Blending Interbull Breeding Values into National Evaluations A New Approach

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Abstract

Publishing Interbull breeding values for bulls together with national breeding values for cows and young bulls can lead to conflicts, if the national and international breeding values show big differences. To solve this problem a new blending algorithm was developed. It is based on the mixed-model-equation and not dependent on any environmental modelling. This procedure combines national and international breeding values simultaneously for all animals by weighting the international information of the Interbull estimates. A FORTRAN program was written to test the procedure with the Brown-Swiss population in Baden-Württemberg/southern Germany. The procedure is fast converging and uses little memory. The results show plausible corrections for the national breeding values and all conflicts were solved.

Introduction

A national breeding value evaluation gives estimates for animals in one breeding area. The results for bulls in this area are sent to Interbull to estimate international breeding values (BV). Bulls used in Germany may have more daughters in foreign countries than in Germany. So the international BV contains much more information than the national and both BVs can be very different. If these Interbull-BVs are published together with the national BVs for cows and non-Interbull bulls, conflicts between BVs can appear. The aim of this study was to develop a procedure to consider Interbull-BVs and their information in the national estimates to keep the published results plausible.

Taking into account international BVs in the national BV estimation is known as 'blending'.

Blending-Procedure and Algorithm

There are many countries, that use blending procedures to adjust breeding values. The most common procedures are not useful for Germany, because the models are too different and complex. A new blending procedure was developed to solve the problem. The new method has to fulfill different demands:

A blending-procedure should:

- be model-independent.
- operate on Interbull-traits.
- weight international information correctly.
- be realized with little expense.
- converge to definite solutions.

Blending - Algorithm

Based on the mixed-model-equations (MME) the part of random effects can be written as:

$$[Z'Z + A^{-1}]\hat{u} = r$$

The equation can be transformed to:

$$[Z'Z\hat{u} + (L^{-1}(L^{-1'}\hat{u}))\lambda] = r$$

and calculated in three single steps:

1. $[L^{-1'}\hat{u}] = v_1$
2. $[L^{-1}v_1] = v_2$
3. $[Z'Z\hat{u} + v_2\lambda] = r$

This calculation has to be done for:

I. Cows and bulls with national BV.
II. Bulls with Interbull-BV and additional performance equivalents

The vector r after this calculation is a combination of r_{nat} for cows and bulls without Interbull-BV and solutions from r_{IB} for bulls with Interbull-BV. For these bulls also the performance equivalences are added to the diagonal matrix Z'Z, and we get:

$[D\hat{u} + (L^{-1}(L^{-1'}\hat{u}))\lambda] = r$ (D = diagonal matrix)

The new blending BVs are calculated from these equations in an iterative process.

Therefore following equation is set up: $[D + A^{-1}\lambda]\tilde{u} = \tilde{r}$ ($\tilde{u}$ = BVs after 'blending') and will be solved like in step 1 to 3. For each animal $\Delta\hat{u}_i = (r_i - \tilde{r}_i) / diag_i$ is calculated and the new solution $\tilde{u}_i^{n+1} = \tilde{u}_i^n + k * \Delta\tilde{u}_i$ (k=relaxation factor) is put into the equation, until $\frac{\sum \Delta\tilde{u}_i}{n}$ reaches a convergence criterion. For every calculation of $\tilde{r}$ the newest breeding values of each round are used (Gauss-Seidel-Iteration).

Calculation of the Performance Equivalents:

The reliability of BVs is dependent on the number of effective daughters of a bull. Similar to this the number of effective daughters can be calculated from the reliabilty of a BV. Bulls having a higher accuracy for the Interbull-BV than for the national, will get an additional number of performance equivalents (= quasi own performances) added to their diagonal elements of the numerator relationship matrix that would raise the national reliability up to the level of the international. The higher information level of the international BV will be expressed in a higher weight of this bull in the equation system. So the relatives of this bull are not only affected by the different breeding value, but also by the higher amount of information it contains.

A FORTRAN-program was developed, which sets up and solves the equation system. It shows following positive features:

For input only the BVs, their reliabilities and the pedigree is used.
The algorithm is fast and efficient.
The size of used memory space is minimized, because only vectors are needed.
If the pedigree is not changed, the A^{-1} can be read from file, which will accelerate the program.

The program was tested with the Brown-Swiss population of Baden-Württemberg with nearly 300.000 animals. It was shown, that there were several conflicts between national and Interbull-BVs, which could be solved in a plausible way. Figure 1 shows a distribution of cows over differences between national and blending BV. The medium bar of the class with no or little differences is shortened. It would bias the figure too much. The first thing to see is the large number of animals affected by the blending procedure. There are more than 4200 cows whose national BV was blended for more than 50 kg milk. The BVs are blended in positive and negative direction. This shows that there are also bulls with a higher national than international BV and that their offspring was considered in the same way.

Figure 1. Distribution of the differences national breeding value - breeding value after blending for the trait kg milk.

