Electronic Journal of Polish Agricultural Universities is the very first Polish scientific journal published exclusively on the Internet, founded on January 1, 1998 by the following agricultural universities and higher schools of agriculture: University of Technology and Agriculture of Bydgoszcz, Agricultural University of Cracow, Agricultural University of Lublin, Agricultural University of Poznan, Higher School of Agriculture and Teacher Training Siedlce, Agricultural University of Szczecin, and Agricultural University of Wroclaw.

ELECTRONIC JOURNAL OF POLISH AGRICULTURAL UNIVERSITIES

2002
Volume 5
Issue 1
Series ANIMAL HUSBANDRY

JAGUSIAK W., ŻARNECKI A. 2002. CHARACTERISTICS OF BULL-DAM HERDS **Electronic Journal of Polish Agricultural Universities**, Animal Husbandry, Volume 5, Issue 1.
Available Online http://www.ejpau.media.pl

CHARACTERISTICS OF BULL-DAM HERDS

Wojciech Jagusiak, Andrzej Żarnecki

Department of Genetics and Animal Breeding, University Agriculture of Kraków, Poland

ABSTRACT

The purpose of this paper was to characterise bull–dam herds by examining herd phenotypic and genetic averages and variances, and their relationships.

To characterise bull–dam herds a total of 97,327 HY containing 35% subclasses with single cows and 22.2% with more than 5 cows were identified. This reflects the structure of the cattle population in Poland, which has a large proportion of small herds. Dams of bulls were found in 1233 HY . The majority of HY (774) contained single bull–dams. Correlations between genetic and phenotypic averages and within–herd genetic and phenotypic standard deviations were significant and positive.

The differences between the weighted average BV of bull–dam HY and subclasses without bull–dams were 171.3 kg of milk, 6.18 kg of fat and 4.58 kg of protein. Correlations between bull–dam yield and herd yield averages ranged from 0.73 for milk to 0.77 for protein, and with standard deviations ranged respectively from 0.41 to 0.48.

Key words: dairy cattle, bull–dam, breeding value

INTRODUCTION

Selection of superior cows as bull–dams is an important part of breeding programmes. Path dams of bulls usually contribute about 30% of the total genetic gain. In Poland between 1990 and 1997 the selection index procedure was used to evaluate cow breeding values. In 1998 the BLUP animal model was implemented; it allowed simultaneous evaluation of sires and cows.

It has been shown that cows from herds with higher variance tend to be overevaluated [1, 7, 10]. This might lead to biased predictions of breeding values (BV), including those of bull–dams. The purpose of this paper was to characterise bull–dam herds by examining herd phenotypic and genetic averages and variances, and their relationships.

MATERIALS AND METHODS

Data consisted of 627,183 Polish Black–and–White cows with first lactation records, 379,839 cows with first two lactation records, and 223,592 cows with first three lactation records. The cows were daughters of 12,513 sires, and calved for the first time between April 1991 and September 1999. The records were made in 23,076 herds (97,327 herd–year subclasses). Herd–year subclasses (HY) containing less than 5 cows were deleted. A search of the sire pedigrees identified 2509 potential bull–dams; 641 of them were dams of evaluated bulls and 419 were dams of AI bulls. Milk, fat and protein yields in the first three lactations were analysed.

BLUP multitrait animal model evaluation of BV was carried out for each production trait separately, according to a linear model including fixed effect of herd–year–season, linear and quadratic regressions on age at calving, fixed effect of genetic groups, random animal additive genetic effect, and random error. Animals with unknown parents were assigned to genetic groups according to the rules described by Westell *et al*. [9]. (Co)variance components used in the mixed model were taken from Jagusiak and Żarnecki [3].

Means and standard deviations (SD) for first lactation yields were calculated for each HY. The same parameters within HY were obtained for BV of sires and cows, estimated from three lactations. Breeding values based on first lactations were not available, but Jagusiak and Żarnecki [3] have already shown that the correlation between single and multitrait breeding value evaluations was close to unity. Product–moment correlations among the means and SD of HY with bull–dams and HY without bull–dams were computed. Finally, the correlations of the yields and BV of bull–dams with the means and SD of their respective HY subclasses were computed, and the means of bull–dams and their contemporaries were compared.

Scheffe's multiple–comparison procedure was used to test yield and BV differences between HY without bull–dams and HY with bull–dams, and the two–sample paired t–test was applied to compare means of bull–dams and their contemporaries [6].

RESULTS AND DISCUSSION

The characteristics of the data structure are given in Table 1. A total of 97,327 HY contained 35% subclasses with single cows and only 22.2% with more than 5 cows. This reflects the structure of cattle breeding in Poland, which is characterised by small herd size and results in a large proportion of cows without or with few contemporaries. Lack of contemporaries reduces the reliability of breeding value estimates.

