MACE – Options for Improvement

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1. Introduction

MACE (Multiple Across Country Evaluation) evaluations are used to convert milk production trait proofs since 1995. Since then Interbull has worked on implementation of MACE for conformation traits, somatic cell count and udder health traits. Compared to the previous system of converting proofs, using a- and b-factor, MACE is more advanced in modelling the theory behind breeding values coming from different countries. One of the features of MACE is that is uses genetic correlations between countries (environments) to be able to take into account genotype*environment interaction effects on ranking of bulls.

This re-ranking of bulls was also one of the features breeding and sales people of AI-organisations had to get used to. Now after 7 years of adaptation AI-industry people still have questions why certain bulls change in their ranking when being converted from one country to another or why they change from one evaluation to another. Legitimate questions that sometimes have strange and/or unexpected reasons.

This paper will deal with two causes of fluctuations of proofs:

1. Effects of genetic group definitions as currently used in MACE;
2. the effect of time edit;

Further some proposals are made what could be adjusted in the current MACE-system.

2. Genetic groups in MACE

2.1 Current MACE

When an estimated breeding value (EBV) of a bull is converted in MACE his proof is assumed to be build up from two information sources: pedigree information and daughter information.

Pedigree of a bull in MACE is base on his sire, maternal grandsire (mgs) and a genetic group for maternal granddam. The daughter information can be defined as deviation of a bull's breeding value from his pedigree information. This daughter information is then converted in MACE to another countries base and scale, using the pedigree information in the other country as starting point.

In the pedigree information part the sire is weighted with 0.50, and mgs and genetic group each with 0.25. The genetic group is defined by breed of the bull times year of birth of bull times country of origin of his maternal granddam (mgd). The genetic group, or mgd group, accounts for selection occurring in the female part of the bull's pedigree, when he is selected by an AI organisation to be tested.

The solution for genetic group or mgd group is converted in the same way as proofs of bulls. A solution for a mgd group in a specific country is based on bulls being tested in this country and being linked to this mgd group. Further bulls being tested in other countries are linked to this mgd group through genetic correlations.

In case a mgd group has a large group of bulls being linked to it in one country, the solution can deviate from what is estimated in another country based on another large group of bulls in that country. Both estimates represent actually maternal granddams from the same country but it is more likely that bulls tested in different countries originate from different maternal granddams. And MACE is assuming that bulls being tested in different countries were selected for the same traits with the same intensity, which is in practice not the case. Further difference can occur due to genotype*environment effect.

A second situation also occurs, the mgd group in the second country is only based on solutions from third countries. In this situation the solution in the second country can deviate also from the solution in the first country.

In case a bull is converted from one country to another his proof can go up or down, just depending upon the level of the estimate for the maternal granddam group.

2.2 Example

The effect a mgd group solution can have on a proof of a bull is demonstrated with 3 bulls. They are born in 1997 and are tested in USA, having the same sire and maternal grandsire (Rudolph and Mascot). Two bulls have a mgd group, representing their USA maternal granddam, and one having a mgd group representing his Canadian maternal granddam. The proofs in USA for milk are compared to how they convert to Germany. The proofs are from the September 2002 test evaluation. Results are in table 1.

Bull A and B, both linked to a mgd group of USA convert as expected: A is on USA scale 74 pounds lower than bull B, which is found back in 53 kg lower breeding value for A on German scale. Bull C however is on USA scale 88 pounds lower than bull A, but 60 kg higher than bull A on German scale. Re-ranking occurs due to the fact of different maternal granddam group solutions for USA and CAN in USA and GER. This is demonstrated with figure 1.

Figure 1 shows the solutions for mgd groups for Holstein bulls born in 1997 for milk yield. The solutions are given in standard deviation units on the scale of six countries. The solution for USA group on USA scale is about 1 standard deviation higher than the CAN group. On the German scale solutions for USA and CAN maternal granddam group are very similar. When converting the 3 bulls to the German scale these last solutions are used, causing re-ranking of these three bulls when converting them from USA to Germany.

The effect of third country solutions is demonstrated with an example from figure 2. The mgd group solutions for USA and NLD maternal granddams are based on 128 bulls and 360 respectively for the NLD scale. The solutions for the NLD scale are very similar. On the USA scale the solutions of the USA and NLD mgd group differ about one standard deviation unit, where the USA mgd group solution is based on 1289 bulls and the NLD mgd group solution on one bull. Most information of this last group is based on other NLD mgd group estimates from other countries. Apparently the solution on NLD scale has hardly any influence on the NLD mgd group solution on USA scale. When converting bulls from NLD, having a NLD mgd group in their pedigree, they will rank on USA scale suddenly lower than bulls, also converted from NLD scale, having a USA mgd.

The above indicated effects, shown for milk production, of course can also be found back in mgd group solutions, for other traits like fat, protein and conformation traits in other birth years and in or for other countries.

