73 | 0.80 | 0.67 | 0.67 | 0.80 | 0.70 | 0.81 | 7.20 |

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RDC scs

| | CAN | DFS | GBR | NOR | USA | DEU | AUS | EST | ZAF | NZL | LTU | LVA | NLD | CAM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAN | 5.99 | | | | | | | | | | | | | |
| DFS | 0.94 | 12.91 | | | | | | | | | | | | |
| GBR | 0.93 | 0.92 | 11.48 | | | | | | | | | | | |
| NOR | 0.87 | 0.90 | 0.82 | 13.82 | | | | | | | | | | |
| USA | 0.92 | 0.86 | 0.88 | 0.81 | 0.23 | | | | | | | | | |
| DEU | 0.94 | 0.96 | 0.95 | 0.89 | 0.89 | 14.12 | | | | | | | | |
| AUS | 0.81 | 0.84 | 0.87 | 0.82 | 0.74 | 0.84 | 0.27 | | | | | | | |
| EST | 0.88 | 0.89 | 0.90 | 0.85 | 0.86 | 0.94 | 0.81 | 19.39 | | | | | | |
| ZAF | 0.84 | 0.86 | 0.86 | 0.89 | 0.86 | 0.92 | 0.76 | 0.88 | 25.39 | | | | | |
| NZL | 0.78 | 0.79 | 0.82 | 0.80 | 0.73 | 0.81 | 0.90 | 0.80 | 0.79 | 0.44 | | | | |
| LTU | 0.85 | 0.90 | 0.87 | 0.89 | 0.82 | 0.90 | 0.78 | 0.90 | 0.87 | 0.77 | 0.34 | | | |
| LVA | 0.87 | 0.89 | 0.91 | 0.85 | 0.83 | 0.93 | 0.83 | 0.95 | 0.88 | 0.81 | 0.90 | 437.03 | | |
| NLD | 0.91 | 0.95 | 0.95 | 0.89 | 0.87 | 0.96 | 0.85 | 0.90 | 0.88 | 0.83 | 0.87 | 0.89 | 4.24 | |
| CAM | 0.89 | 0.90 | 0.90 | 0.89 | 0.83 | 0.90 | 0.88 | 0.90 | 0.89 | 0.86 | 0.89 | 0.88 | 0.90 | 6.42 |

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RDC mas

| | CAN | DFS | GBR | NOR | USA | AUS | EST | ZAF | NZL | LTU | LVA | NLD | CAM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAN | 7.63 | | | | | | | | | | | | |
| DFS | 0.90 | 13.61 | | | | | | | | | | | |
| GBR | 0.86 | 0.85 | 2.05 | | | | | | | | | | |
| NOR | 0.82 | 0.73 | 0.74 | 13.82 | | | | | | | | | |
| USA | 0.79 | 0.74 | 0.78 | 0.80 | 0.23 | | | | | | | | |
| AUS | 0.70 | 0.69 | 0.69 | 0.74 | 0.70 | 0.13 | | | | | | | |
| EST | 0.82 | 0.75 | 0.80 | 0.83 | 0.81 | 0.72 | 19.39 | | | | | | |
| ZAF | 0.84 | 0.83 | 0.82 | 0.88 | 0.79 | 0.72 | 0.85 | 25.43 | | | | | |
| NZL | 0.65 | 0.63 | 0.67 | 0.77 | 0.70 | 0.69 | 0.82 | 0.77 | 0.44 | | | | |
| LTU | 0.79 | 0.75 | 0.81 | 0.88 | 0.80 | 0.74 | 0.91 | 0.86 | 0.79 | 0.34 | | | |
| LVA | 0.78 | 0.72 | 0.81 | 0.87 | 0.75 | 0.71 | 0.94 | 0.87 | 0.84 | 0.91 | 435.86 | | |
| NLD | 0.85 | 0.79 | 0.84 | 0.86 | 0.84 | 0.71 | 0.87 | 0.85 | 0.72 | 0.83 | 0.86 | 4.65 | |
| CAM | 0.85 | 0.85 | 0.85 | 0.88 | 0.82 | 0.84 | 0.89 | 0.88 | 0.88 | 0.89 | 0.88 | 0.86 | 6.42 |

