Sire Variance Trends over Time: Is there an Answer to an Old Problem?

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Abstract

The existence of sire variance trends over time has been known since the very beginning of the international bull evaluation service. In a simulation study (Miglior *et al.,* 1998) showed the need of MACE to take into account the heterogeneity of sire variance. Time edit was introduced in 1998 as a way to limit the impact of heterogeneity of international evaluation results. In 2001 Miglior *et al.,* suggested as a possible solution the use of the last five years of data for sire variance estimation within country. No studies were further conducted to demonstrate that the 5 year approach increased the predictive ability of the international evaluation system. February 2005 data from 8 different countries were used to compare the predictive ability of the official international evaluation to a system that applied the 5 year approach when estimating within country sire variance. Sire variance estimates varied when based on bulls born on the most recent 5 years, depending on the country and on the trait, from +11% to –4%. Second country proofs and bulls progeny tested in multiple countries were used to assess the predictive ability of the 5year approach compared to the official procedure. Results showed on average very small differences, while the 5year approach was slightly better in predicting second country bulls, it was not performing as well with bulls proven in more than one country.

Introduction

The problem of heterogeneity of sire variance across time has been discussed and raised many times in relation to its impact on international comparison of bulls.

Cassandro *et al.* (1996, 1997) showed the existence of the problem and the possible effects on sire ranking across countries.

Weigel and Banos in 1996 investigated the impact of time period of data used in International evaluations and showed an impact of import of semen, upgrading of populations and selection itself as possible causes of trends in sire variances. They suggested to edit some historical data in order to improve the ability of the international evaluation system to compare bulls from different populations structures in terms of data, import of foreign genetics and selection history.

Miglior *et al.* (1998) in a simulation study showed the impact of heterogeneity of variance on international evaluation results. The study suggested that MACE should account for heterogeneity of variance in order to provide unbiased estimates of bull EBVs.

After a long discussion time edit was introduced in 1998 as a way to reduce the impact of heterogeneity and every February the bull birth year that defined the lower limit of the evaluation was moved ahead one year.

In 2001 Miglior *et al.* suggested the use of the last 5 years of data to estimate within country sire variance. According to their field study the 5 year approach yields results closer to the expected ranking based on a simulation study.

No final decisions to apply this approach were taken.

Time edit was official until 2004 when it was stopped because of the impact that taking away some bulls, founders of important families had on sires EBVs. Unexpected changes were observed, caused by the use of a genetic phantom group instead of the real proof of the ancestors (De Jong, 2003).

Therefore by now the impact of heterogeneity of variance may be greater today, because of the use of more years of data than it was in the past.

It is true that over time few improvements were introduced in MACE procedures that may have had an impact on the ability of the system to take into account differences due to data structure over time: EDC was used instead of raw number of daughters, better taking into account contemporary group size and number of records per bull.

In 2005 Van der Linde *et al.* in presenting results of Mace with Animal pedigree versus sire-mgs pedigree used an interesting approach to assess the predictive ability of MACE making use of bulls progeny tested in multiple countries and of second crop bulls.

The objective of the present study is to assess the predictive ability of official MACE compared to a system that would use the last 5 year of data to estimate sire variance within country (M-5yr).

Materials and Methods

Data from February 2005 international evaluation from 8 different countries were used to compare:

1) official Mace procedure (MACE) that estimates sire variance within country using all bulls born from 1986 onward;
2) M-5year procedure (M-5YR) that estimates sire variance within country using for each country the last 5 complete years of data.

The two MACE methods were validated in two settings, as previously done by Van der Linde *et al.* (2005) :

1) Bulls with type 11 proofs in multiple countries;
2) Bulls with type 21 proofs in multiple countries.

Validation 1: For bulls with type 11 proofs in multiple countries the two countries with the most daughters were determined. Within this validation two genetic evaluation were carried out. In the first evaluation data of one of randomly chosen country was discarded and in the second evaluation data of the other country was discarded. In this way, every bull had in two countries a proof with daughters (realised proof) and a proof without daughters (converted proof) and these two proofs were compared afterwards. Around 1400 bulls born after 1985 had type 11 proof in multiple countries.

Validation 2: All bulls with type 21 proof born after 1992 were removed. After the evaluation the converted proof was compared to the realised proof.

Results and Discussion

Table 1 to 3 illustrates the differences in sire variance estimated for the eight countries in the two procedures and the percent difference. Differences are quite large in some cases ranging from –4.20% to +11.29%.

Table 1. Sire variance estimates for milk yield.

Country	MACE	M-5YR	% difference
1	410	412	0.64
2	288	300	4.24
3	245	246	0.44
4	346	334	-3.53
5	253	267	5.54
6	355	348	-1.77
7	321	317	-1.06
8	720	715	-0.68

Table 2. Sire variance estimates for fat yield.

