

Trait specific computation of shared reference population

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Introduction

The GenoList file (Interbull 733 file format), containing different genotype status codes of genotyped animals (e.g. "T"=used for training for protein yield) has so far served the purpose of computing the amount of shared genomic data among national reference populations. Both males and females holding a status code "T" in the GenoList have been used in the computations. Due to the lower reliability of female EBVs five females were assumed equivalent to one male, in terms of the effective information contributed for genomic predictions. The amount of sharing is used to prevent double counting of shared information at the national level, when combining the information in GMACE (VanRaden & Sullivan, 2010).

Until the August 2013 GMACE implementation run it has been assumed that countries have the same proportion of sharing across traits, even though the size of reference populations may differ for different traits. The amount of sharing (T_{ij}) between countries i and j was computed as:

$$T_{ij} = \frac{\text{shared reference bulls}_{ij}}{\sqrt{\text{reference bulls}_i * \text{reference bulls}_j}}$$

Where five cows in a reference population contributed an equivalent of one reference bull.

Starting with the September 2013 GMACE test run it was decided to compute the amount of sharing based on the GenoList plus the

national EBVs submitted to Interbull for each individual trait for the corresponding classical

MACE run. Countries using females in their genomic reference population can only do so for traits evaluated with an animal model, and the EBVs of females are not submitted for classical MACE. Accounting for females by trait would be very difficult, and the GMACE WG therefore decided that females should no longer be used in the computation of reference sharing, when the sharing should be computed for each trait individually. The aim of this note was to describe the implementation of the trait-specific reference sharing.

Material and Methods

Material

Twelve countries participated with young bull GEBV data for as many as 37 different traits for the September 2013 GMACE test run. These countries were Australia (AUS), Canada (CAN), Switzerland RHOL (CHR), Germany (DEU), Denmark-Finland-Sweden (DFS), France (FRA), Great Britain (GBR), Italy (ITA), The Netherlands (NLD), Poland (POL), Spain (ESP), and The United States of America (USA). Each country also provided a GenoList file with the reference population codes for protein.

Methods

Firstly, one joint reference list was formed by selecting all animals used in training for protein by any country, in the country-provided GenoLists. Secondly, an Interbull

cross-reference file was applied to the animals in the joint reference list to prevent any double counting of aliases of the same animal. Trait-specific reference lists were then derived for each country, by assuming if a bull was used in the reference population for protein, and he is submitted for MACE for a second trait, that he was also included in the reference population for the second trait. T_{ij} was still computed as:

$$T_{ij} = \frac{\text{shared reference bulls}_{ij}}{\sqrt{\text{reference bulls}_i * \text{reference bulls}_j}}$$

but now ignoring contributions from any reference females.

Results and discussion

Number of reference bulls in trait-specific reference lists can be seen in the diagonals of Tables 1 through 6 for protein, stature,

somatic cell score, direct stillbirth, female fertility CC1, and milking speed. The numbers of reference bulls in common with other countries are shown below the diagonal and the proportion of shared reference bulls (T_{ij}) are above the diagonal.

Numbers of bulls in reference populations were generally very similar for the different traits, with milking speed as an exception for countries in the “Intercontinental” consortium. Reference populations were much smaller for that trait because USA did not participate in classical MACE for milking speed and thus did not contribute any reference bulls with MACE proofs.

References

VanRaden, P.M. and Sullivan, P.G. 2010. International genomic evaluation methods for dairy cattle. *Gen. Sel. Evol.* 42: 7

Table 1. In diagonal: number of bulls in reference population for **protein**; below diagonal: number of reference bulls in common with other countries; above diagonal: proportion of shared reference bulls (T_{ij})

