Genetic Trend Validation in the PROTEJE Data and the Influence of Genetic Correlations on MACE EBVs

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Introduction

The aim of the PROTEJE project is to develop an international genetic evaluation system for bulls and cows (Canavesi *et al.,* 2001). The participating countries with data are France (FRA), Germany (DEU), Italy (ITA) and the Netherlands (NLD). Recent results (Van der Linde and De Jong, 2003) showed no evidence for genotype by model interaction. However, several analyses did not fulfil the Interbull test 2 (Boichard *et al.,* 1995) requirements.

Aim of this study was to:

1. Investigate the background of the failure to fulfil Interbull test 2.
2. Evaluate sire breeding values (EBV) based on MACE (Interbull) and estimates based on across country analysis using pre-corrected data, either with genetic correlations equal to 1 or equal to Interbull.

Material and Methods

Data available were projected and realised 305-day yields for lactation traits (raw data) and yield deviations precorrected for national fixed effects and heterogeneity of variance (pre-corrected data) and pedigree data.

The French and Italian data included parity 1-3 records of Holstein cows having calved between 1988 and 1997. The Dutch data included parity 1-3 records of all Black and White cows having at least 75% Holstein genes with first calving year between 1990 and 1998. The German data included parity 1-3 records of Holstein cows with first calving between 1990 and 1997 and last calving before 2000. The German data was used in the across-country analysis only. Because this data was retrieved from het fixed regression test-day model, which treated lactations as different traits, Interbull test 2 could not be applied on the German data.

Further details of the data and performed edits are given by Van der Linde and De Jong (2003). Table 1 shows the distribution of lactations over country, parity and calving year.

Table 1. Number of lactations per country, parity and calving year.

Country	France			Germany			Italy			The Netherlands		
Parity	1	2	3	1	2	3	1	2	3	1	2	3
1988	452346	320010	245620	0	0	0	145592	114185	79274	0	0	0
1989	442004	351224	240951	0	0	0	158076	122761	87772	0	0	0
1990	458505	350952	262940	225140	0	0	168538	128869	89551	155849	2921	0
1991	470461	348874	255571	327812	125112	0	172383	128842	88188	180016	101824	2868
1992	503010	358332	250213	505956	220899	79220	181230	132672	88253	196114	132101	67434
1993	505937	384398	260070	515669	354703	151476	181415	138452	91405	200737	150304	96672
1994	495824	402556	287042	518551	379801	249528	181109	145184	98532	203516	153659	109281
1995	481755	394782	297060	546359	384057	269835	193855	145422	104304	222968	160106	113718
1996	507223	376362	289444	518419	391755	259208	194094	147079	99080	213798	168751	114569
1997	527300	378744	265708	495943	354173	251700	195836	146905	98611	253464	157460	118503
1998	0	0	0	0	320086	212176	0	0	0	0	0	0
1999	0	0	0	0	0	190120	0	0	0	0	0	0
total	4844365	3666234	2654619	3653849	2530586	1663263	1772128	1350371	924970	1626462	1027126	623045

Validation of the genetic trend

Boichard *et al.* (1995) described a method to validate the estimation of genetic trend using daughter yield deviations (DYD) of bulls. DYDs are average daughter performances adjusted for the dam breeding value and for all the effects included in genetic evaluation model. This test has been adopted as Interbull test 2. The description of the test by Interbull (Anonymous, 2004) leaves some room for interpretation. When analysing bull*year averages it is not clear whether or not a weighted analysis should be performed.

DYDs were estimated from a genetic evaluation of raw en precorrected data using a repeatability animal model.

Raw data was analysed using a model including fixed effects for age at calving, month and year of calving and herd-year-season-parity (first vs higher) random effects for permanent environment and the additive genetic effect and correction for heterogeneity of variance due to herd and year of calving and age at calving.

The model for analysing precorrected data included the mean plus the random effects only, and no correction for heterogeneity of variance was performed. The heritability was 0.30 and the repeatability is 0.50.