Country	MACE	M-5YR	% difference
1	15.32	15.58	1.66
2	11.29	11.96	5.88
3	10.25	10.21	-0.44
4	13.56	13.10	-3.38
5	8.77	9.76	11.29
6	13.09	13.03	-0.46
7	12.32	12.34	0.14
8	25.94	25.93	-0.05

Table 3. Sire variance estimates for protein yield.

Country	MACE	M-5YR	% difference
1	11.36	11.02	-2.92
2	8.35	8.90	6.52
3	6.80	6.84	0.63
4	9.46	9.06	-4.20
5	6.92	7.39	6.80
6	11.15	10.84	-2.79
7	8.81	8.58	-2.66
8	18.64	18.36	-1.48

Figure 1 to 3 reports the trend of sire variances per bull birth year in the 8 countries for milk, fat and protein yield respectively. Milk and protein are very similar, fat sire variance over time seems to behave a little differently across countries.

Figure 1. Sire variance trends over time for milk yield.

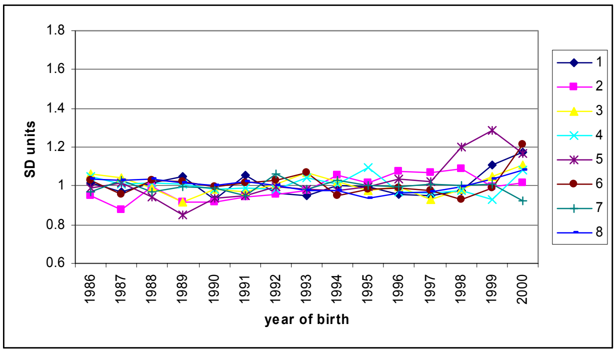

Figure 2. Sire variance trend by birth year for fat yield.

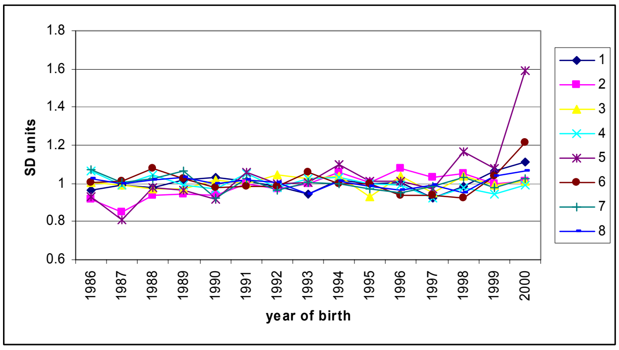

Figure 3. Sire variance trend by birth year for protein yield.

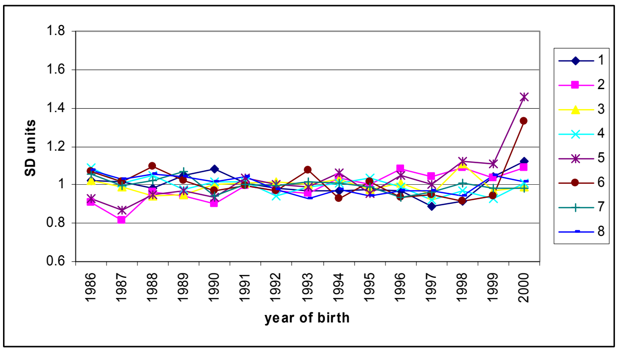

Table 4 reports the comparison between the two procedures in terms of average difference on converted proofs i.e. the estimated proofs of bulls that do not have daughters in the country. All the differences are expressed as percentages of the within country estimated official standard deviation. The differences refer only to protein yield results, since the other two traits show a similar pattern.. Differences are not very large, and smaller with respect to minimum and maximum differences found by Van der Linde at al. for MACE with Animal Pedigree (2005).

Table 5 and 6 report results for validation 1 in terms of average, SD, minimum and maximum difference between realized and converted proof expressed as percent of the within country standard deviation. Table 5 reports results for the MACE procedure and Table 6 for the M-5YR procedure.

In general M-5YR resulted in larger average differences. This may be due to the fact that sire variance in the most recent years may be not appropriate for bulls that were progeny tested at the beginning of the time period considered in the evaluation.

Table 4. Average (AV), standard deviation (STD),minimum (MIN) and maximum (MAX) difference (M-5YR-MACE) in ETA for converted protein proof per country expressed as percentage of within country estimated MACE σ_s.

Country	n	AV	SD	MIN	MAX
1	57430	0.44	4.32	-30.82	30.82
2	50777	-1.92	6.82	-35.91	29.92
3	57990	-2.21	14.26	-38.66	38.66
4	54176	1.59	5.29	-31.72	37.01
5	59782	-3.61	8.82	-43.36	28.91
6	58180	1.52	4.13	-26.91	31.39
7	55591	1.36	4.54	-28.38	34.05
8	43132	0.27	4.18	-21.46	26.82

Table 5. MACE: Average (AV), standard deviation (STD),minimum (MIN) and maximum (MAX) of the realized-converted ETA for protein proof of bulls with type 11 proof in multiple countries expressed as percentage of within country estimated MACE σ_s.