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SIM scs

| | FRM | FRA | ITA | NLD | CHE | DEA | HUN | SVN | GBR | HRV | USA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FRM | 1.09 | | | | | | | | | | |
| FRA | 0.89 | 1.00 | | | | | | | | | |
| ITA | 0.88 | 0.87 | 12.54 | | | | | | | | |
| NLD | 0.91 | 0.93 | 0.85 | 4.31 | | | | | | | |
| CHE | 0.93 | 0.93 | 0.88 | 0.93 | 10.35 | | | | | | |
| DEA | 0.92 | 0.93 | 0.85 | 0.91 | 0.89 | 12.25 | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HUN | 0.89 | 0.90 | 0.92 | 0.88 | 0.89 | 0.90 | 16.37 | | | | |
| SVN | 0.88 | 0.83 | 0.83 | 0.83 | 0.85 | 0.82 | 0.85 | 9.17 | | | |
| GBR | 0.91 | 0.95 | 0.88 | 0.95 | 0.90 | 0.93 | 0.89 | 0.84 | 11.70 | | |
| HRV | 0.87 | 0.80 | 0.80 | 0.80 | 0.81 | 0.80 | 0.84 | 0.80 | 0.81 | 9.74 | |
| USA | 0.84 | 0.90 | 0.87 | 0.87 | 0.86 | 0.82 | 0.91 | 0.81 | 0.90 | 0.81 | 0.20 |

SIM mas

| | FRM | FRA | ITA | NLD | CHE | DEA | HUN | SVN | GBR | HRV | USA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FRM | 1.08 | | | | | | | | | | |
| FRA | 0.87 | 1.00 | | | | | | | | | |
| ITA | 0.90 | 0.82 | 12.54 | | | | | | | | |
| NLD | 0.87 | 0.86 | 0.79 | 4.08 | | | | | | | |
| CHE | 0.84 | 0.89 | 0.87 | 0.85 | 9.57 | | | | | | |
| DEA | 0.92 | 0.92 | 0.85 | 0.87 | 0.76 | 12.25 | | | | | |
| HUN | 0.87 | 0.83 | 0.89 | 0.86 | 0.85 | 0.89 | 16.37 | | | | |
| SVN | 0.87 | 0.81 | 0.81 | 0.79 | 0.82 | 0.81 | 0.84 | 9.17 | | | |
| GBR | 0.77 | 0.88 | 0.77 | 0.81 | 0.89 | 0.79 | 0.83 | 0.79 | 2.75 | | |
| HRV | 0.84 | 0.78 | 0.79 | 0.72 | 0.78 | 0.79 | 0.83 | 0.80 | 0.75 | 9.74 | |
| USA | 0.81 | 0.86 | 0.72 | 0.84 | 0.81 | 0.80 | 0.75 | 0.71 | 0.80 | 0.73 | 0.20 |

^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 | 88 | 56 | 185 | 145 | 154 | 31 | 139 | 68 | 37 |
| FRA | 78 | 0 | 86 | 122 | 168 | 223 | 27 | 196 | 58 | 62 |
| NLD | 52 | 69 | 0 | 88 | 105 | 159 | 30 | 136 | 43 | 52 |
| USA | 182 | 82 | 79 | 0 | 327 | 334 | 35 | 234 | 95 | 47 |
| CHE | 124 | 124 | 97 | 304 | 0 | 619 | 34 | 481 | 78 | 91 |
| DEA | 139 | 166 | 152 | 299 | 516 | 0 | 47 | 680 | 82 | 119 |
| NZL | 31 | 21 | 23 | 32 | 27 | 42 | 0 | 38 | 23 | 14 |
| ITA | 123 | 155 | 113 | 164 | 422 | 581 | 31 | 0 | 82 | 111 |
| GBR | 69 | 50 | 37 | 94 | 62 | 58 | 21 | 62 | 0 | 25 |
| SVN | 34 | 60 | 53 | 38 | 87 | 111 | 13 | 109 | 22 | 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 | 82 | 52 | 185 | 70 | 154 | 31 | 139 | 31 | 37 |
| FRA | 73 | 0 | 70 | 107 | 71 | 209 | 23 | 186 | 29 | 62 |
| NLD | 46 | 59 | 0 | 76 | 44 | 142 | 30 | 126 | 21 | 49 |
| USA | 182 | 73 | 66 | 0 | 92 | 333 | 35 | 234 | 41 | 47 |
| CHE | 64 | 54 | 44 | 70 | 0 | 227 | 17 | 193 | 19 | 57 |
| DEA | 139 | 156 | 133 | 299 | 196 | 0 | 47 | 680 | 39 | 119 |
| NZL | 31 | 19 | 23 | 32 | 15 | 42 | 0 | 38 | 10 | 14 |
| ITA | 123 | 150 | 104 | 164 | 163 | 581 | 31 | 0 | 42 | 111 |
| GBR | 30 | 25 | 18 | 41 | 16 | 28 | 8 | 33 | 0 | 15 |
| SVN | 34 | 60 | 50 | 38 | 54 | 111 | 13 | 109 | 13 | 0 |