DYDs were analysed with the following fixed models:

1. $AY_{ij} = BULL_i + b*yc_j + e_{ij}$
2. $Y_{ijk} = BULL_i + b*yc_j + e_{ijk}$

where:

AY_{ij} is the average YD considering daughters of the i^{th} bull that calved in the j^{th} year (yc); by definition j=0 for the first year when at least 10 daughters of a bull calved for the first time;
$Bull_i$ is the effect of the i^{th} bull;
Y_{ijk} is the yield deviation of a lactation of daughter k of bull i, who calved at year j;
b is the regression coefficient used for validation of the genetic trend.

The model is validated by Interbull when the absolute value of the regression coefficient is less than .01*SD, where SD is the genetic standard deviation for the trait.

Model 1 was used by Van der Linde and De Jong (2003) to compare the fit of the model to analyse the raw data of the three individual countries, with the model to analyse the pre-corrected data. Model 2 was used to evaluate the effect of weighted regression analysis.

Across-country analysis

The PEST3.1-package (Groeneveld and Kovac, 1990) was used to perform a multivariate repeatability analysis for milk yield in four European countries. For all countries a heritability and repeatability of 0.30 and 0.50 was used, respectively. Genetic (co)variance components for the different countries were taken from the Interbull evaluation of August 2000 and given in Table 2.

The multivariate model used to analyse the pre-corrected data was:

$Y_{ijkl} = country_i + cow_j + animal_k + error_{ijkl}$,

where:

Y_{ijkl} is the milk yield record l of animal k with permanent environment of cow j in country i.

Two analyses were performed:

1. genetic correlations between milk yield in the different countries equal to one (mv_rg1);
2. genetic correlations taken from Interbull August 2000 evaluation (mv_mace).

Reranking of bulls was investigated in the top 100 bulls in both analyses and the August 2000 Interbull EBVs.

Table 2. Genetic standard deviations (diagonal) and genetic correlation for milk production (Interbull, August. 2000 evaluation).

Country	Germany	France	Italy	The Netherlands
Germany	620	0.88	0.88	0.90
France		734	0.92	0.94
Italy			638	0.93
The Netherlands				580

Results and Discussion

Validation of the genetic trend

Table 1 shows the amount of data per country, parity and calving year and points to three different data selection strategies. Data from France and Italy was selected on calving date, Germany on birth date and The Netherlands on calving and birth date.

Table 3 presents the results of Interbull test 2 with model 1 and 2 for France, Italy and The Netherlands. Validation of the genetic analysis with model 2 gave considerable better results (closer to zero) than with model 1 in both raw and pre-corrected data. For Italy and The Netherlands analysis of both raw and pre-corrected data fulfilled the Interbull test 2 requirements when applying model 2.

Across-country analysis

Descriptives for milk yield deviation per parity for the different countries are presented in table 4. Parity differences can be explained partly by the data selection strategies. For France and Italy lactation 3 is produced by cows that are born two years before the cows who produced the first lactation. Therefore it is expected that parity averages also reflect differences in average genetic level. When assuming a yearly genetic progress of 0.15 SD for all countries, this is approximately 100 kg milk per year. Parity differences (Table 4) as found for Italy, The Netherlands and partly France can therefore be explained by the data selection strategy applied by those countries. This explanation does not hold for the differences found for Germany and partly France.

Except for Germany, all countries show only small differences in standard deviation for pre-corrected milk yield between the three parities. For Germany, standard deviation of parity 1 is over 200 kg less than of parity 2 and 3. At the time PROTEJE data were prepared Germany used a test day model and therefore pre-corrected milk yields were on the original scale while other countries used a repeatability lactation model and expressed milk yields on a common scale.

Table 5 shows the correlations of unique multivariate EBVs (mv_rg1) with country specific EBVs (mv_mace) for bulls with daughters in just one country and for all bulls. Correlations between EBVs are very high and range from 0.984 to 1.0.

Rank correlations were equal to the correlations shown in Table 5.

Table 3. Results of Interbull test 2 for milk, fat and protein for France, Italy and the Netherlands with model 1 and 2.