Country	n	AV	SD	MIN	MAX
1	495	-0.88	46.67	-145.30	118.89
2	249	3.59	47.40	-131.66	137.65
3	21	-14.71	78.68	-154.65	115.99
4	384	-0.42	51.08	-126.90	174.49
5	280	4.19	39.89	-173.45	101.18
6	99	-13.99	46.01	-134.54	107.64
7	228	-1.48	43.70	-158.91	119.18
8	581	-2.20	37.98	-112.65	139.47
Average		2.55	44.44		

Table 6. M-5YR: Average (AV), standard deviation (STD),minimum (MIN) and maximum (MAX) of the realized-converted ETA for protein proof of bulls with type 11 proof in multiple countries expressed as percentage of within country estimated M-5YR σ_s.

Country	n	AV	SD	MIN	MAX
1	495	-2.09	48.08	-149.67	127.00
2	249	4.94	45.06	-123.60	140.46
3	21	-16.37	76.43	-153.68	115.26
4	384	-1.38	52.99	-132.47	176.62
5	280	6.63	38.17	-175.95	108.27
6	99	-14.03	47.70	-138.41	110.72
7	228	-2.45	44.31	-163.26	116.61
8	581	-2.23	38.77	-119.79	136.13
Average		3.52	44.91		

Table 7 and 8 report results for validation 2 in terms of average, SD, minimum and maximum difference between realized and converted proof expressed as percentage of the within country standard deviation. Table 7 reports result for the MACE procedure and Table 8 for the M-5YR procedure. Results are contradictory. The average difference is larger but the SD of those difference is slightly smaller.

Again these may indicate that results are different depending on the period in which those bulls were used in the country. For type 21 bulls only bulls born after 1993 were used for the validation procedure, closer to the period of time for which sire variance were estimated.

Table 7. MACE: Average (AV), standard deviation (STD),minimum (MIN) and maximum (MAX) of the realized-converted ETA for protein proof of bulls with type 21 born after 1993 expressed as percentage of within country estimated MACE σ_s

Country	n	AV	SD	MIN	MAX
1	58	5.72	28.71	-61.64	79.26
2	259	-7.54	46.68	-179.54	101.74
3	94	10.29	49.41	-115.99	154.65
4	55	16.07	34.90	-58.16	89.89
5	121	-3.04	41.05	-115.63	72.27
6	166	2.42	38.75	-125.58	112.12
7	97	-2.38	35.07	-85.13	73.78
8	117	0.91	27.09	-96.56	75.10
Average		5.42	39.60		

Table 8. M-5YR: Average (AV), standard deviation (STD),minimum (MIN) and maximum (MAX) of the realized-converted ETA for protein proof of bulls with type 21 born after 1993 expressed as percentage of within country estimated M-5YR σ_s

Country	n	AV	SD	MIN	MAX
1	58	7.08	29.39	-58.96	81.64
2	259	-10.00	43.49	-168.55	89.89
3	94	9.79	48.52	-153.68	153.68
4	55	19.32	34.33	-55.20	93.83
5	121	-6.77	36.95	-108.27	67.67
6	166	3.14	39.86	-129.18	115.34
7	97	-1.63	35.80	-87.46	75.80
8	117	0.76	27.23	-98.01	76.23
Average		6.79	38.43		

Conclusions

Although the MACE procedure has been progressively improved over time some trend in sire variances over time still exists and may reduce the ability of the system to correctly predict future realized proofs of bulls.

The comparison between official MACE procedure and M-5YR procedure did show some differences in converted proofs of bulls across countries, but those differences were rather small.

The predictive ability of M-5YR determined looking at type 11 bulls tested in multiple countries and type 21 bulls born after 1993 did not show any superiority compared to official MACE procedure.

Future research

Estimating sire variances within countries comparing bulls sampled differently from different populations without having enough information in the data to account for that is perhaps partially causing some of the variations on sire variances over time. The same validation approach can perhaps be used to verify whether estimating sire variances excluding imported bulls can help improve the predictive ability of the system compared to the official procedure.

Another possible option is to estimate sire variances that are supposed to be a population parameter, thus quite stable after some years of selection, when estimating genetic correlations using all data from the different populations and use those variances in MACE to compute genetic evaluations instead of re-estimating them at each evaluation.

Acknowledgments

Many thanks go to all the countries who provided the data of the February 2005 evaluation and made this study possible: Canada, Germany, Denmark, France, Greta Britain, The Netherlands and USA. Interbull support in providing the programs and technical support to make them work was also important in this research, as well as the programming expertise of G.B. Jansen.

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