Experiences of Blending Foreign Information in the National Genetic Evaluation

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Introduction

In the Danish dairy breeds, a large proportion of genes originate from foreign countries. Both semen, embryos and live animals have been imported. These foreign animals are usually highly selected and consequently excluding the foreign information would bias the national genetic evaluation. The Interbull estimates of breeding values (EBV) for sires include all available information worldwide and must therefore be considered the most reliable estimates. Ignoring foreign information may cause a conflict between the breeding value of the sire and the breeding values of close relatives.

This is a special problem in the evaluation of females out of a foreign dam or of females with a highly selected foreign sire without a national test. Since these two groups of females are often considered potential bull dams and bull dam selection takes place among very young females, it is important in practice to make unbiased comparisons between females with a native and a foreign pedigree.

Bonaiti & Boichard (1995) presented a method to include foreign information in a national genetic evaluation system. This method has been implemented in the DMU-program (Jensen & Madsen, 1993) which is used for genetic evaluation in Denmark. This paper describes how the method of Bonaiti & Boichard (1995) has been adapted in the Danish evaluation and presents the results of blending foreign information in the routine evaluation.

The Danish Animal model

Breeding values for yield of milk, fat and protein are estimated with a single breed, single trait Animal Model. Data from the first three lactation records are included and precorrected for heterogeneous variance between years, lactations and management groups.

The fixed effects in the model are:

- Management groups defined by means of a clustering procedure
- Year × month of calving × lactation number
- Age of calving × lactation number × time period
- Previous calving interval × lactation number × time period
- Present calving interval × lactation number × time period
- Heterosis × lactation number (heterosis is a regression degree of heterozygosity)
- Genetic groups defined as phantom parent groups.

The random effects are:

- Animal (heritability: 0.30 for all traits and breeds)
- Permanent environment (repeatability: 0.45 for all traits and breeds)
- Residual.

Foreign information

Foreign information is included in the national genetic evaluation by means of the method described by Bonaiti & Boichard (1995). This method is based on incorporating a number of virtual daughters of the animal in question, each daughter with a production record based on foreign information (DYD and EBV). The number of progeny depends on the reliability of the foreign information. The other parent of the virtual daughters is assumed unknown and put into genetic groups (phantom parent groups).

The first step in this procedure is to obtain information on the reliability and estimates of breeding values for foreign animals who have daughters in Denmark.

- For sires the proofs published by Interbull are used. If the reliability is above 80%, a maximum reliability of 80% is used
- For cows breeding values estimated in the respective country are obtained and converted to a Danish scale by means of the factors recommended by Interbull. The reliability is assumed to be 30% for all cows.

The next step is to calculate the efficient number of progeny (n) by:

$$n = ((4-h^2)/h^2) \times (R/(1-R)) - R_p/(1-R_p)$$

where

h^2 = heritability
R = reliability
$R_p = 0.25(R_{sire} + R_{dam})$

The daughter yield deviations (DYD) are calculated by:

$$DYD = 0.5 \times (u_p + (1 + d \times \lambda/n) \times (u - u_p)$$

where

u = breeding value
u_p = average of parents' breeding values
d = *1 (unknown parents), 2 = both parents known, 3 = sire known, 4 = dam known*
$\lambda = (4 - h^2)/h^2$
n = effective number of progeny

In the Danish application it is always assumed that the EBVs of the parents are unknown, even though the EBV of the animal often includes pedigree information. Therefore there might be some double counting of pedigree information.

For Danish Holsteins and Danish Jerseys the sires are treated as one genetic group as the Interbull EBVs are directly comparable across countries and years. The foreign information for dams is subdivided into genetic groups according to country of origin. For Danish Jerseys all foreign information on females comes from the USA. For cows two more genetic groups are formed within each of these groups: One with cows having progeny in Denmark and one without Danish progeny. For the groups having progeny in Denmark we expect breeding values to be equal to the average of the parents. Animals that have no progeny in Denmark are probably selected on their performance outside of Denmark and we expect breeding values above average of the parents.

For Red Danish the number of animals with foreign information is low and it is not possible to form genetic groups of acceptable size. Only one group is considered.

For the Interbull evaluation of sires an identical evaluation is made excluding all the foreign information.

Table 1 shows the number of foreign animals with EBVs included in the evaluation of Danish Holstein. The information from France is pooled with the Dutch information due to the limited number of French relatives with proof in Denmark.

Table 1. Number of foreign animals with EBV included in the genetic evaluation of Danish Holstein, August 1999

Category	Country	Number
Bulls	All countries	434
Cows	USA	1079
Cows	Netherlands and France	649
Cows	Germany	587
Cows	Canada	115

Results and Discussion

Only results for Danish Holstein are presented. The EBVs are expressed in relative index units. One unit is approx. 68 kg milk, 2.8 kg fat and 2.3 kg protein. Table 2 shows the results of comparing EBVs for foreign Holstein AI-bulls born within the last 15 years. The average official Danish proof resulting from the blending of information is shown together with Interbull proofs and Danish proofs calculated without blending of information. The three averages are very similar. As for sire evaluation the benefit of blending information is limited, but for individual sires there are variations. The standard deviation of the difference between Danish proof with and without blending of information is 0.7 index units for protein.