Table 1. Proofs for milk yield for 3 Holstein bulls, being progeny tested in USA and for USA base and scale (TA, pounds) converted to German base and scale (BV, kgs).

bull	mgd	USA proof	Germany proof
A	USA	1793	1787
B	USA	1867	1840
C	CAN	1705	1847

2.3 Options for solutions

To avoid re-ranking in conversion due to maternal granddam groups maternal granddam groups could be re-defined as year of birth of bull times breed of bull times country of origin times country of test of bull. By adding the country of test difference in selection of bull dams from the same (country) population due to difference in selection goal and selection intensity can be accounted for. Further in the conversion the bull his original maternal granddam group is converted together with him to a second country base and scale. This will reduce re-ranking due to linking bulls a different genetic group when converting them.

Another option to improve MACE and reduce effect op genetic groups on conversion of bull proofs is adding more pedigree information to the MACE system. For example the dam of a bull could be added to the system.

From an analyses of the Interbull February 2003 file it appears that the majority of the dams have two or more sons. Distribution of dams for the number of sons in the February 2003 Interbull evaluation is found in table 2. About 65 percent of the bulls have dams with 2 or more sons in the evaluation. More than 1700 dams have six or more sons. One cow had even 43 sons. By adding dams to the pedigree, son groups of one dam can deviate from a son group of another dam. Further the influence of mgd group on a bulls proof can be reduced.

A third option to reduce the influence of genetic groups is adding a full pedigree for all bulls in the MACE system in stead of using only sire and maternal grandsire. At the same time the genetic groups are moved further from the bull with data, reducing the influence of the genetic groups on the proof of a bull. This could give less re-ranking when converting bulls due to genetic group effects.

Table 2. Distribution dams for the number of sons in Interbull evaluation of February 2003 (n=68,896, 812 bulls with unknown dams).

nr sons per dam	nr dams	nr bulls	% bulls of total
1	23798	23798	34.5
2	6146	12292	17.8
3	2564	7692	11.2
4	1267	5068	7.4
5	759	3795	5.5
6-10	1295	9555	13.9
11-20	353	4726	6.9
>20	46	1158	1.7

3. Time edit

In the MACE evaluations national breeding values for bulls are used if they are born after a certain minimum birth year. In every February evaluation the minimum year is increased with one. The objective if this edit is to maintain a constant window of recent data across country on which international evaluations are based. Weigel et al. (1997) showed that such recent data best describe the current situation in changing populations and more accurately assess the genetic merit of young bulls. For evaluations in 2003 the minimum year of birth is 1986. This procedure was started in 1998.

Due to the fact EBVs of sires and maternal grandsires of bulls born in 1985 are not used in the evaluations of February 2003, bulls can change in their proof. Effect of this time edit is shown in table 3 for bulls with the proof of their sire or mgs removed. Further distinction was made for bulls having a proof in the Netherlands (NLD) based on daughters or their was a converted proof.

From the November 2002 evaluations to February 2003 evaluations 5192 bulls had a maternal grandsire which lost his proof based on his daughters and 5785 bulls had a sire without any proof in MACE evaluation of February 2003 based on daughters in contrast to the November 2002 evaluation.

In general bulls with a proof based on Dutch daughter information changed less from November to February than those bulls which completely rely on conversion from another country. Proofs changed on average (as absolute difference) at least 50 kg of milk, 2 kg of fat and 1.5 kg of protein due to removal of the sire or maternal grandsire proof from MACE. Some individual effects can be rather large, as shown for groups of bulls, which mgs lost his proof base on daughter information, in table 4.

For the time edit the question can be raised if this edit should be continued or not. Populations have been upgraded further since 1998 and now there is less need to edit data for inclusion in MACE.

One option is to decide to stop to increase the minimum year of birth every year. Another option is to increase the time frame data is used from. Current method uses data of a time frame of 10 years, but less fluctuations in proofs already is reached when a time edit is used of 12 or 15 years.

Table 3. Difference (diff) in proofs for milk, fat and protein for bulls having a proof in the Netherlands based on daughters or a proof base on conversion by Interbull due to the fact of removal of the proof of their sire or maternal grandsire from the MACE evaluation. Difference (diff) is proof February 2003 minus proof November 2002. Proofs are on Dutch base and scale.

removal effect of	daus in NLD	nr bulls	average diff milk	fat	protein	average abs(diff) milk	fat	protein
MGS	no	4546	9.8	0.2	0.1	60.0	2.3	1.8
MGS	yes	646	-2.4	-0.2	-0.1	37.9	1.8	1.3
SIRE	no	5225	14.1	-0.3	0.0	52.3	2.0	1.5
SIRE	yes	560	-4.6	-0.1	-0.1	11.8	0.5	0.4

Table 4. Effect of removal of maternal grand sire proof on four grandsire son groups. Effect is difference in proof February 2003 minus proof November 2002. Proofs are on Dutch base and scale.

maternal grandsire	number maternal grandsire sons	average difference breeding value milk	fat	protein
Hanoverhill Lincoln	59	64	1.5	2.1
Broomfiled Peta Jacob	34	-307	-10.9	-10.1
Carnation Bionic	68	89	5.6	3.5
Hanoverhill Stardom	120	-67	-5.5	-2.7

4. Conclusions

For credibility of MACE in AI-industry it is important to explain fluctuations of proofs and avoid unnecessary or unwanted fluctuations.