GUE

common bulls below diagonal
common three quarter sib group above diagonal

| | CAN | GBR | USA | AUS | NZL |
|---|---|---|---|---|---|
| CAN | 0 | 29 | 74 | 51 | 14 |
| GBR | 25 | 0 | 86 | 38 | 13 |
| USA | 66 | 89 | 0 | 69 | 29 |
| AUS | 49 | 32 | 67 | 0 | 26 |

| | | | | | |
|---|---|---|---|---|---|
| NZL | 11 | 11 | 29 | 26 | 0 |

GUE

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HOL

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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 | 904 | 2515 | 1619 | 290 | 1567 | 1734 | 1732 | 3797 | 146 | 1876 | 1551 | 1119 | 879 | 1441 | 1385 | 504 | 810 | 539 | 1222 | 452 | 1646 | 349 | 527 | 1062 | 737 | 245 | 333 | 843 |
| CHE | 824 | 0 | 1161 | 745 | 176 | 706 | 711 | 962 | 1035 | 67 | 758 | 657 | 448 | 636 | 491 | 589 | 258 | 425 | 378 | 544 | 243 | 738 | 195 | 253 | 498 | 281 | 159 | 212 | 330 |
| DEU | 1948 | 1093 | 0 | 2791 | 457 | 2460 | 2103 | 3539 | 3659 | 174 | 2642 | 1728 | 1318 | 1293 | 1485 | 1601 | 548 | 1020 | 801 | 1942 | 701 | 2819 | 683 | 746 | 1227 | 657 | 366 | 681 | 838 |
| DFS | 1423 | 698 | 2097 | 0 | 333 | 1722 | 1626 | 2334 | 2290 | 160 | 1644 | 1380 | 986 | 934 | 1051 | 1114 | 504 | 893 | 700 | 1358 | 427 | 1834 | 409 | 503 | 954 | 517 | 292 | 453 | 699 |
| EST | 177 | 98 | 329 | 207 | 0 | 284 | 274 | 407 | 384 | 53 | 305 | 236 | 222 | 217 | 227 | 229 | 110 | 149 | 132 | 293 | 126 | 371 | 131 | 181 | 202 | 131 | 105 | 139 | 154 |
| FRA | 1068 | 634 | 1324 | 951 | 138 | 0 | 1576 | 2084 | 2578 | 131 | 1641 | 1333 | 987 | 1002 | 1259 | 1224 | 472 | 828 | 673 | 1297 | 435 | 1842 | 327 | 435 | 945 | 542 | 222 | 319 | 632 |
| GBR | 1961 | 678 | 1609 | 1259 | 159 | 992 | 0 | 1863 | 2311 | 157 | 1574 | 1472 | 922 | 906 | 1094 | 1126 | 506 | 952 | 892 | 1118 | 390 | 1485 | 349 | 446 | 950 | 521 | 235 | 357 | 713 |
| NLD | 1681 | 958 | 3337 | 2093 | 294 | 1329 | 1633 | 0 | 2743 | 173 | 1852 | 1570 | 1058 | 1374 | 1149 | 1227 | 514 | 1123 | 832 | 1644 | 570 | 2148 | 460 | 536 | 1075 | 521 | 307 | 491 | 734 |
| USA | 4287 | 969 | 2704 | 1819 | 266 | 1394 | 2074 | 2456 | 0 | 210 | 2714 | 2068 | 1427 | 1036 | 2061 | 1650 | 632 | 1155 | 747 | 1778 | 565 | 2417 | 469 | 707 | 1327 | 900 | 279 | 421 | 1210 |
| ISR | 106 | 39 | 135 | 118 | 33 | 67 | 109 | 131 | 199 | 0 | 146 | 123 | 123 | 88 | 116 | 118 | 65 | 121 | 94 | 139 | 54 | 158 | 61 | 77 | 110 | 66 | 53 | 72 | 99 |
| ITA | 1598 | 700 | 1870 | 1341 | 176 | 946 | 1250 | 1600 | 2076 | 102 | 0 | 1223 | 1083 | 844 | 1197 | 1326 | 442 | 724 | 562 | 1315 | 403 | 1846 | 382 | 536 | 993 | 620 | 276 | 421 | 713 |
| AUS | 1579 | 580 | 1314 | 1019 | 121 | 902 | 1283 | 1385 | 2117 | 78 | 946 | 0 | 792 | 798 | 964 | 945 | 480 | 1268 | 689 | 921 | 323 | 1165 | 292 | 400 | 806 | 477 | 197 | 319 | 723 |
| HUN | 1059 | 379 | 1064 | 810 | 135 | 678 | 805 | 916 | 1416 | 84 | 956 | 603 | 0 | 585 | 776 | 842 | 395 | 537 | 420 | 996 | 330 | 1080 | 259 | 380 | 729 | 482 | 185 | 287 | 555 |
