Relationship Between Fertility and Intermediate Optimum Type Traits in Polish HF

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Introduction

In recent years a decline in fertility has been observed as a result of selection for production traits (Pryce et al. 2000). Fertility traits are of low heritability and are measured late; some type traits may provide useful information on reproduction earlier. The routine evaluation system of linear type traits in Poland is based on a scale of 1 to 9. The highest and lowest values of the scale are related to biological extremes, whereas the average values correspond to the most frequent forms of the traits. For some traits the form of a trait considered optimal by breeders is related to the value in the middle of the scale. In this paper a modified scale for traits with intermediate optima was applied, in which the more desirable form of the trait is related to a higher score. The purpose of this study was to estimate genetic correlations of linear routine and modified type evaluations with reproduction traits.

Material and methods

Data were type evaluations of 9,236 primiparous cows born in western parts of Poland in 2005 and 2006. All cows calved in 2008 in 828 herds and were evaluated by four type classifiers. The restrictions imposed were these: sires with more than 5 daughters, and groups of contemporaries with at least 3 cows. The final data file consisted of records of 8,041 cows, daughters of 359 sires. Cows were classified in 1,110 herd-year-season-classifier subclasses (HYSC). Six type traits with intermediate optima were evaluated by classifiers using simultaneously routine and modified scales. Intermediate form for body depth, rump angle, and rear legs were treated as optimal. Extremely strong or shallow udders and steep feet are considered by breeders as not desired. In the modified evaluation system, which was also based on a linear scale from 1 to 9, the more desirable form of a trait always received the higher score.. Five dscriptive conformation traits scored on a scale from 50 to 90 were also included in the analysis. Descriptive statistics of routine and modified scores are shown in Table 1.

Four reproduction traits are included in the Polish evaluation system: non-return rates until 56th day for heifers (NRh) and primiparous cows (NRc); interval from calving to first insemination (ICF) and days open (DO) for first parity cows. Non-return rates are binary traits measuring return to service within 56 day of first insemination. ICF is the number of days between date of first calving and date of first insemination after this calving, DO is the number of days between date of first calving and date of last insemination. ICF and DO were not available for each cow. Intervals shorter than 21 days were excluded; the longest accepted intervals were 250 days for ICF and 365 days for DO. Descriptive statistics and numbers of cows with computed fertility measures are presented in Table 1.

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A multi-trait animal model was used and a Bayesian approach with Gibbs sampling was applied to estimate (co)variance components (Misztal 1999). The linear model of observation included fixed effects of HYSC, stage_of_lactation, and regression on age_at_calving for type traits. The linear model for NRh and NRc consisted of fixed effects of herd-year_of_insemination, month_of_insemination, and age_at_insemination. The linear model for ICF and DO comprised fixed effects of herd-year_of_calving, month_of_calving, and age_at_calving. Random additive genetic effects were included in the model for each trait. Animals with unknown parents were assigned to genetic groups (Westell 1984). Genetic parameters and their standard deviations were computed based on 90,000 written samples.

Results and Discussion

Numbers of observations and descriptive statistics for all traits are shown in Table 1. Mean linear routine scores ranged from 5.0 for rump angle to 5.9 for body depth. The largest asymmetry of distribution occurred for body depth (0.44), indicating that more observations were located on the left side of the mean. Modified linear conformation traits showed larger means and standard deviations than routine ones. Means and standard deviations of fertility measures were similar to those reported by Wall et al. (2005); Kadarmideen (2004) and Pryce et al. (2001) obtained lower means for ICF. The distributions of both interval traits were strongly skewed. Coefficients of asymmetry were positive; that is, the tails of the distributions are longer on the right side than on the left.

Estimated heritabilities are presented in Table 1. Among descriptive traits, the largest heritabilities were obtained for size (0.53), and the smallest for feet & legs (0.13). The routine linear traits showed relatively large heritabilities, ranging from 0.16 for foot angle to 0.44 for udder depth. Heritabilities for modified type scores were smaller (from 0.09 for rump angle to 0.31 for udder depth). All heritabilities were higher than previous Polish estimates (Ptak et al. 2009) and those reported by Dal Zotto et al. (2007). Heritabilities of fertility measures were also larger than previous Polish estimates (Jagusiak 2005). Heritabilities of NRh and NRc were 0.06 and 0.12, respectively; estimates for intervals were even higher: 0.15 for ICF and 0.14 for DO.

Among the modified linear type traits, body depth, rump angle and leg traits showed moderate genetic correlations with NRc and ICF (Table 2). The largest and negative correlation was found between NRc and rear leg side view (-0.36). Classifiers prefer cows with intermediate rump and legs. In fact, cows with slope rump and sickled legs are more resistant to infection what have positive impact on fertility. DO showed a high genetic relationship with rump angle (0.36). Genetic correlations between routine linear traits and fertility measures were small for udder traits and rump angle, and moderate for leg traits and body depth (Table 3). Foot angle was correlated with NRc, ICF and DO (-0.34, 0.44 and 0.31, respectively); the correlation between body depth and NRc was 0.41. Genetic correlations were relatively low between fertility measures and descriptive type traits: the largest were found for DO and conformation & dairy character (0.43) and for DO and size (0.30) (Table 4.). All phenotypic correlations were very small and ranged from -0.05 to 0.06. Genetic correlations of DO with routine linear type traits reported in the literature vary in magnitude, but the correlation between body depth and DO was similar to those given by Dal Zotto et al. (2007) and Pryce et al. (2000).