| | CAN | DEU | DFS | FRA | ITA | NLD | USA | CHR | POL | GBR | ESP | AUS |
|-----|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-------------|-------------|--------------|--------------|-------------|
| CAN | 22853 | 0.047 | 0.044 | 0.056 | 0.944 | 0.048 | 0.982 | 0.060 | 0.018 | 0.950 | 0.038 | 0.053 |
| DEU | 1139 | 25875 | 0.941 | 0.881 | 0.042 | 0.883 | 0.048 | 0.055 | 0.026 | 0.043 | 0.903 | 0.042 |
| DFS | 1025 | 23429 | 23956 | 0.902 | 0.039 | 0.900 | 0.044 | 0.052 | 0.026 | 0.040 | 0.919 | 0.042 |
| FRA | 1284 | 21607 | 21275 | 23241 | 0.048 | 0.921 | 0.057 | 0.057 | 0.031 | 0.051 | 0.902 | 0.045 |
| ITA | 20664 | 981 | 865 | 1058 | 20964 | 0.047 | 0.942 | 0.052 | 0.019 | 0.945 | 0.037 | 0.037 |
| NLD | 1064 | 21009 | 20590 | 20772 | 1007 | 21871 | 0.050 | 0.060 | 0.028 | 0.045 | 0.932 | 0.052 |
| USA | 22454 | 1171 | 1036 | 1307 | 20622 | 1110 | 22867 | 0.060 | 0.018 | 0.939 | 0.040 | 0.052 |
| CHR | 539 | 522 | 474 | 518 | 449 | 528 | 540 | 3503 | 0.195 | 0.050 | 0.052 | 0.064 |
| POL | 142 | 215 | 211 | 250 | 143 | 220 | 140 | 604 | 2731 | 0.018 | 0.025 | 0.035 |
| GBR | 20839 | 1010 | 893 | 1138 | 19851 | 973 | 20596 | 429 | 135 | 21041 | 0.037 | 0.050 |
| ESP | 850 | 21365 | 20923 | 20231 | 796 | 20283 | 883 | 454 | 189 | 779 | 21641 | 0.042 |
| AUS | 474 | 400 | 385 | 405 | 321 | 462 | 469 | 225 | 110 | 435 | 372 | 3553 |

Tabel 2. In diagonal: number of bulls in reference population for **stature**; below diagonal: number of reference bulls in common with other countries; above diagonal: proportion of shared reference bulls (T_{ij})

| | CAN | DEU | DFS | FRA | ITA | NLD | USA | CHR | POL | GBR | ESP |
|-----|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-------------|-------------|--------------|--------------|
| CAN | 21629 | 0.048 | 0.045 | 0.057 | 0.954 | 0.049 | 0.984 | 0.061 | 0.018 | 0.951 | 0.039 |
| DEU | 1135 | 25809 | 0.941 | 0.882 | 0.043 | 0.883 | 0.049 | 0.055 | 0.026 | 0.044 | 0.903 |
| DFS | 1023 | 23374 | 23898 | 0.902 | 0.039 | 0.900 | 0.046 | 0.052 | 0.026 | 0.041 | 0.919 |
| FRA | 1276 | 21552 | 21221 | 23148 | 0.049 | 0.922 | 0.058 | 0.058 | 0.031 | 0.053 | 0.903 |
| ITA | 19868 | 977 | 863 | 1051 | 20064 | 0.048 | 0.953 | 0.054 | 0.019 | 0.954 | 0.038 |
| NLD | 1064 | 20955 | 20536 | 20720 | 1006 | 21807 | 0.051 | 0.060 | 0.029 | 0.047 | 0.933 |
| USA | 21247 | 1167 | 1034 | 1299 | 19818 | 1108 | 21566 | 0.062 | 0.018 | 0.941 | 0.041 |
| CHR | 534 | 522 | 474 | 518 | 449 | 528 | 535 | 3498 | 0.195 | 0.051 | 0.052 |
| POL | 142 | 215 | 211 | 250 | 143 | 220 | 140 | 602 | 2729 | 0.018 | 0.025 |
| GBR | 19708 | 1006 | 891 | 1131 | 19058 | 973 | 19474 | 429 | 135 | 19876 | 0.038 |
| ESP | 850 | 21315 | 20872 | 20183 | 796 | 20235 | 883 | 454 | 189 | 779 | 21592 |