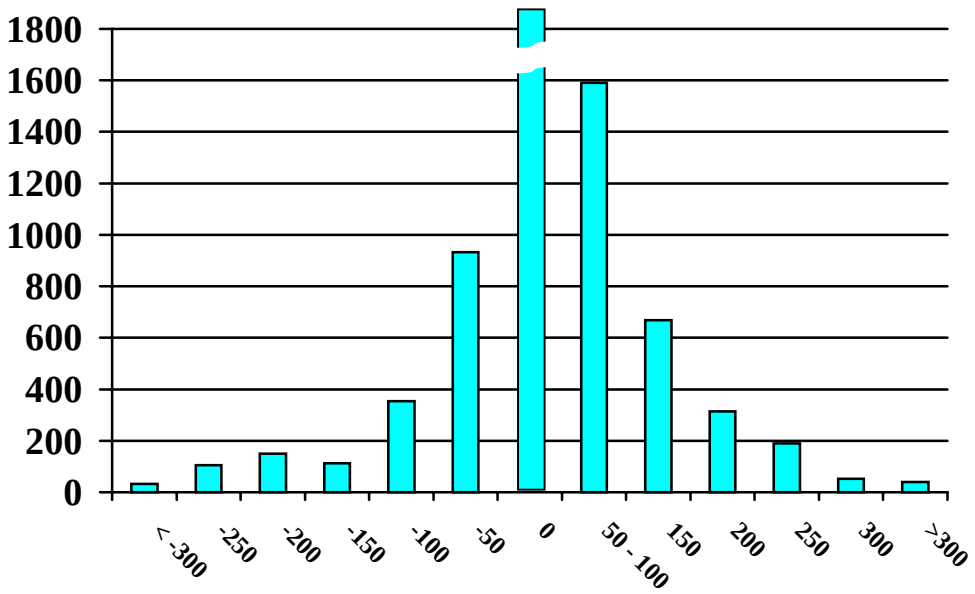


Figure 2. Comparison of the differences between the BVs of bulls (national - international) with the average differences of the BVs (national - blending) of their offspring.

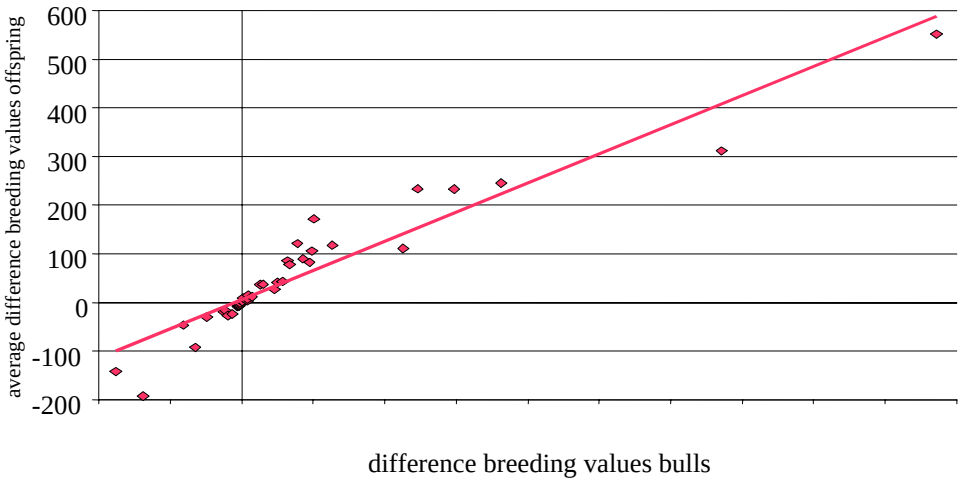
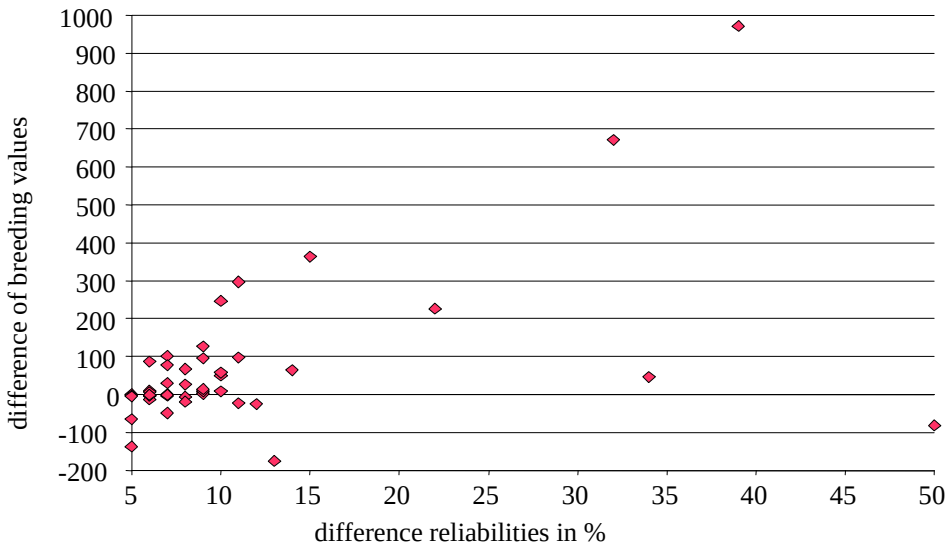


Figure 2 shows a positive relationship between the difference of the national and international BV for bulls and the correction of the BVs of their offspring. If a bull has a higher Interbull breeding value than a national, then the average blended breeding value of his offspring will also raise. In this case the regression coefficient is .6. This is dependent on the information with which the Interbull breeding value is weighted, that means the higher amount of international information.

Figure 3 shows the relationship of the differences between national and international BVs and their reliabilties.

Figure 3. Comparison of the differences between the BVs of bulls (national - international) with their reliabilities.



It can be shown, that high differences in reliabilities come together with high differences in breeding values. The amount of the BV-differences depend on the level of their reliabilities. Alterations on a low level (e.g. r^2_{nat}=.80 - r^2_{IB}=.88) cause a higher difference between national and international BVs than on a high level of reliabilities. Fig. 3. shows only the dependence between reliabilities and breeding values and not the level of their differences.

The features of the blending procedure and the program can be concluded in following points:

The use of the blending procedure is independent from the national model.
Modelling of the environment and calculation of single performances is not necessary.
a definitive solution exists.
The blending of breeding values occurs simutaneously for all animals.
The Interbull information is weighted correctly.

Literature

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