For rump angle the genetic correlations with NRc, ICF and DO were stronger for the modified score than for the routine score. The modified score for rear leg side view showed a higher genetic correlation with NRc and IC than its routine score. For body depth and foot angle the correlations with fertility measures were higher for routine evaluations. Generally, modified body depth, rump angle and leg traits were correlated with fertility, but the forms of these traits more desired by breeders were often associated with lower fertility.

References

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Table 1: Descriptive statistics and heritabilities of conformation and fertility traits

No	Trait	$\bar{x}$	SD	skewness	heritability	
					h^2	SD
Descriptive conformation traits						
1.	Size	81.6	5.5	-0.85	0.53	0.06
2.	Conformation &dairy character	79,1	4.4	-0.64	0.40	0.05
3.	Overall feet & legs	78.9	4.1	-0.81	0.13	0.03
4.	Overall udder	77.3	5.1	-1.83	0.19	0.03
5.	Overall conformation score	78.5	3.9	-0.88	0.28	0.04
Linear routine conformation traits						
6.	Body depth	5.9	1.4	-0.44	0.32	0.04
7.	Rump angle	5.0	1.2	0.14	0.39	0.05
8.	Rear leg side view	5.4	1.2	-0.09	0.23	0.03
9.	Foot angle	5.1	1.4	-0.04	0.16	0.03
10.	Fore udder height	5.5	1.4	-0.27	0.35	0.04
11.	Udder depth	5.4	1.6	-0.23	0.44	0.05
Linear modified conformation traits						
12.	Body depth	7.3	1.7	-0.50	0.12	0.02
13.	Rump angle	7.7	1.6	-0.32	0.09	0.02
14.	Rear leg side view	7.4	1.8	-0.15	0.14	0.03
15.	Foot angle	5.6	1.8	-0.21	0.15	0.02
16.	Fore udder height	6.3	1.9	-0.37	0.30	0.03
17.	Udder depth	6.5	2.0	-0.23	0.31	0.04
Fertility traits						
18.	NRh	0.78	0.42	-	0.06	0.04
19.	NRc	0.63	0.48	-	0.12	0.04
20.	ICF	93,8	40.2	1.19	0.15	0.03
21.	DO	131.8	64.1	0.96	0.14	0.03

Table 2: Genetic (r_g) and phenotypic (r_p) correlations between linear modified conformation and fertility traits

Trait	r_g				r_p			
	NRh	NRc	ICF	DO	NRh	NRc	ICF	DO
Body depth	-0.15	-0.33	-0.12	-0.11	0.02	-0.01	-0.02	-0.01
Rump angle	-0.07	-0.25	0.35	0.36	-0.03	0.00	-0.03	-0.01
Rear leg side view	0.06	-0.36	-0.33	-0.07	0.01	-0.01	-0.04	-0.01
Foot angle	-0.08	-0.20	0.32	0.21	-0.01	0.00	-0.02	-0.01
Fore udder height	0.07	-0.07	-0.02	0.11	0.01	0.04	-0.01	-0.04
Udder depth	0.15	-0.15	0.05	0.18	0.01	0.03	-0.02	-0.04

SD for r_g ranged from 0.09 to 0.21, SD for r_p ranged from 0.01 to 0.02

Table 3: Genetic (r_g) and phenotypic (r_p) correlations between linear routine conformation and fertility traits

Trait	r_g				r_p			
	NRh	NRc	ICF	DO	NRh	NRc	ICF	DO
Body depth	0.08	-0.41	0.26	0.36	0.00	-0.02	-0.01	0.02
Rump angle	-0.08	0.01	0.10	-0.05	-0.02	0.01	0.02	0.02
Rear leg side view	-0.26	0.21	0.14	-0.14	-0.01	0.03	0.04	0.03
Foot angle	-0.22	-0.34	0.44	0.31	-0.01	0.00	-0.03	-0.02
Fore udder height	0.01	-0.02	0.01	0.10	0.01	0.04	-0.01	-0.04
Udder depth	0.06	-0.03	-0.08	-0.03	0.01	0.03	-0.01	-0.04

SD for r_g ranged from 0.11 to 0.36, SD for r_p ranged from 0.01 to 0.02

Table 4: Genetic (r_g) and phenotypic (r_p) correlations between descriptive conformation and fertility traits

Trait	r_g				r_p			
	NRh	NRc	ICF	DO	NRh	NRc	ICF	DO
Size	-0.05	-0.28	0.03	0.30	-0.03	-0.01	0.00	0.03
Conf. & dairy character	0.02	-0.24	0.21	0.43	0.00	-0.01	0.04	0.06
Feet & legs	-0.05	-0.07	-0.24	-0.06	0.00	0.00	-0.05	0.00
Udder	-0.11	0.05	0.07	0.02	0.01	0.01	0.03	0.02
Overall conf. score	-0.08	-0.11	0.04	0.17	0.00	0.01	0.02	0.03

SD for r_g ranged from 0.11 to 0.21, SD for r_p ranged from 0.01 to 0.02

NRh - non-return rate until 56th day for heifers
NRc - non-return rate until 56th day for cows
ICF - interval from calving to first insemination
DO - days open

Acknowledgments

This research was supported by the Ministry of Science and Higher Education, grant No. N311 046 32/2756. The authors are grateful to the Polish Federation of Cattle Breeders and Dairy Farmers for making conformation and fertility data available.