		France			Italy			The Netherlands		
model	data	Milk	Fat	Protein	Milk	Fat	Protein	Milk	Fat	Protein
1	pre-corr.	3.1%	2.9%	3.9%	1.1%	0.8%	0.9%	0.7%	0.8%	0.3%
2	pre-corr.	2.0%	1.6%	2.9%	0.7%	0.2%	0.5%	0.2%	-0.3%	-0.5%
1	raw	2.4%	2.4%	2.7%	1.2%	1.0%	1.3%	1.8%	2.0%	1.9%
2	raw	1.2%	1.0%	1.5%	0.9%	0.5%	1.0%	1.0%	0.5%	0.8%

Table 4. Mean and standard deviation for milk yield deviation per country and parity.

Descriptive	Parity	France	Germany	Italy	The Netherlands
Mean	1	1266	76	-628	815
	2	1270	176	-737	797
	3	1202	248	-845	740
Standard deviation	1	1608	928	1325	927
	2	1585	1133	1378	908
	3	1583	1161	1356	876

Table 5. Correlations between unique multivariate EBVs (mv_rg1) and country specific multivariate EBVs (mv_mace) for country specific group of bulls.

	Bulls with daughters in one country only				
Country	France	Germany	Italy	The Netherlands	All
Number of bulls	6235	5005	2187	3629	17613
France breeding value	1.000	0.990	0.994	0.997	0.996
German breeding value	0.991	1.000	0.988	0.995	0.993
Italian breeding value	0.993	0.984	1.000	0.995	0.992
Dutch breeding value	0.997	0.993	0.994	1.000	0.997

Table 6 presents the correlations between August 2000 Interbull EBVs for each of the four countries and the country specific multivariate EBVs, based on all bulls and on bulls with maximal 20 or 10% difference in number of daughters in the Interbull analysis compared to the PROTEJE data. A large part of the bulls has a considerable difference in number of daughters in the national analysis of August 2000 compared to the PROTEJE data. This is probably the main reason for the correlations to be different from one.

For Germany 70% of the bulls had over 20% difference in number of daughters in the PROTEJE data compared to their national analysis of August 2000. This was due to the restriction applied for the PROTEJE data where each lactation had to consist of at least 8 tests, whereas in the national analysis of August 2000 each daughter with at least one test was counted.

A top 100 ranking of bulls, based on Interbull EBVs, was made. For bulls used in only one country, the difference in number of daughters in the national analysis and the PROTEJE data was restricted to maximal 20%. Bulls with daughters in several countries had to have at least 50 daughters in the PROTEJE data. The number of bulls in both top 100 Interbull and top 100 EBV from the mv_mace analysis is 75, 63, 67 and 75 for France, Germany, Italy and The Netherlands respectively. The differences in ranking can be due to:

1. smaller amount of PROTEJE data in the countries involved compared to the national analyses, due to PROTEJE specific data selection criteria,
2. daughter information in other Interbull countries than the PROTEJE countries which is included in the Interbull estimates,
3. exclusion of national EBV from Interbull estimates of second crop bulls (France)
4. Test day model compared to lactation model (Germany).

Table 6. Correlations between country specific Interbull EBVs and multivariate EBVs for three groups of bulls used in one country only as indicated by information from Interbull.

	Number of bulls			Correlation		
Maximal difference in # daughters	100%*	20%	10%	100%	20%	10%
Bulls used in France only	6235	5384	5142	0.969	0.979	0.980
Bulls used in Germany only	5005	1496	94	0.918	0.974	0.968
Bulls used in Italy only	2187	1563	1294	0.954	0.982	0.985
Bulls used in The Netherlands only	3629	1821	868	0.960	0.990	0.991

*: No restriction on difference in number of daughters applied.

Conclusions

Differences in the application of the Interbull test 2 can result into different conclusions for validation of the genetic trend. A more explicit definition of the test should result in identical validation of the genetic trend between countries.

Only minor differences in EBVs were observed between a multivariate repeatability lactationmodel with genetic correlations between countries being one and results based on genetic correlations equal to estimates from MACE.

Estimation of international EBV for cows with a multivariate repeatability lactation model based on pre-corrected data, is technically feasible with hardware presently available.

The PROTEJE data are inadequate for methodological comparison of MACE using national bull breeding values, with across country evaluation based on pre-corrected data.

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