To reduce fluctuations in proofs when converted by MACE from one country to another:

- genetic groups should be re-defined by taking into account country of test of bull;
- add more pedigree information in MACE system:
- add dam to pedigree besides sire, maternal grand sire and a genetic group for maternal granddam;
- add full pedigree, several generations dams and sire, of bulls to MACE system.

To reduce fluctuations due to time edits in MACE time:

- use 12 or 15 years time frame;
- stop increase minimum birth year from now on.

Acknowledgement

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References

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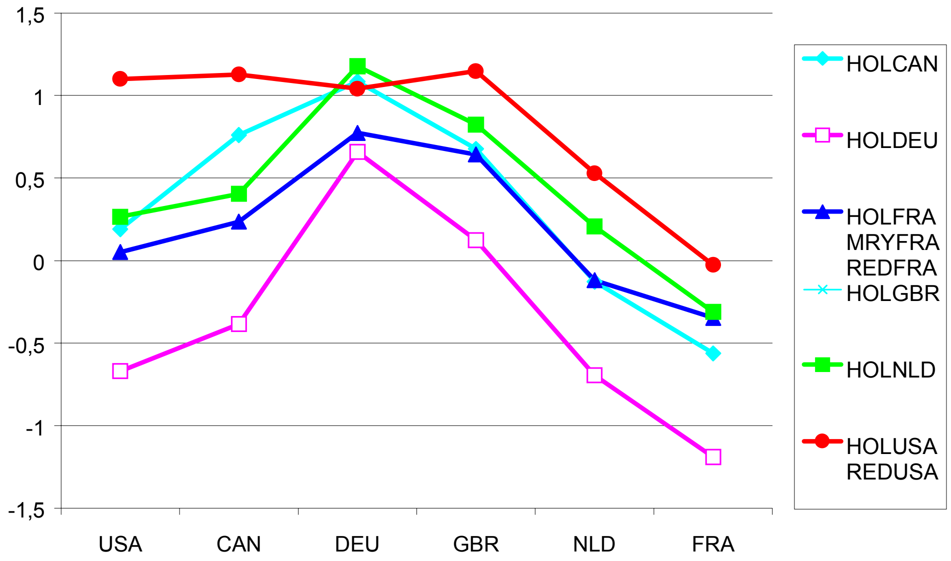

Figure 1. Solutions for maternal granddam group in MACE (test evaluation September 2002), for trait milk yield for maternal granddam group for Holstein bulls born in 1997 with maternal granddam originating from Canada (CAN), Germany (DEU), France (FRA), the Netherlands (NLD), United States (USA) and Great Britain (GBR). Solutions are given in units of standard deviations (Y-ax) on scale of country (on X-ax).

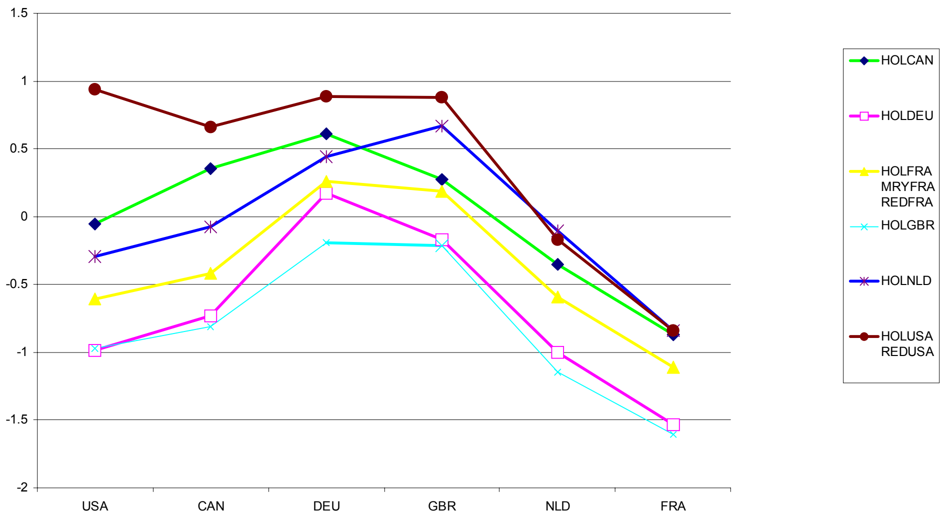

Figure 2. Solutions for maternal granddam group in MACE (test evaluation September 2002), for trait milk yield for maternal granddam group for Holstein bulls born in 1998 with maternal granddam originating from Canada (CAN), Germany (DEU), France (FRA), the Netherlands (NLD), United States (USA) and Great Britain (GBR). Solutions are given in units of standard deviations (Y-ax) on scale of country (on X-ax).