Potential dams of bulls were found in 1233 HY (Table 2). The majority of HY (774) contained single bull–dams. Most of these subclasses (495) consisted of 1 to 5 cows. Two bull–dams were nominated from each of 215 HY. Three or more bull–dams were selected from a small proportion of HY.

Table 1. Number of herd–year subclasses (HY) by number of cows

No. of cows/HY	No. of HY		No. of HY with bull–dams		No. of HY with dams of evaluated bulls		No. of dams of AI sires	
	n	%	n	%	n	%	n	%
1	34031	35.0	111	9.0	45	12.5	19	7.6
2	20542	21.1	125	10.1	39	10.8	27	10.8
3	11162	11.5	119	9.7	29	8.0	20	8.0
4	6369	6.5	70	5.7	17	4.7	10	4.0
5	3573	3.7	60	4.9	8	2.2	7	2.8
6–10	7167	7.4	112	9.1	34	9.4	25	10.0
11–20	6374	6.5	167	13.5	62	17.2	43	17.2
>20	8109	8.3	469	38.0	127	35.2	99	39.6
Total	97327	100.0	1233	100.0	361	100.0	250	100.0

Table 2. Number of herd–year subclasses (HY) with potential bull–dams by number of cows and number of bull–dams (HY with dams of evaluated bulls in brackets)

No. of bull–dams/HY	Number of cows by HY					Total
	1–5	6–10	11–15	16–20	>20	
1	417 (127)	65 (18)	46 (17)	43 (16)	203 (70)	774 (248)
2	60 (11)	32 (13)	13 (11)	14 (4)	96 (28)	215 (67)
3	7 (0)	8 (2)	10 (1)	11 (5)	49 (10)	85 (18)
4	1 (0)	5 (1)	6 (3)	7 (1)	37 (4)	56 (9)
5	0	2 (0)	3 (0)	5 (0)	27 (3)	37 (3)
6–10	0	0	5 (3)	4 (1)	37 (8)	46 (12)
11–15	0	0	0	0 (0)	12 (3)	12 (3)
16–20	0	0	0	0	6 (0)	6 (0)
>20	0	0	0	0	2 (1)	2 (1)
Total	485 (138)	112 (34)	83 (35)	84 (27)	469 (127)	1233 (361)

The averages of first lactation yield traits were significantly higher in HY with bull–dams than in herds without bull–dams (Table 3). Also the average yields differed markedly between bull–dam herds classified according to bull–dam category, except protein yield. A similar pattern was shown by average BV. Again the average BV's based on the first three lactations were lowest in herds without bull–dams. The highest and positive were the BV in herds with cows nominated as bull–dams. In herds with dams of tested bulls the BV dropped significantly; all averages were low and negative. The average BV of herds with dams of bulls used in AI were slightly but significantly higher than those of herds with dams of tested bulls, but remained negative (Table 3). Selection of bull–dams in the period covered by this research was based on the selection index. The multitrait animal model currently applied in genetic evaluation allows characterisation of genetic level of herds and dams in retrospect; therefore the differences in BV presented in Table 3 reflect the effectiveness of index selection and its application in practice.

The differences between the weighted average BV of bull–dam HY and subclasses without bull–dams were 171.3 kg of milk, 6.18 kg of fat and 4.58 kg of protein. Bull–dam herds also displayed higher variation in both yield traits and BV. (Table 3). Mao *et. al*. [4] reported average BV of bull–dam herds in American northeastern and Michigan cattle populations significantly higher than in other herds.

Table 3. Means and standard deviations of yields and breeding values in herd–year subclasses (HY) with bull–dams and without bull–dams

Trait	Herd–year subclasses							
	with potential bull–dams		with dams of evaluated bulls		with dams of AI sires		without bull–dams	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
No. of cows	29,182		8,091		6,165		598,001	
Milk yield	5640.0^{A}	1317.0	5549.9^{B}	1264.2	5660.9^{C}	1291.1	4164.6^{D}	1173.8
Fat yield	230.4^{A}	57.0	227.9^{B}	54.0	233.2^{C}	54.7	169.4^{D}	51.6
Protein yield	180.3^{A}	43.9	175.8^{B}	40.6	179.5^{A}	41.6	131.6^{C}	39.4
Milk BV	26.3^{A}	347.0	-75.8^{B}	302.1	-60.1^{C}	307.2	-145.3^{D}	270.0
Fat BV	0.2^{A}	14.2	-3.8^{B}	12.5	-3.2^{C}	12.9	-6.0^{D}	11.0
Protein BV	0.4^{A}	9.7	-2.8^{B}	8.1	-2.3^{C}	8.3	-4.2^{D}	7.5

Means with the same letter do not differ significantly.

