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A Comparison of Different Selection Indices for Genetic Improvement for Milk Traits in Holstein Friesian Cattle in Turkey by Using One Standard Deviation as Relative Economic Weight

Hulya Atil
Department of Animal Science, Faculty of Agriculture, Ege University, Turkey

Abstract: A total of 2133 normal lactation records of Holstein Friesian cows raised at five herds in Turkey, during the period from 1982 to 1998 were used in this study to estimate phenotypic and genetic parameters for 305 day milk yield (305 dMY), Lactation Period (LP) and Age at First Calving (AFC). In addition, four selection indices were constructed by using one standard deviation as a relative economic weight. Least squares analysis showed significant effects of herds, sire within herds, year and moth of calving on all traits studied ($p<0.01$), except the effect of year and month of calving on LP. Heritability estimates were 0.47, 0.18 and 0.53 for 305 dMY, LP and AFC, respectively. Genetic and phenotypic correlations among 305 dMY and LP were positive and highly significant, while, other correlations were small. Four selection indices were constructed, index I1 incorporating 305 dMY, LP and AFC was the best (R_{IH} = 0.77) and it is recommended if the selection was exercised at the end of the first lactation. In addition, using one standard deviation as relative economic values is easy in estimation and small differences between this method and actual economic values.

Key words: Selection index, relative economic weight, genetic improvement, holstein

INTRODUCTION

Genetic improvement in several traits can be most effectively accomplished if the information about those traits is combined into an index of net merit or total score. Hazel and Lush (1942) showed that the selection index was the most efficient method for selection in farm animal. Many different forms of selection indices have been suggested. The traits involved vary according to their relative economic values. Falconer and Mackay (1996) suggested a one standard deviation for a trait as economic weight. Hussein (2004) in a study based on 2181 normal lactation records of Friesian cattle in Egypt, using two methods for estimating economic values., (1) actual relative economic values and (2) one standard deviation. The both methods of relative economic values are succeeded in constructed different selection indices, while one standard deviation is easy in calculated (Hussein, 2004).

The purpose of this study was to construct a set of selection indices to be used for the improvement of milk production in Holstein Friesian cattle in Turkey by using one standard deviation as a relative economic weight.

MATERIALS AND METHODS

Data: The data used in the present study were collected from the history sheets of Holstein Friesian cows maintained at five herds of Turkey (i.e., Tahirova, Dalaman, Turkgeldi, Sarmisakli and Menemen). The data comprised 2133 normal first lactation records spread over the period from 1982 to 1998. Abnormal records of cows affected by diseases (such as mastitis and udder troubles) or reproductive disorders were excluded. All cows were fed on silage, concentrates and Alfalfa all the year. Milk yield was recorded to the nearest 0.2 kg, for each cow. Cows producing more than 15 kg a day and those in the last two months of pregnancy were supplemented with extra concentrates rations. Cows were artificially inseminated by using frozen semen. Assignment of sires to cows was at random. Number of sires and daughters per sire were 159 and 12.74, respectively. Heifers were served for the first time when they reached 24 months or 350 kg. Traits studied in the present study were 305 day milk yield (305 dMY), lactation period (LP) and age at first calving (AFC).

Analysis: Data were analysis by using mixed model least squares and maximum likelihood computer program of Harvey (1990). The model included the fixed effects of herds, season of calving (Winter, Spring, Summer and Autumn), year of calving (1982,…,1998) as a fixed effects and age at first calving as a covariate, sire within herd and residual as a random effects. Estimates of sires and reminder components variance and covariance were computed according to Method II of Henderson (1953).

Table 1: The Relative Economic Weight (REW) for different traits studied by using one standard deviation

Traits	σ^2_p	σ_p	REW according to 305 dMY
305 dMY(kg)	667935	817	1
LP (day)	2053	45.1	18.03
AFC (mo)	13.74	3.71	- 220.22

Estimates of heritability (h^2) was calculated as four times the ration of σ_s^2 (sire variance components) to the sum of σ_s^2 and σ_e^2 (reminder variance components). Standard error of heritability was calculated using an approximate formula described by Swiger *et al.* (1964). Genetic and phenotypic correlations were computed by program of Harvey (1990).

The estimates of phenotypic and genetic variance and covariance for 305 dMY, LP and AFC were used for the construction of several indices.

Relative Economic Weight (REW): Falconer and Mackay (1996) discussed in detail the using one standard deviation as an economic weight. The economic weights were assigned to one standard deviation of change of each character. The weights (a_i) assigned were therefore the reciprocals of the phenotypic standard deviations. Then the economic weight = (σ_p/σ_p^2) where σ_p is the phenotypic standard deviation and σ_p^2 = the phenotypic variance for each trait. Therefore, the relative economic weight for 305 dMY, LP and AFC are given in Table 1.

