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Conference paper

GENETIC EVALUATION OF BODY WEIGHT OF LACTATING HOLSTEIN FRIESIAN HEIFERS USING BODY MEASUREMENTS AND CONFORMATION TRAITS

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Summary

Genetic and phenotypic parameters of body weight (BW), body measurements, and conformation traits were estimated using field data on 7344 lactating Holstein Friesian heifers. Estimated heritability was 0.33 for BW and ranged from 0.32 to 0.54 for heart girth, hip height and conformation traits. Genetic correlations with BW were high (0.48 - 0.77) for heart girth, muscularity, hip height, rump width, and body depth. Based on 40 daughters the accuracy of selection of a selection index was 0.88 for direct selection and 0.79 for indirect selection using those conformation traits. It is concluded that considerable genetic variation exists for BW and that hip height, heart girth and conformation traits can be used as indirect measurements of BW.

Keywords: body weight, body measurements, conformation, genetic parameters, dairy heifers.

Introduction

Body weight (BW) in dairy cattle has a negative economic value (Dempfle, 1986; Groen, 1989; Visscher et al., 1994). Inclusion of BW in aggregate genotype or breeding goal is only effective in terms of changing genetic trends when BW measurements on potential breeding animals and/or their relatives are also in the information index (Groen and Korver, 1990). As weighing cows is impractical on a large scale, body measurements and conformation traits might be useful as indirect predictors of BW (e.g. Heinrichs et al., 1992; Veerkamp and Brotherstone, 1997). Moreover, for a genetic evaluation of BW genetic and phenotypic parameters have to be

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known. Ahlborn and Dempfle (1992) analysed subjective scoring of BW and found a heritability of 0.24. Hietanen and Ojala (1995) estimated BW using heart girth measurements and found heritabilities for BW ranging from 0.13 for heifers to 0.24 for third parity cows. At present, knowledge about recording of BW and about genetic and phenotypic parameters of BW is limited.

Therefore, this study estimated genetic and phenotypic parameters for BW and studied possibilities for genetic evaluation of field data of BW using observations on body measurements and conformation traits.

Material and methods

Data. In the period September 1995 through March 1996 BW, heart girth, hip height, and linear conformation traits were collected on 7344 lactating Holstein Friesian heifers at 560 herds in the Netherlands. Number of heifers per herd ranged from 3 to 65. Conformation traits were linearly scored by 8 classifiers of the Royal Dutch Cattle Syndicate, whereas BW and heart girth were measured by 7 persons specifically trained for this experiment. Description, phenotypic mean, and standard deviation of BW, body measurements and conformation traits are in Table 1. Stage of lactation at measurement was on average 129 ± 82 days. Average 305 days production records were 7113 kg milk, 312 kg fat and 247 kg protein. Average age at calving was 795 days.

Statistical analysis. The statistical model included month of recording (7 levels), lactation stage (21), pregnancy stage (6), genetic Holstein Friesian group (4), parity of the dam (2) and classifier (8) or person (7) as class variables, age at calving as a covariate, and herd and animal as random effects. Stage of lactation was defined in the model as 21 biweekly periods: week 1-2, week 3-4, ... , week 39-40, and week ≥ 41. Stage of pregnancy was divided in 6 groups: ≤ 3 months, 4 months, ... , 7 months, and ≥ 8 months. Genetic groups were defined according to percentage of Holstein Friesian genes (≤ 62.5%, 75%, 87.5%, and 100%). Two classes were defined for parity of the dam: 1st parity and higher parities. Variance components (additive genetic variance, herd variance, and error variance) were estimated using DFREML software (Meyer, 1991). In the analyses, an additive genetic relationship matrix including parents and grandparents of the heifer was used to account for genetic relationships. Genetic and phenotypic correlations were estimated in bivariate analyses. Possibilities for predicting breeding values for BW in a field recording scheme were evaluated by comparing selection indexes including direct or indirect measurements of BW. Index calculations were based on a situation where on average 40 daughters of young sires are routinely scored for conformation traits.

Results and discussion

Table 1. - DESCRIPTION, UNADJUSTED MEAN, STANDARD DEVIATION (σ_p), RELATIVE HERD VARIANCE (c^2) AND HERITABILITY (h^2) OF BODY WEIGHT, BODY MEASUREMENTS AND CONFORMATION TRAITS

Trait	Scale	Mean	σ_p	c^2	h^2
Body weight	(kg)	546	56.5	0.33	0.33^
Heart girth	(cm)	192.9	7.34	0.21	0.33
Hip height	(cm)	141.7	3.72	0.12	0.54
Body depth	(1=shallow to 9=deep)	5.23	1.57	0.06	0.43
Rump width	(1=narrow to 9=wide)	4.87	1.50	0.08	0.32
Muscularity	(1=poor to 9=strong)	4.71	1.67	0.08	0.44
Udder depth	(1=deep to 9=shallow)	4.76	1.36	0.09	0.35
Size	(65 to 100)	80.9	4.30	0.12	0.52
Dairy character	(65 to 100)	80.5	3.71	0.08	0.45

^Estimated s.e. of the heritabilities range from 0.04 to 0.07.