Correlations among the means and standard deviations of yield traits and BV in HY with potential bull–dams are shown in Table 4. The average herd yields were highly correlated with average BV (0.63–0.65), and herd yield standard deviations with BV standard deviations (0.63–0.68). The lowest correlations were found between herd yield averages and BV standard deviations (from 0.16 in fat to 0.19 in protein). The relationships between averages and variation indicate the possible existence of heterogeneous variance. Mao et al. [5] found small and negative correlations between genetic averages and within–herd genetic variation, and moderate correlations between herd yield average and intraherd yield variation. Possible heterogeneous within–herd variance could affect the evaluation of bull–dams and response to selection. It has been well documented that greater herd variability can cause overevaluation of genetic values, and that a higher proportion of individuals is selected from more variable herds [2, 8] The possible bias in evaluation of breeding values caused by heterogeneity requires further research.

Table 4. Correlations between means and standard deviations (SD) of cow yields and breeding values in herd–year subclasses (HY) with potential bull–dams (808 HY subclasses with at least 5 cows/subclass)

Correlation between		Milk	Fat	Protein
Average herd yield	SD of herd yield	0.2445	0.3172	0.2779
	average herd BV	0.6515	0.6348	0.6356
	SD of herd BV	0.1570	0.1940	0.1770
SD of herd yield	average herd BV	0.1983	0.2274	0.2216
	SD of herd BV	0.6811	0.6299	0.6510
Average herd BV	SD of herd BV	0.2481	0.2686	0.2968

All correlations are highly significant (p<0.01).

The differences between phenotypic and genetic weighted average yields of potential bull–dams, dams of evaluated bulls, and dams of AI bulls and their contemporaries were significant (Table 5). All phenotypic differences were larger than the respective genetic differences. The largest differences in yield traits were found for dams of AI bulls. However, the realised selection intensity, estimated on the basis of animal model BV evaluation, was slightly higher in the group of dams of AI bulls.

Table 5. Weighted average differences between yields and breeding values of bull–dams and their contemporaries within herd–year subclass (HY)

Trait	Potential bull–dams	Dams of evaluated bulls	Dams of AI bulls
N	1233	361	250
Milk yield	699.52	697.16	761.04
Fat yield	35.72	36.63	40.60
Protein yield	22.93	22.76	25.00
Milk BV	197.77	161.58	167.02
Fat BV	10.05	8.32	9.15
Protein BV	5.53	4.43	4.76

All differences are highly significant (p<0.01).

CONCLUSIONS

The means and standard deviations of breeding values of herd–year subclasses containing nominated bull–dams were larger than the respective parameters of the breeding values of subclasses without bull–dams. The differences between average breeding values were smaller when herd–year subclasses with AI dams were compared with herd–year subclasses without bull–dams. The weighted average differences between breeding values of bull–dams and their contemporaries were generally small, showing low intensity of selection on the dam–son path.

The positive phenotypic correlations between herd averages and within–herd standard deviations indicate the possible existence of heterogeneous variance. The same pattern was shown by the average herd breeding values and intraherd breeding value standard deviations.

REFERENCES

1. Dong M. C., Mao I. L., 1990. Heterogeneity of (co) variance and heritability in different levels of intraherd milk production variance and of herd average. J. Dairy Sci., 73, 843–851.
2. Hill C. R., Edwards M. R. , Ahmed M. K. A., Thomas R., 1983. Heritability of milk yield and composition at different levels of variability of production. Anim. Prod., 36, 59.
3. Jagusiak W., Żarnecki A., 2000. The selection index and single– and multi–trait animal model evaluation of Polish Black–and–White cows. J. Appl. Genet., 41 (3), 171–179.
4. Mao I. L., Dong M. C., Meadows C. E., 1991. Selection of bulls for progeny testing using pedigree indices and characteristics of potential bull–dams' herds. J. Dairy Sci., 74, 2747–2756.
5. Mao I. L., Wilhelm A. E., Dong M. C., Meadows C. E., 1991. Comparison of bull–dam herds, progeny testing herds, and other dairy herd improvement herds. J. Dairy Sci., 74, 1413–1419.
6. SAS Institute Inc., Cary, NC, USA. 2001. Proprietary Software Release 8.2.
7. Smothers C. D., Pearson R. E., Vinson W. E., 1991. Relationships among phenotypic standard deviations and herd level for type and their effect on selection response in United States Holstein. J. Dairy Sci., 74, 637–644.
8. Vinson W. E., 1987. Potential bias in genetic evaluations from differences in variation within herds. J. Dary Sci., 70, 2450–2455.
9. Westell, R. A., Quaas R. L., Van Vleck L. D., 1988. Genetic groups in an animal model. J. Dairy Sci., 71, 1310–1320.
10. Wilhelm A. E. , Mao I. L., 1989. Relationships between characteristics of herd of bull–dams and predicting transmitting ability of young bulls. J. Dairy Sci., 72, 2395–2401.

Wojciech Jagusiak, Andrzej Żarnecki
Department of Genetics and Animal Breeding,
University Agriculture of Kraków
A. Mickiewicza 24/28, 30–059 Kraków, Poland
e-mail: rzjagusi@cyf–kr.edu.pl