Tabel 3. In diagonal: number of bulls in reference population for **somatic cell score**; below diagonal: number of reference bulls in common with other countries; above diagonal: proportion of shared reference bulls (T_{ij})

| | CAN | DEU | DFS | FRA | ITA | NLD | USA | CHR | POL | GBR |
|-----|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-------------|-------------|--------------|
| CAN | 22796 | 0.047 | 0.044 | 0.056 | 0.945 | 0.048 | 0.984 | 0.060 | 0.018 | 0.951 |
| DEU | 1139 | 25874 | 0.941 | 0.881 | 0.042 | 0.883 | 0.048 | 0.055 | 0.025 | 0.043 |
| DFS | 1025 | 23428 | 23957 | 0.901 | 0.039 | 0.899 | 0.044 | 0.051 | 0.026 | 0.040 |
| FRA | 1283 | 21607 | 21275 | 23251 | 0.048 | 0.921 | 0.057 | 0.057 | 0.031 | 0.052 |
| ITA | 20634 | 981 | 865 | 1058 | 20934 | 0.047 | 0.943 | 0.052 | 0.019 | 0.946 |
| NLD | 1064 | 21009 | 20590 | 20778 | 1007 | 21882 | 0.050 | 0.060 | 0.028 | 0.045 |
| USA | 22422 | 1171 | 1036 | 1306 | 20591 | 1110 | 22755 | 0.060 | 0.018 | 0.942 |
| CHR | 539 | 522 | 474 | 518 | 449 | 528 | 540 | 3539 | 0.193 | 0.050 |
| POL | 142 | 215 | 211 | 250 | 143 | 220 | 140 | 604 | 2764 | 0.018 |
| GBR | 20785 | 1010 | 893 | 1137 | 19820 | 973 | 20565 | 429 | 135 | 20959 |

Tabel 4. In diagonal: number of bulls in reference population for **direct stillbirth**; below diagonal: number of reference bulls in common with other countries; above diagonal: proportion of shared reference bulls (T_{ij})

| | CAN | DEU | DFS | NLD |
|-----|--------------|--------------|--------------|--------------|
| CAN | 20077 | 0.053 | 0.049 | 0.054 |
| DEU | 1136 | 23131 | 0.939 | 0.877 |
| DFS | 1022 | 20822 | 21274 | 0.897 |
| NLD | 1046 | 18396 | 18044 | 19027 |

Tabel 5. In diagonal: number of bulls in reference population for **female fertility (CC1)**; below diagonal: number of reference bulls in common with other countries; above diagonal: proportion of shared reference bulls (T_{ij})

| | CAN | DEU | DFS | FRA | NLD | USA | CHR | GBR |
|-----|--------------|--------------|--------------|--------------|--------------|--------------|-------------|--------------|
| CAN | 20777 | 0.050 | 0.047 | 0.060 | 0.051 | 0.987 | 0.064 | 0.953 |
| DEU | 1134 | 24536 | 0.940 | 0.877 | 0.881 | 0.052 | 0.057 | 0.046 |
| DFS | 1020 | 22148 | 22609 | 0.900 | 0.899 | 0.048 | 0.054 | 0.043 |
| FRA | 1279 | 20328 | 20015 | 21895 | 0.921 | 0.061 | 0.060 | 0.055 |
| NLD | 1057 | 19729 | 19329 | 19486 | 20430 | 0.054 | 0.063 | 0.049 |
| USA | 20410 | 1165 | 1031 | 1298 | 1098 | 20564 | 0.065 | 0.945 |
| CHR | 539 | 522 | 474 | 518 | 525 | 540 | 3400 | 0.053 |
| GBR | 19038 | 1005 | 888 | 1133 | 967 | 18795 | 429 | 19222 |

Tabel 6. In diagonal: number of bulls in reference population for **milking speed**; below diagonal: number of reference bulls in common with other countries; above diagonal: proportion of shared reference bulls (T_{ij})

| | CAN | DEU | DFS | NLD | GBR |
|-----|-------------|--------------|--------------|--------------|-------------|
| CAN | 9588 | 0.069 | 0.066 | 0.069 | 0.905 |
| DEU | 1028 | 23279 | 0.944 | 0.891 | 0.066 |
| DFS | 945 | 21172 | 21591 | 0.906 | 0.061 |
| NLD | 947 | 18927 | 18530 | 19373 | 0.068 |
| GBR | 8000 | 903 | 815 | 859 | 8147 |