Journal of Animal and Veterinary Advances 7 (11): 1422-1425, 2008
ISSN: 1680-5593

Estimation of Genetic Parameters and Breeding Values for Test-Day and 305-Days Milk Yields in Some Iranian Holstein Herd

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Abstract: Test day milk yield records of 68956 first-parity Holstein cows were used to estimate genetic parameters for milk yield. Comparison of breeding value of two evaluation method include test day and classical model (305 days) indicated that the EBVs for TD milk yields are closely correlated with EBVs for 305 days milk yields. Genetic correlations between individual test days and 305 days were high. Results suggested that test day milk yields, mainly in mid-lactation, can be used of 305 days milk yield in genetic evaluation. the heritability estimate of milk yield under the TD model is lower than the corresponding estimate for 305-days milk yield.

Key words: Genetic evaluation, test day model, random regression, variance components

INTRODUCTION

Dairy cattle have traditionally been evaluated on the basis of 305-days lactation yield. Yield for completed 305 days lactation is composed of 7-10 TD yields, such that the factors affecting TD yields are averaged together. Averaging would be appropriate if the factors were the same for each TD and represented random environmental variation, but, as a rule, the factors change for each TD (Wiggans and Goddard, 1997; Jamrozik and Schaeffer, 1997). The use of TD yields mainly depends on the relative amount of genetic variation during lactation. The heritability estimates for TD yields for mid lactation have been either the same or slightly lower than those for 305-days yields, although estimates were lower for the beginning and end of lactation (Swalve, 2000; Schaeffer *et al*., 2000; Jensen, 2000).

Recently, 305-days milk yield was replaced by test-day milk yield with the latter approach showing several advantages. It permits the removal of environmental variation in phenotypic data on milk yield, since test-day milk yield considers the specific environmental effects for each production record, which is not possible when 305 days data are used (Visscher and Goddard, 1995), it grants a more accurate evaluation of cows due to using a larger number of records per cow, as compared to the same records fitted to 305 days (Rekaya *et al*., 2001), it permits a more accurate estimation of the genetic and permanent environmental effects that affect milk yield. Traditional models is used data from test-day records combined into 305-days mature equivalent lactation records. The test-day model would use test-day records collected at various times during the lactation. To avoid extending lactations to 305-days, individual test day milk yields can be used in genetic evaluation of dairy sires and cows. Models that include test day milk yields in statistical analysis provide an alternative to selection on 305 days milk yield (Swalve, 1995). Several models have been used for estimation of variance components for test-day yields. With test day models it is attempted to account for systematic, environmental and genetic effects directly there, where they are expressed, at the day of recording (Van Der Werf *et al*., 1998; Degroot *et al*., 2007).

These factors on each test-day are averaged in the lactation yield. But these factors for a cow are not the same for each test-day and it would be difficult to model for 305-days yields. Now-a-days, test-day model is therefore used instead of 305-days model for the genetic evaluation of dairy cattle (Strabel *et al*., 2005).

Swalve (1995) reported that a comparison of both sets of breeding values indicated only minor changes in sire rank, but more drastic reranking for individual cows. Correlations between Estimated Breeding Values (EBVs) for TD and 305-days yields ranged from 0.87-0.97 in the (Jamrozik *et al*., 1997) study (1) and from 0.88-0.96 in that by Swalve (1995).

The present study aims to estimate genetic parameters and breeding values for TD and 305-days milk yields and to compare the results from TD and 305-days analyses.

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MATERIALS AND METHODS

Data were obtained from first lactation Holstein cows calving between 2001 and 2004. This data collected by Iran breeding genetic center. Data were restricted to first lactation, TD records between 5 and 305-days, age at first calving between 18 and 36 months, milk yields from 1.5-80 kg. The mean number of TD records per cow was 8. Four calving seasons were distinguished: winter (December to February), spring (March to May), summer (June to August) and autumn (September to November).

Test day milk yields recorded at approximately monthly intervals throughout lactation (TD1-TD10) and milk yields up to 305-days were the traits under analysis. test day yield was defined as the sum of all weighings of milk in a 24 h period.

The models used were as follows:

- For 305-days lactation records.
- For 305-days lactation milk yield, following individual animal model was used:

$$Y_{ijk} = PS_i + b_1X_{1ijk} + b_2X_{2ijk} + a_j + e_{ijk}$$

Y_{ijk} = For 305-days milk yield record.
PS_i = Fixed effect of period and season of calving (12 combinations).
X_1 = Age at calving (as a covariable).
X_2 = (Age at calving) 2 (as a covariable).
a_j = Animal's random additive genetic effect.
e_{ijk} = Random residual efFor TD records.

$$Y_{ijk} = HYS_i + b_1x_{1ijk} + b_2x_{2ijk} + b_3x_{3ijk} + b_4x_{4ijk} + b_5x_{5ijk} + a_j + p_{ej} + e_{ijk}$$

where:
Y_{ijk} = Milk yield record from a single TD.
HYS_i = Fixed effect of herd-year-season of calving.
X_1 = Age of calving, as a covariable.
X_2 = DIM/c, as a covariable, where c is a constant set to 305 (1).
X_3 = (DIM/c)2, as a covariable.
X_4 = ln(c/DIM), as a covariable.
X_5 = (ln(c/DIM)2, as a covariable.
a_j = Animal random additive genetic effect.
p_{ej} = Effect of random permanent environment of the cow during lactation.
e_{ijk} = Random residual effect.