Table 2. Average EBVs of foreign Holstein AI-bulls progeny tested in Denmark. Bulls born within the last 15 years. Reliability at least 60% based on Danish data

Trait	Number	Danish proof	Interbull proof	Danish proof without blending
Milk	107	104,0	103.8	103.7
Fat	107	101.8	101.8	101.3
Protein	107	102.9	102.7	102.7

The foreign bulls are generally highly selected proven bulls. The group effect derived from the male proof is mainly estimated by comparing their international and Danish daughters. The results show agreement between the official Danish proof and the Interbull proof. The Danish proof without blending of foreign information is slightly lower than the other 2 proofs. This indicates that foreign bulls with low reliabilities in Denmark are regressed against parents' mean when foreign information is omitted.

The effect of blending foreign information is expected to be largest for heifers because they have no Danish records. The tables 3 and 4 show the effect of blending the EBVs of heifers and their dams. Table 3 shows the average of the Danish proofs for heifers with foreign dams. The utilization of foreign information increases the EBVs of these animals because the foreign dams are highly selected (most by dams out of imported embryos). The group effect derived from female proofs is estimated by comparing these females in the foreign country with their progeny in Denmark, particularly the sons used in artificial insemination. Table 4 shows the average proofs for the foreign dams and their converted proofs. As expected the two averages are very similar. Small differences will occur due to the influence of relatives, but the major source of information is the converted EBVs.

Table 3. Average EBVs of heifers born by a foreign dam after 1996

Trait	Number	Danish proof (1)	Danish proof without blending (2)	Difference (1-2)
Milk	176	114.9	111.4	3.5
Fat	176	107.6	104.5	3.1
Protein	176	113.3	108.8	4.6

Table 4. Average EBVs of foreign dams with a Danish heifer born after 1996

Trait	Number	Danish proof (1)	Converted proof (2)	Difference (1-2)
Milk	108	114.8	113.7	1.1
Fat	108	107.3	109.1	-1.8
Protein	108	113.2	112.0	1.2

Table 5 shows results for foreign cows that have Danish daughters with milk production records. In this situation the Danish proofs are lower than the converted proofs. This is (probably) due to overestimated EBVs for bull dams. The overestimation seems to be a little higher for the Dutch group than for the US-group. No results are presented for the German and Canadian groups as the number of foreign cows were low.

Table 5. Average EBVs of foreign dams with milking daughters in Denmark. Daughters born after 1989

Country	Trait	Number	Danish proof (1)	Converted proof (2)	Difference (1-2)
USA	Milk	143	108.9	110.3	-1.5
	Fat	143	103.3	106.4	-3.1
	Protein	143	106.0	107.2	-1.1
NLD/FRA	Milk	20	107.3	109.4	-2.2
	Fat	20	103.4	107.5	-4.0
	Protein	20	107.7	109.8	-2.1

Table 6. Average EBVs of foreign dams with a Danish progeny tested son born after 1989. Reliability of son's EBV> 60%

Country	Trait	Number	Danish proof (1)	Converted proof (2)	Difference (1-2)
USA	Milk	98	107.7	109.9	-2.2
	Fat	98	102.2	105.9	-3.7
	Protein	98	104.4	106.5	-2.1
NLD/FRA	Milk	41	106.1	106.6	-0.5
	Fat	41	103.5	104.9	-1.4
	Protein	41	104.9	104.9	-0.0
Germany	Milk	122	100.3	104.0	-3.7
	Fat	122	99.0	105.0	-5.9
	Protein	122	98.7	102.7	-4.0
Canada	Milk	11	106.8	106.5	0.3
	Fat	11	102.5	102.0	0.5
	Protein	11	104.4	102.4	2.0

The results of foreign bull dams with a Danish progeny tested son (table 6) show that the Danish proof is lower than the converted proof, indicating that the superiority of the male progeny was lower than expected from the converted EBVs of the dam. It is found in many studies that EBVs of bull dams are upwardly biased.

Conclusion

The estimates of breeding values including the foreign information are published as official breeding values. We have used this procedure in the routine evaluation for 1½ years. It allows for a dynamic blending of foreign and Danish information. As a foreign animal obtains more and more Danish data (own data or progeny data) the importance of the foreign information will gradually be diminished, but a slight effect will always remain. Using this procedure we avoid the sudden changes when the official breeding value for sires changes from Interbull proof to national estimate.

The results show that the procedure only has a minor effect on the sire evaluation. The procedure has a greater impact on female evaluation and makes it possible to compare females with a native and a foreign pedigree by means of all available information.

The applied procedure for blending of foreign information avoids double counting. This is done by putting restrictions on the reliability of the foreign information at maximum 80% for foreign bulls and 30% for foreign cows. In this way the effect of double counting is limited. Ideally the Interbull EBVs and the converted EBVs should be corrected for the Danish information before the blending. However, to do this accurate reliabilities are needed (Bonaiti & Boichard, 1995). Especially for the cows it is difficult to get accurate reliablities.

References

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