| BEL | 878 | 649 | 1329 | 882 | 135 | 986 | 894 | 1592 | 929 | 56 | 850 | 704 | 513 | 0 | 592 | 725 | 337 | 547 | 481 | 708 | 312 | 905 | 228 | 300 | 677 | 321 | 197 | 293 | 384 |
| JPN | 792 | 344 | 697 | 606 | 86 | 475 | 590 | 647 | 999 | 52 | 620 | 561 | 457 | 391 | 0 | 969 | 427 | 604 | 414 | 901 | 329 | 1095 | 248 | 384 | 733 | 591 | 190 | 250 | 627 |
| ESP | 933 | 490 | 1061 | 857 | 112 | 901 | 901 | 1117 | 1102 | 69 | 999 | 685 | 687 | 720 | 488 | 0 | 448 | 574 | 469 | 932 | 333 | 1186 | 263 | 401 | 855 | 513 | 216 | 312 | 564 |
| ZAF | 464 | 216 | 427 | 388 | 56 | 334 | 443 | 437 | 617 | 42 | 356 | 418 | 320 | 287 | 298 | 399 | 0 | 366 | 294 | 405 | 180 | 417 | 118 | 164 | 431 | 265 | 100 | 156 | 326 |
| NZL | 809 | 359 | 781 | 638 | 77 | 495 | 820 | 1027 | 1104 | 98 | 548 | 1276 | 417 | 442 | 335 | 440 | 297 | 0 | 695 | 663 | 265 | 728 | 205 | 264 | 585 | 328 | 146 | 239 | 571 |
| IRL | 475 | 363 | 648 | 553 | 69 | 489 | 846 | 733 | 627 | 68 | 459 | 567 | 342 | 447 | 260 | 425 | 246 | 567 | 0 | 493 | 203 | 592 | 160 | 203 | 440 | 208 | 121 | 181 | 350 |
| CZE | 932 | 416 | 1532 | 955 | 185 | 825 | 818 | 1502 | 1440 | 106 | 985 | 631 | 923 | 573 | 443 | 688 | 285 | 496 | 366 | 0 | 518 | 1494 | 355 | 442 | 810 | 508 | 245 | 397 | 608 |
| SVK | 320 | 126 | 519 | 225 | 54 | 235 | 225 | 403 | 380 | 22 | 250 | 161 | 232 | 191 | 126 | 171 | 97 | 161 | 97 | 441 | 0 | 475 | 142 | 164 | 321 | 209 | 95 | 151 | 251 |
| POL | 1474 | 634 | 2604 | 1550 | 263 | 1248 | 1275 | 2047 | 2397 | 125 | 1526 | 907 | 995 | 841 | 617 | 872 | 315 | 563 | 465 | 1274 | 332 | 0 | 507 | 633 | 1040 | 616 | 302 | 522 | 718 |
| LTU | 196 | 90 | 631 | 244 | 66 | 127 | 183 | 299 | 327 | 29 | 208 | 132 | 158 | 122 | 88 | 111 | 47 | 99 | 78 | 243 | 72 | 400 | 0 | 225 | 246 | 162 | 87 | 182 | 191 |
| LVA | 330 | 128 | 590 | 310 | 102 | 200 | 257 | 360 | 604 | 48 | 348 | 200 | 275 | 177 | 173 | 217 | 96 | 149 | 109 | 293 | 76 | 504 | 150 | 0 | 399 | 259 | 130 | 265 | 281 |
| PRT | 1101 | 448 | 1114 | 849 | 137 | 797 | 875 | 1070 | 1393 | 76 | 927 | 649 | 725 | 675 | 460 | 812 | 386 | 476 | 369 | 674 | 222 | 1042 | 155 | 301 | 0 | 482 | 173 | 331 | 570 |
| KOR | 723 | 201 | 453 | 382 | 64 | 320 | 381 | 380 | 1030 | 38 | 508 | 350 | 390 | 237 | 368 | 361 | 196 | 238 | 135 | 366 | 126 | 515 | 69 | 154 | 402 | 0 | 112 | 159 | 409 |
| SVN | 180 | 117 | 354 | 235 | 61 | 155 | 172 | 268 | 217 | 37 | 234 | 138 | 139 | 157 | 108 | 162 | 72 | 104 | 93 | 184 | 51 | 272 | 44 | 72 | 136 | 67 | 0 | 127 | 118 |
| HRV | 198 | 139 | 705 | 360 | 99 | 201 | 255 | 450 | 323 | 50 | 330 | 200 | 211 | 238 | 118 | 240 | 107 | 142 | 121 | 297 | 75 | 472 | 127 | 205 | 265 | 72 | 99 | 0 | 196 |
| URY | 815 | 262 | 612 | 505 | 87 | 384 | 594 | 601 | 1504 | 56 | 538 | 575 | 451 | 305 | 375 | 454 | 291 | 468 | 273 | 444 | 152 | 601 | 109 | 161 | 500 | 326 | 69 | 120 | 0 |