Variance components (additive genetic, residual and permanent environmental variances) heritability and breeding values for 305-days and TD milk yields were estimated by the REML method using animal models with a DFREML 3.0 program.

RESULTS AND DISCUSSION

Phenotypic means and standard errors of 305-days milk yield and test-day milk yield for the first lactation Holstein cows are given in Table 1.

Estimates of variance components, heritability and the relative portion of permanent environment variance to total variance (PE) for TD and 305-days milk yields are presented in Table 2. The heritability estimates for 305-days and TD milk yields were 0.089 and 0.061, respectively. The heritability estimate of milk yield under the TD model is lower than the corresponding estimate for 305-days milk yield. This result is in agreement with the result reported by Swalve (1995). The lower estimate in this study could be explained by the small number of observations and the model used for TD milk yield analysis.

Table 1: Mean and standard deviations of milk yield, number of test-day records

Test day	Mean	S.D.	No. of records
1	21.52	4.82	8256
2	23.68	5.21	8564
3	23.75	5.42	8725
4	23.38	5.54	8124
5	22.75	5.74	7612
6	22.15	5.81	7415
7	20.64	5.74	6765
8	19.68	5.76	6075
9	18.59	5.68	5202
10	17.95	5.87	2218
Overall test-day milk yield	21.41	5.55	68956
305-days milk yield	4366	14.00	8256

Table 2: Estimates of variance components, heritability estimates and permanent environment effects for 305-days and test-day models

Trait	σ2A	σ2E	σ2PE	h2 (±SE)
Pooled test-day	0.52	4.14	4.29	0.061±0.523
305-days	42072.3	467650.1	-----	0.089±0.412

SE = Standard error of heritability estimate

Table 3: Estimates genetic (r_g) and phenotypic (r_p) correlations of test day milk yields and 305-days milk yield

Trait	r_g	r_p
TD1	0.58	0.56
TD2	0.61	0.51
TD3	0.78	0.58
TD4	0.72	0.72
TD5	0.72	0.76
TD6	0.76	0.76
TD7	0.83	0.71
TD8	0.79	0.69
TD9	0.43	0.54
TD10	0.41	0.29

Table 4: Correlations between estimated breeding values for 305-days milk yield and test-day milk yields

Trait	r	r_s
All cows	0.941	0.938
Sires with		
≥5 daughters	0.932	0.937
≥10 daughters	0.946	0.951
≥15 daughters	0.947	0.949
≥20 daughters	0.951	0.965

r = pearson correlation, r_s = Spearman rank correlation

The additive genetic variance increased with increasing length of lactation. Highest additive variance was observed in the mid lactation. Additive variance decreased towards the end of lactation. Heritability estimates of individual test day records were highest in the during mid-lactation and was lowest during early lactation. These findings concur with the previous studies (Jamrozik *et al*., 2002).

This study has shown that genetic correlations between test day milk yields and 305-days milk yield are high and positive, indicating that test day milk yields could be utilized in place of 305 days in genetic evaluations of dairy animals. Genetic correlations between test day milk yields and 305-days milk yield varied from 0.41-0.83. Higher values were also found in mild-lactation (Table 3). However, other reports (Rekaya *et al*., 2001) found the highest genetic correlation between the first test and 305-days (0.89), but in the second half of the lactation genetic correlations between test day milk yields and 305-days tended to decrease.

Estimates for genetic correlations were higher than those found for phenotypic correlations, which followed the same trend in the literature, where smaller values were found in first and last test days and the largest were in mid-lactation.

In this study, EBVs for TD milk yields are closely correlated with EBVs for 305-days milk yields. This result is similar with the results reported by Hammami *et al*. (2008) and Jamrozik and Schaeffer (1997). The correlations between EBVs for 305-days and TD milk yields for cows and sires were very high all correlations were >0.92. Within sires, the correlations increased as number of daughters per sire increased because of the improved accuracy. This suggests that TD milk yields could be used instead of 305-days milk yield for the genetic evaluation of dairy cattle.

The pearson product-moment, Spearman rank correlations between EBVs for 305-days and TD milk yields for cows and sires with different numbers of daughters are given in Table 4.

CONCLUSION

This study has shown that heritability estimate of milk yield under the TD model was lower than the corresponding estimate for 305 days milk yield. The highest estimastes of heritability in mid-lactation indicating that test day yields could be used as the selection criteria, leading to a reduction in generation interval. Also genetic correlation between test day milk yields and 305-days milk yield are high and positive.

In addition, test day milk yields could be utilized instead 305-days milk yield in genetic evaluations of dairy animals.

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