In Table 1 estimates for the herd variance and additive genetic variance for BW, body measurements and conformation traits are expressed relative to the total variance as c^2 and h^2 respectively. Estimated heritability of BW was 0.33 and was higher than estimated heritabilities of indirect measurements of BW found by Ahlborn and Dempfle (1992) and Hietanen and Ojala (1995). Heritabilities for body measurements and conformation traits ranged from 0.32 to 0.54. The herd variance was relatively moderate for BW (c^2 = 0.33) and heart girth (c^2 = 0.21) but low for other traits (c^2 = 0.06 to 0.12). The large herd variance for BW might be related to differences in feeding practices in rearing young replacement heifers. As herds were visited at variable moments during a day, differences in weight of gut fill and udder content might also be related to the large herd variation.

Genetic and phenotypic correlations between BW, body measurements and conformation traits are in Table 2. Heart girth had the highest genetic correlation with BW (r=0.77). Genetic correlations of BW with hip height, body depth, rump width, muscularity and size were 0.50, 0.48, 0.43, 0.58, and 0.59, respectively.

Table 2. - GENETIC (BELOW DIAGONAL) AND PHENOTYPIC CORRELATIONS (ABOVE DIAGONAL) BETWEEN BW, BODY MEASUREMENTS AND CONFORMATION TRAITS

	BW	HG	HT	BD	RW	MU	UD	SI	DC
BW[A]		0.74	0.46	0.42	0.19	0.54	-0.15	0.49	0.11
HG	0.77[B]		0.46	0.40	0.20	0.44	-0.09	0.48	0.08
HT	0.50	0.51		0.35	0.28	0.07	0.13	0.95	0.51
BD	0.48	0.44	0.33		0.27	0.25	-0.28	0.47	0.38
RW	0.43	0.35	0.38	0.43		0.04	-0.11	0.31	0.19
MU	0.58	0.31	-0.15	0.08	0.16		-0.08	0.10	-0.25
UD	-0.18	-0.02	0.32	-0.49	-0.26	-0.15		0.07	-0.01
SI	0.59	0.60	0.95	0.49	0.45	-0.10	0.16		0.61
DC	0.15	0.14	0.65	0.56	0.25	-0.47	-0.01	0.70	

[A]BW = body weight, HG = heart girth, HT= hip height, BD = body depth, RW = rump width, MU = muscularity, UD = udder depth, SI = size, DC = dairy character.

[B]Estimated s.e. of the genetic correlations range from 0.01 to 0.11.

When a selection index is based on direct measurements of BW on 40 daughters the accuracy of selection was 0.88 whereas it was 0.75 when observations on hip height, body depth, rump width, and muscularity were used simultaneously. These conformation traits are presently included in the regular scoring system in the Netherlands, whereas heart girth is not included. When heart girth is added the accuracy of selection increased to 0.79. These results indicate that it is feasible to evaluate BW from indirect measurements from linearly scored conformation traits rather than from direct BW with only a limited loss in accuracy. In this study parameters for BW were estimated using data on heifers, whereas in earlier studies on breeding goals mostly mature BW is considered (Groen, 1989). However, high genetic and phenotypic correlations have been found between BW observations at different ages (Persuad et al., 1991; Koenen and Groen, 1996) indicating that BW on heifers is a proper information source for the breeding goal mature weight.

To evaluate the effect of inclusion of BW in the breeding goal, genetic relations with other traits have to be considered as well. Genetic correlations of BW with production traits are generally reported to be positive and low (Ahlborn and Dempfle, 1986; Hietanen and Ojala, 1995). Van Elzakker and Van Arendonk (1993) showed that the relation between BW and production traits in lactating heifers is dependent on the stage of lactation. Veerkamp and Brotherstone (1997) also considered the relation between BW, condition scores and feed intake capacity. They found a genetic correlation of 0.66 between BW and condition scores and a correlation of 0.31

between BW and feed intake. It was suggested that BW per se was not an appropriate measure of size. After adjusting BW for variation in condition scores a higher genetic correlation with production traits was found. Hoffman (1997) suggested the incorporation of measures of skeletal growth when defining body size. Further studies focusing on the relation between BW and other size related traits such as height on the one side and production on the other side are needed to define a breeding goal which is optimal from a economical and biological point of view.

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GENETSKA PROCJENA TJELESNE TEŽINE HOLŠTAJN FRIZIJSKIH JUNICA U LAKTACIJI POMOĆU TJELESNIH MJERA I OSOBINA KONFORMACIJE

Sažetak

Genetski i fenotipski parametri tjelesne težine (BW), tjelesnih mjera i osobina konformacije procijenjeni su pomoću terenskih podataka o 7 344 Holštajn-frizijskih junica u laktaciji. Procjenjena heritabilnost bila je 0.33 za BW i kretala se od 0.32 do 0.54 za opseg prsa, visina križa i osobine

konformacije. Genetske korelacije s BW bile su visoke (0.48 - 0.77) za opseg prsa, mišićavost, visinu križa, širinu sapi i dubinu tijela. Na osnovi 40-ero kćeri točnost selekcije selekcijskog indeksa bila je 0.88 za izravnu selekciju i 0.79 za neizravnu selekciju. Služeći se ovim osobinama konformacije zaključuje se da postoji znatna genetska raznolikost za BW i da se visina križa, opseg prsa i osobine konformacije mogu upotrijebiti kao neizravne mjere BW.

Ključne riječi: težina tijela, tjelesne mjere, konformacija, genetski parametri, mliječne junice

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