HOL

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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 | 257 | 697 | 838 | 180 | 880 | 952 | 354 | 1235 | 94 | 1231 | 883 | 721 | 559 | 863 | 908 | 251 | 440 | 325 | 755 | 247 | 1108 | 229 | 363 | 653 | 522 | 176 | 229 | 493 |
| CHE | 219 | 0 | 240 | 224 | 58 | 226 | 229 | 145 | 230 | 23 | 248 | 223 | 127 | 203 | 167 | 193 | 64 | 145 | 122 | 160 | 66 | 255 | 68 | 82 | 138 | 106 | 66 | 63 | 96 |
| DEU | 529 | 209 | 0 | 900 | 219 | 759 | 735 | 508 | 663 | 79 | 925 | 626 | 541 | 549 | 521 | 648 | 195 | 375 | 310 | 680 | 217 | 1203 | 300 | 414 | 470 | 287 | 245 | 389 | 316 |
| DFS | 843 | 198 | 774 | 0 | 297 | 1302 | 1348 | 730 | 983 | 148 | 1279 | 1244 | 904 | 827 | 980 | 1038 | 486 | 822 | 666 | 1249 | 349 | 1626 | 360 | 459 | 882 | 471 | 263 | 412 | 584 |
| EST | 111 | 27 | 154 | 184 | 0 | 238 | 250 | 170 | 227 | 52 | 265 | 226 | 213 | 207 | 221 | 224 | 107 | 144 | 127 | 287 | 109 | 351 | 122 | 177 | 192 | 127 | 103 | 136 | 140 |
| FRA | 664 | 196 | 514 | 744 | 119 | 0 | 1191 | 496 | 872 | 111 | 1278 | 1060 | 856 | 839 | 989 | 1059 | 383 | 657 | 557 | 1124 | 322 | 1608 | 267 | 380 | 810 | 452 | 199 | 277 | 474 |
| GBR | 966 | 207 | 586 | 1065 | 153 | 794 | 0 | 555 | 1110 | 156 | 1310 | 1327 | 874 | 835 | 996 | 1059 | 464 | 867 | 821 | 1068 | 338 | 1391 | 308 | 412 | 880 | 481 | 226 | 331 | 614 |
| NLD | 330 | 129 | 449 | 737 | 115 | 368 | 536 | 0 | 361 | 83 | 515 | 489 | 376 | 525 | 353 | 429 | 206 | 436 | 333 | 667 | 169 | 862 | 201 | 240 | 423 | 190 | 153 | 280 | 253 |
| USA | 1419 | 200 | 535 | 994 | 169 | 661 | 1208 | 323 | 0 | 147 | 1359 | 1001 | 863 | 564 | 987 | 871 | 348 | 553 | 411 | 922 | 267 | 1356 | 265 | 497 | 759 | 616 | 199 | 224 | 691 |
| ISR | 65 | 10 | 56 | 104 | 33 | 61 | 108 | 64 | 143 | 0 | 134 | 121 | 120 | 88 | 114 | 118 | 63 | 119 | 91 | 139 | 51 | 155 | 56 | 76 | 110 | 66 | 52 | 69 | 92 |
| ITA | 1021 | 213 | 694 | 1061 | 157 | 762 | 1088 | 457 | 1392 | 90 | 0 | 1039 | 980 | 739 | 1074 | 1181 | 368 | 592 | 470 | 1159 | 331 | 1614 | 328 | 478 | 871 | 566 | 248 | 343 | 582 |
| AUS | 957 | 189 | 485 | 890 | 120 | 742 | 1173 | 418 | 1112 | 77 | 841 | 0 | 776 | 767 | 960 | 944 | 463 | 1239 | 671 | 910 | 294 | 1133 | 265 | 390 | 779 | 455 | 194 | 300 | 653 |
| HUN | 696 | 98 | 418 | 741 | 135 | 593 | 783 | 318 | 925 | 82 | 886 | 598 | 0 | 565 | 767 | 832 | 383 | 530 | 407 | 991 | 306 | 1055 | 242 | 373 | 706 | 464 | 181 | 274 | 495 |
| BEL | 589 | 190 | 553 | 782 | 133 | 828 | 854 | 542 | 546 | 56 | 758 | 696 | 509 | 0 | 570 | 708 | 330 | 531 | 473 | 691 | 282 | 869 | 210 | 292 | 654 | 312 | 195 | 282 | 356 |
