Determining Changes in Definition of Conformation Traits and the Effect on International Evaluations

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1. Introduction

Conformation traits in dairy cattle are scored in a subjective way. A classifier scores an animal following a certain definition for a trait. These definitions are set by a herdbook organisation or in Holstein cattle, by the World Holstein Friesian Federation (WHFF). Within the conformation traits two groups can be distinguished: linear traits and general characteristics. A linear trait is scored on a linear scale, where traits are scored individually from one biological extreme to the other. The variation within traits is identifiable and no direction for a certain desirability is given. With the linear scoring system a dairy cow is described for the most important conformation traits. At this moment WHFF has defined 16 standard traits, which should be score by all members of WHFF identically. The general characteristics, or breakdowns, give a linear qualification and characteristic of the cow in relation to the standard, and are not linear in a biological sense.

At WHFF level a lot of work has been done do uniform the definitions for linear traits across countries. In the Netherlands the definition of several traits has been adjusted once or more times during a period of twenty years. In the genetic evaluation the scores for a trait were considered to follow the same definition over time. This is not correct when knowing the definition has changed. The effect is that breeding values for animals born in different periods do not have a genetic correlation of one. This can cause for example extra changes in breeding values for second crop bulls. Further the breeding values are used as input in the international genetic evaluation of Interbull. When countries keep on using data based on former trait definitions, the breeding values are representing very slowly the new trait definition, which slows down the improvement of genetic correlation between countries.

This genetic correlation is an important parameter in the Interbull evaluation to compare bulls across countries.

The objective of this study was to estimate genetic correlations between adjacent trait definition periods and investigate the effect on the genetic correlation with other countries in the Interbull genetic evaluation.

2. Materials and Methods

2.1 Data editing

In the analysis all linear traits were analysed. The results of five traits, which changed during time, are presented in this paper. Other traits did not change over time. The traits considered are body depth, angularity, rump width, foot angle, fore udder attachment and rear udder height. Old and new definitions for these traits are given in Table 1.

Scores on heifers, being in first lactation and scored for the Black&White standard, were used. The heifers contained only Holstein Friesian and/or Dutch Friesian genes The scores originate from the herd classification system, carried out by NRS.

The change of trait definition always occurred at 1st of September. For body depth the change was in 1991 and 1996, for angularity in 1996, for rump width in 1991, for foot angle in 1997, for fore udder attachment in 1996 and for rear udder height in 1996.

To estimate the genetic correlation between two trait definitions all scores one calendar year before the change and scores of one calendar year after the changed were used. So when trait definition took place in 1996, scores of 1995 and scores of 1997 were used. Data of the calendar year when the change of definition occurred were skipped for the analyses to avoid a possible effect of an adjusting period for the classifiers.

2.2 Statistical analyses

The genetic correlation was estimated with a bi-REML procedure, as no cow received scores for both trait definitions. The model used for each trait was:

$$Y_{ijklmno} = HVC_i + LS_j + AGE_k + BD_l + BS_m + S_n + E_{ijklmno}$$

where:

$Y_{ijklmno}$ = the score for a conformation trait, on scale 1-9 on cow o;
HVC_i = herd-visit-classifier effect (fixed);
LS_j = lactation stage of cow at moment of scoring (fixed);
AGE_k = age of cow at moment of scoring (fixed);
BD_l = breed dam of cow (fixed);
BS_m = breed sire of cow(fixed);
S_n = sire of cow, including the relationships of sire with his sire and maternal grandsire (random);
$E_{ijklmno}$ = residual (random);

The genetic correlations estimated with REML were used in the national genetic evaluation for the traits changed definitions. For these traits multiple trait analysis was applied, where normally the traits were considered as the same trait in a single trait analysis.

Traits were considered to be different for the different periods they were scored. So for body depth 3 traits were defined for scores before 1st of September 1991, 1st of September 1991 to 1st of September 1996 and after 1st of September 1996. Angularity, rump width, fore udder attachment and rear udder height were split in two traits: scored before and after 1st of September 1996. Rump width was split in two traits: scored before and after 1st of September 1991. Foot angle was split in two traits: scored before and after 1st of September 1997. The national genetic evaluation was carried out using data of the routine national evaluation of February 2000.

The estimated breeding values of bulls for the most recent trait definition were send to Interbull and used in the March 2000 test evaluation. In the MACE evaluation, the correlations between The Netherlands other countries were estimated. Results with eight of the largest countries (CAN, DEU, DNK, FRA, GBR, ITA and USA) are presented in this paper.

Table 1. Trait definition of traits changed in 1991 or 1996.

Trait	year of change	definition before	definition after
body depth	1991	length of ribs	depth and width of the body related to stature
body depth	1996	depth and width of the body related to stature	depth and width of ribcage related to stature
rump width	1991	measured in cm. at the thurls	distance between the most posterior point of the pin bones
Angularity	1996	-1*(former muscularity score): amount of muscles over the body with emphasis on the thighs	angel and openness of the ribs, combined with flatness of bone avoiding coarseness.
foot angle	1997	claw diagonal	angle at the front of the rear hoof measured from the floor to the hairline at the right hoof
fore udder attachment	1996	angle between the fore udder and body wall	the strength of attachment of the fore udder to the abdominal wall
rear udder height	1996	distance between vulva and milk secreting tissue measured at udder fold	distance between vulva and milk secreting tissue measured in centre of udder: in relation to height of the animal

3. Results and Discussion

The estimated genetic correlations for the six traits are presented in Table 2. The trait definition change has least effect on fore udder attachment with genetic correlation of 0.987 between new and old trait. Most effect was found for rear udder height, angularity and foot angle with respectively a genetic correlation of 0.961, 0.946 and 0.907 between the new and old trait. For all these three traits the genetic correlation is significantly different from 1.0 (p=.05), meaning we have to deal with a different trait. Also the definition change for body depth in 1991 caused a significant (p=.05) different trait with a genetic correlation of 0.965.