| JPN | 592 | 126 | 308 | 547 | 86 | 418 | 578 | 254 | 772 | 52 | 586 | 559 | 457 | 391 | 0 | 969 | 424 | 596 | 419 | 901 | 305 | 1081 | 232 | 378 | 708 | 567 | 186 | 236 | 553 |
| ESP | 618 | 149 | 456 | 794 | 112 | 799 | 878 | 405 | 698 | 69 | 854 | 680 | 686 | 720 | 488 | 0 | 442 | 572 | 465 | 932 | 304 | 1171 | 245 | 395 | 839 | 501 | 211 | 300 | 515 |
| ZAF | 236 | 51 | 151 | 371 | 56 | 289 | 428 | 183 | 389 | 42 | 310 | 412 | 319 | 287 | 298 | 399 | 0 | 361 | 284 | 399 | 169 | 408 | 110 | 162 | 419 | 252 | 98 | 146 | 305 |
| NZL | 402 | 125 | 299 | 576 | 76 | 421 | 726 | 393 | 524 | 98 | 482 | 1242 | 416 | 439 | 335 | 440 | 295 | 0 | 684 | 661 | 252 | 706 | 192 | 260 | 569 | 317 | 145 | 228 | 526 |
| IRL | 323 | 118 | 271 | 500 | 66 | 431 | 795 | 316 | 396 | 65 | 399 | 546 | 335 | 449 | 261 | 422 | 235 | 560 | 0 | 487 | 186 | 575 | 152 | 195 | 419 | 210 | 117 | 174 | 329 |
| CZE | 583 | 109 | 507 | 842 | 185 | 669 | 801 | 636 | 865 | 106 | 872 | 621 | 923 | 573 | 443 | 688 | 285 | 496 | 353 | 0 | 486 | 1473 | 330 | 434 | 790 | 491 | 243 | 379 | 549 |
| SVK | 178 | 25 | 123 | 193 | 53 | 182 | 218 | 96 | 187 | 22 | 215 | 156 | 228 | 185 | 126 | 171 | 96 | 158 | 95 | 441 | 0 | 424 | 118 | 155 | 301 | 196 | 89 | 139 | 224 |
| POL | 1049 | 208 | 1206 | 1348 | 258 | 1111 | 1235 | 855 | 1549 | 124 | 1393 | 900 | 983 | 828 | 617 | 870 | 314 | 559 | 455 | 1274 | 317 | 0 | 470 | 615 | 991 | 590 | 295 | 494 | 643 |
| LTU | 142 | 26 | 244 | 225 | 64 | 114 | 181 | 137 | 193 | 29 | 184 | 133 | 156 | 121 | 88 | 111 | 47 | 97 | 73 | 243 | 68 | 386 | 0 | 214 | 222 | 143 | 82 | 167 | 169 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LVA | 223 | 30 | 317 | 276 | 101 | 171 | 245 | 151 | 418 | 48 | 293 | 193 | 272 | 174 | 170 | 215 | 94 | 146 | 107 | 288 | 76 | 493 | 149 | 0 | 389 | 251 | 129 | 257 | 263 |
| PRT | 661 | 120 | 409 | 779 | 136 | 709 | 844 | 421 | 822 | 76 | 851 | 638 | 718 | 673 | 460 | 812 | 385 | 473 | 358 | 674 | 215 | 1017 | 151 | 301 | 0 | 463 | 170 | 309 | 519 |
| KOR | 516 | 81 | 202 | 349 | 64 | 283 | 367 | 130 | 682 | 38 | 487 | 339 | 386 | 237 | 368 | 361 | 195 | 234 | 143 | 366 | 124 | 505 | 66 | 151 | 399 | 0 | 111 | 146 | 366 |
| SVN | 134 | 47 | 233 | 207 | 61 | 146 | 172 | 127 | 160 | 36 | 210 | 137 | 138 | 156 | 108 | 162 | 72 | 104 | 90 | 184 | 51 | 270 | 44 | 71 | 136 | 67 | 0 | 123 | 111 |
| HRV | 145 | 38 | 376 | 327 | 99 | 189 | 253 | 251 | 181 | 50 | 262 | 195 | 211 | 235 | 118 | 240 | 107 | 142 | 119 | 297 | 75 | 465 | 127 | 205 | 262 | 71 | 98 | 0 | 179 |
| URY | 476 | 71 | 230 | 448 | 87 | 315 | 560 | 199 | 772 | 55 | 494 | 571 | 440 | 303 | 375 | 454 | 288 | 465 | 274 | 444 | 151 | 584 | 109 | 159 | 491 | 317 | 69 | 118 | 0 |

JER

common bulls below diagonal
common three quarter sib group above diagonal

| | CAN | DFS | GBR | NLD | USA | AUS | ZAF | NZL | CHE | ITA |
|---|---|---|---|---|---|---|---|---|---|---|
| CAN | 0 | 121 | 168 | 46 | 475 | 274 | 155 | 191 | 41 | 36 |
| DFS | 114 | 0 | 183 | 155 | 210 | 166 | 156 | 162 | 60 | 40 |
| GBR | 172 | 178 | 0 | 100 | 249 | 231 | 170 | 232 | 74 | 46 |
| NLD | 41 | 157 | 93 | 0 | 102 | 80 | 79 | 86 | 40 | 29 |
| USA | 503 | 191 | 273 | 108 | 0 | 518 | 292 | 389 | 71 | 46 |
| AUS | 281 | 136 | 235 | 71 | 564 | 0 | 237 | 449 | 58 | 44 |
| ZAF | 151 | 139 | 171 | 75 | 308 | 227 | 0 | 202 | 57 | 43 |
| NZL | 198 | 139 | 238 | 81 | 461 | 497 | 212 | 0 | 55 | 37 |
| CHE | 35 | 59 | 71 | 34 | 72 | 49 | 50 | 47 | 0 | 32 |
| ITA | 31 | 40 | 47 | 24 | 45 | 38 | 38 | 35 | 32 | 0 |

JER

common bulls below diagonal
common three quarter sib group above diagonal

| | CAN | DFS | GBR | NLD | USA | AUS | ZAF | NZL | CHE | ITA |
|---|---|---|---|---|---|---|---|---|---|---|
| CAN | 0 | 46 | 80 | 20 | 88 | 127 | 69 | 90 | 25 | 23 |
| DFS | 41 | 0 | 116 | 115 | 63 | 133 | 133 | 136 | 58 | 37 |
| GBR | 76 | 109 | 0 | 69 | 85 | 166 | 130 | 163 | 65 | 42 |
| NLD | 13 | 110 | 65 | 0 | 36 | 75 | 74 | 79 | 37 | 29 |
| USA | 80 | 52 | 84 | 33 | 0 | 163 | 118 | 122 | 37 | 26 |
| AUS | 115 | 99 | 169 | 68 | 173 | 0 | 230 | 442 | 54 | 43 |
| ZAF | 63 | 112 | 131 | 71 | 129 | 226 | 0 | 198 | 54 | 43 |
| NZL | 81 | 110 | 166 | 74 | 124 | 489 | 209 | 0 | 51 | 37 |
| CHE | 23 | 55 | 62 | 32 | 31 | 48 | 49 | 46 | 0 | 31 |
| ITA | 19 | 35 | 41 | 24 | 25 | 37 | 38 | 35 | 32 | 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 | 181 | 85 | 7 | 214 | 14 | 105 | 3 | 70 | 92 | 17 | 10 | 7 | 0 |
| DFS | 186 | 0 | 112 | 135 | 210 | 59 | 204 | 121 | 51 | 177 | 110 | 126 | 60 | 0 |
| GBR | 87 | 108 | 0 | 57 | 118 | 14 | 90 | 10 | 39 | 89 | 27 | 16 | 40 | 0 |
| NOR | 6 | 109 | 60 | 0 | 80 | 15 | 74 | 25 | 0 | 47 | 25 | 19 | 48 | 0 |
| USA | 200 | 207 | 114 | 81 | 0 | 23 | 144 | 24 | 59 | 129 | 34 | 25 | 48 | 25 |
| DEU | 13 | 50 | 14 | 14 | 22 | 0 | 42 | 24 | 1 | 19 | 29 | 35 | 15 | 0 |
| AUS | 106 | 178 | 86 | 63 | 146 | 41 | 0 | 37 | 34 | 156 | 45 | 39 | 39 | 12 |
| EST | 2 | 108 | 9 | 25 | 23 | 24 | 34 | 0 | 0 | 13 | 26 | 50 | 19 | 0 |
| ZAF | 72 | 48 | 35 | 0 | 53 | 1 | 34 | 0 | 0 | 35 | 5 | 2 | 3 | 0 |
| NZL | 90 | 174 | 85 | 47 | 131 | 19 | 156 | 12 | 30 | 0 | 28 | 17 | 23 | 12 |
| LTU | 16 | 98 | 25 | 22 | 29 | 28 | 42 | 25 | 5 | 25 | 0 | 53 | 15 | 0 |
| LVA | 10 | 85 | 16 | 17 | 22 | 29 | 35 | 43 | 2 | 14 | 47 | 0 | 15 | 0 |
| NLD | 7 | 58 | 39 | 47 | 47 | 14 | 37 | 18 | 3 | 23 | 14 | 14 | 0 | 0 |
| CAM | 0 | 0 | 0 | 0 | 25 | 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 | AUS | EST | ZAF | NZL | LTU | LVA | NLD | CAM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAN | 0 | 78 | 29 | 3 | 74 | 33 | 0 | 35 | 35 | 13 | 7 | 3 | 0 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DFS | 77 | 0 | 75 | 137 | 201 | 219 | 121 | 46 | 174 | 109 | 126 | 57 | 0 |
| GBR | 28 | 71 | 0 | 53 | 80 | 56 | 6 | 27 | 60 | 21 | 14 | 30 | 0 |
| NOR | 3 | 110 | 56 | 0 | 80 | 74 | 25 | 0 | 47 | 25 | 19 | 41 | 0 |
| USA | 74 | 199 | 79 | 81 | 0 | 133 | 24 | 54 | 126 | 34 | 25 | 46 | 25 |
| AUS | 33 | 196 | 54 | 63 | 136 | 0 | 37 | 31 | 148 | 42 | 38 | 35 | 10 |
| EST | 0 | 108 | 6 | 25 | 23 | 34 | 0 | 0 | 13 | 26 | 49 | 18 | 0 |
| ZAF | 36 | 46 | 26 | 0 | 52 | 33 | 0 | 0 | 33 | 5 | 2 | 2 | 0 |
| NZL | 35 | 169 | 59 | 47 | 131 | 149 | 12 | 30 | 0 | 28 | 17 | 21 | 12 |
| LTU | 12 | 97 | 19 | 22 | 29 | 40 | 25 | 5 | 25 | 0 | 53 | 14 | 0 |
| LVA | 7 | 84 | 14 | 17 | 22 | 35 | 42 | 2 | 14 | 47 | 0 | 14 | 0 |
| NLD | 3 | 55 | 30 | 40 | 46 | 33 | 17 | 2 | 21 | 13 | 13 | 0 | 0 |
| CAM | 0 | 0 | 0 | 0 | 25 | 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 | SVN | GBR | HRV | USA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FRM | 0 | 2 | 175 | 128 | 228 | 270 | 2 | 17 | 67 | 2 | 67 |
| FRA | 1 | 0 | 132 | 73 | 9 | 239 | 4 | 55 | 0 | 94 | 3 |
| ITA | 200 | 116 | 0 | 237 | 95 | 944 | 18 | 147 | 46 | 308 | 33 |
| NLD | 152 | 69 | 235 | 0 | 91 | 366 | 8 | 70 | 49 | 156 | 28 |
| CHE | 279 | 7 | 98 | 95 | 0 | 354 | 2 | 5 | 53 | 2 | 32 |
| DEA | 314 | 194 | 859 | 387 | 319 | 0 | 37 | 257 | 49 | 690 | 34 |
| HUN | 0 | 3 | 15 | 8 | 1 | 24 | 0 | 12 | 0 | 19 | 0 |
| SVN | 17 | 50 | 139 | 67 | 5 | 235 | 11 | 0 | 0 | 125 | 1 |
| GBR | 83 | 0 | 50 | 49 | 60 | 52 | 0 | 0 | 0 | 0 | 19 |
| HRV | 1 | 84 | 296 | 154 | 2 | 723 | 17 | 114 | 0 | 0 | 4 |
| USA | 81 | 3 | 40 | 30 | 31 | 40 | 0 | 1 | 26 | 4 | 0 |