The heritabilities estimates are very similar for body depth, rump width and fore udder attachment, before and after trait definition change. For angularity the heritability of the new defined trait was 0.05 lower. For foot angle the heritability dropped with 0.04 from 0.21, for claw diagonal, to 0.17 for the new definition, which is foot angle. Reurink (1987) also found a lower heritability for foot angle compared to claw diagonal, based on a pilot data set. Environment and management of farmer affects the trait foot angle more then the trait claw diagonal. The higher heritability was at the end of the eighties the reason to score claw diagonal instead of foot angle. Rear udder height showed a decrease of 0.06 in heritability. This could be caused by the effect that the latest trait definition does relate the trait to the height of the animal as the former definition did not. By not relating the trait to the height of animal, the effect of height becomes part of the trait. Height of the animals has a heritability of about 0.50, resulting then is a higher heritability in the trait scored according to the former definition.

In the MACE evaluation, the correlations between The Netherlands and eight other countries were estimated by Interbull (see Table 3). The average correlation with other countries increased on average with 0.01 for fore udder attachment to 0.18 for angularity. Foot angle also showed a large increase on average with 0.08, from 0.62 in February 2000 routine evaluation to 0.70 in the March 2000 test evaluation. So by handling traits which were scored according to another trait definition, the average correlation with all other countries increased. Even though not all trait definition changes had lead to significant different traits in the national evaluation (Table 2).

The current situation of the genetic correlation of the Netherlands with other countries is shown in table 4. Since February 2000 there has been an increase of the level correlations between countries. The strongest increase for the traits considered in this research was found for angularity and foot angle with respectively 0.17 and 0.15 higher correlation in the March 2002 test evaluation. The average increase during this period for all six traits was 0.08. This increase is caused by an increase of 0.06 by handling trait with changed definition as different trait in the national evaluation and 0.02 caused by a new procedure used by Interbull for bending the correlation matrix (Interbull, 2002).

Table 2. Genetic correlation and heritabilities for the analysed traits. Traits analysed are scores in calendar year before year of change and scores in calendar year after year of change. (s.e. for heritabilities are 0.02).

trait	year of change	genetic correlation (s.e.)	$h^2_{\text{year -1}}$	$h^2_{\text{year +1}}$
body depth	1991	0.965 (.014)	0.37	0.37
body depth	1996	0.979 (.011)	0.38	0.38
rump width	1991	0.976 (.013)	0.27	0.27
angularity	1996	0.946 (.020)	0.34	0.31
foot angle	1996	0.907 (.035)	0.21	0.17
fore udder attachment	1996	0.987 (.011)	0.26	0.27
rear udder height	1996	0.961 (.018)	0.32	0.26

Table 3. Correlation in MACE for the six traits for the Netherlands with CAN, DEU, DNK, FRA, GBR, ITA and USA in February 2000 routine and March 2000 test Interbull evaluation.

Trait	avg. correlation Feb 2000	avg. correlation March 2000	avg. increase	max increase (country)	min increase (country)
body depth	0.79	0.83	0.04	0.05(FRA)	0.00(CAN)
rump width	0.79	0.81	0.02	0.06(DEU)	0.00(CAN)
angularity	0.68	0.86	0.18	0.27(DNK)	0.15(ITA)
foot angle	0.62	0.70	0.08	0.23(DNK)	0.04(USA)
fore udder attachment	0.84	0.85	0.01	0.03(FRA)	0.00(DNK)
rear udder height	0.77	0.79	0.02	0.04(GBR)	0.00(USA)

Table 4. Correlation in MACE for the six traits for the Netherlands with CAN, DEU, DNK, FRA, GBR, ITA and USA in February 2002 and May 2002 Interbull evaluation.

trait	avg. correlation Feb 2002	avg. correlation May 2002	avg. increase Feb 2002 - May 2002	avg. increase Feb 2000 -May 2002
body depth	0.83	0.85	0.02	0.06
rump width	0.82	0.84	0.02	0.05
angularity	0.84	0.85	0.01	0.17
foot angle	0.72	0.77	0.05	0.15
fore udder attachment	0.86	0.88	0.02	0.04
rear udder height	0.86	0.88	0.02	0.11

4. Conclusions

- Some trait definition changes has lead in the Netherlands to significant different traits. This holds for the change of definition for body depth in 1991, angularity in 1996, foot angle in 1996 and rear udder height in 1996. Three changes did not lead to significantly different traits: body depth in 1996, rump width in 1996 and fore udder attachment in 1996.
- By submitting traits, which were defined according to the latest WHFF recommendations, for the Interbull evaluations, the average correlation with other countries increased.
- Countries should consider changes in trait definitions in their genetic evaluations. This can be done by omitting data, scored with a former definition, or by treating these different scores as different traits in a multiple trait national evaluation. The last option is applied in the Netherlands.
- Effect of trait harmonisation on genetic correlations between countries in MACE can be seen much faster when data, based on the former definition, is omitted or used in a multiple trait national evaluation.
- The new bending procedure of Interbull has a positive effect on the genetic correlation of the Netherlands with other countries. This new bending procedure should also be applied in the Interbull MACE evaluations for other traits.
- The average overall correlation for the traits in this study increase on with 0.08 during last 2 years.

References

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