SIM

common bulls below diagonal
common three quarter sib group above diagonal

| | FRM | FRA | ITA | NLD | CHE | DEA | HUN | SVN | GBR | HRV | USA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FRM | 0 | 2 | 157 | 104 | 5 | 228 | 2 | 17 | 25 | 2 | 36 |
| FRA | 1 | 0 | 85 | 31 | 1 | 161 | 3 | 34 | 0 | 59 | 1 |
| ITA | 183 | 74 | 0 | 225 | 7 | 943 | 18 | 147 | 18 | 308 | 33 |
| NLD | 127 | 30 | 222 | 0 | 6 | 330 | 8 | 67 | 18 | 146 | 26 |
| CHE | 5 | 1 | 7 | 6 | 0 | 83 | 0 | 0 | 1 | 0 | 4 |
| DEA | 276 | 124 | 859 | 350 | 74 | 0 | 37 | 257 | 20 | 690 | 34 |
| HUN | 0 | 2 | 15 | 8 | 0 | 24 | 0 | 12 | 0 | 19 | 0 |
| SVN | 17 | 29 | 139 | 64 | 0 | 235 | 11 | 0 | 0 | 125 | 1 |
| GBR | 34 | 0 | 23 | 20 | 1 | 25 | 0 | 0 | 0 | 0 | 16 |
| HRV | 1 | 51 | 296 | 145 | 0 | 723 | 17 | 114 | 0 | 0 | 4 |
| USA | 51 | 1 | 40 | 28 | 4 | 40 | 0 | 1 | 22 | 4 | 0 |