The principle of selection by means of an index developed by Hazel (1943) was followed in deriving the different indices used in this study. Some modifications of this method were suggested by Henderson (1963). The basic index including the three traits was calculated using the matrix technique as described by Cunningham (1972). In addition, to the complete index, three reduced indices were computed using all combinations of traits. These indices were compared via the correlation with the aggregate genotype (R_{IH}). The expected genetic change in any one of the traits included in the aggregate genotype was calculated according to Tabler and Touchberry (1955).

RESULTS AND DISCUSSION

Means: Unadjusted means, Standard Deviations (SD) and coefficient of variability (CV%) for different traits studied are presented in Table 2. Mean of 305 day milk yield was lower than those estimated on another herds of Holstein Friesian in Turkey i.e., Atay *et al.* (1995) (5490 kg) and Bakir and Sogut (1999) (6964 kg). In addition, Makuza and McDaniel (1996) working on two herds of Holstein Friesian cows in Zimbabwe and North Carolina, found that 305 dMY for the first lactation was 4791 and 8221 kg, respectively. El-Awady *et al.* (2002) on 20500 normal first lactation records of Holstein Friesian cows in Germany found that the average 305 dMY was 6096 kg. Mean of Lactation Period (LP) was 299 day (Table 2). The present mean was lower than those reported by Atay *et al.* (1995) (339 day) and Khattab and Sultan (1991) (338 day) working on Friesian in Turkey and Egypt, respectively. The overall mean of age at first calving was 28 mo (Table 2). The present mean was lower than those reported by Khattab and Sultan (1991) (31.20 m). The large CV% for 305 dMY (27.59) reflects a large of variation among individuals in such important productive trait.

Table 2: Unadjusted means, Standard Deviations (SD) and Coefficient of Variability (CV%) for 305 day milk yield, lactation period and age at first calving

Traits	Means	SD	CV (%)
305 dMy (kg)	4030	1112	27.59
LP day	299	50	16.72
AFC (mo)	28	4.11	14.68

Table 3: F-values for factors affecting 305 day milk yield (305 dMY), Lactation Period (LP) and Age at First Calving (AFC)

Source of variation	df	F-values 305 dMY	LP	AFC
Herds	4	122.34**	53.87**	10.99**
Sire: Herds	154	2.67**	1.58**	2.90**
Month of calving	3	7.34**	0.956	7.71**
Year of calving	16	4.23**	0.641	5.16**
Reminder, MS	1955	667936	2053	13.74

**p<0.01

The differences in the present means of milk traits studied and those reported in other studies for Holstein Friesian cows raised in Turkey, could be possibly due to one or more of the following reasons: (1) The herds were raised under different climatic and managerial conditions, (2) Some animals were imported and some were locally produced, (3) Different herds could possibly be genetic and phenotypic different from others and (4) Different methods and models of analysis were used.

Non genetic effects: Least squares analysis of variances for factors affecting present traits studied are presented in Table 3. Herds, sire within herds, season of calving and year of calving had a significant effects on all traits studied ($p < 0.01$, Table 3), except the effect of season and year of calving on LP. Similar results are reported by Khattab and Sultan (1991), Atay *et al.* (1995), Bakir and Sogut (1999), Atil and Khattab (2000), El-Awady *et al.* (2002) and El-Arian *et al.* (2003) working on Friesian cows in different countries. The significant effects of these factors may be attributed to differences in types and amount of feed available and to variation in environmental conditions. The present results indicate the importance of considering the effect of herd, year and month of calving in the model used for describing productive traits for unbiased genetic parameters.

Sire variance components: Results obtained in the present study (Table 3) show that the sire within herds had a highly significant effect on 305 dMY, LP and AFC. This is similar to results of Basu *et al.* (1982), Khattab and Sultan (1991) working on Tharparkar and Friesian cows, respectively.

Heritability estimates: Estimates of heritability for 305 dMY was 0.47 (Table 4), which is higher that those 0.262 and 0.27, found by Atay *et al.* (1995) and Atil and Khattab (2000) working on Holstein Friesian in Turkey and Egypt, respectively. The higher estimates of heritability for 305 dMY in the present Holstein Friesian data indicate relatively larger contribution of additive genetic variance.

The heritability estimate of LP was 0.18 (Table 4), which was lower than that 0.338 found by Atay *et al.* (1995) from other Turkey Holstein Friesians. Low estimates of heritability for LP indicate that this trait was affected mainly by environmental factors, improvement of feeding, management system.

Heritability estimates for AFC was 0.53 (Table 4). The present estimates was higher than those reported by Basu *et al.* (1982) (0.35), Khattab and Sultan (1991) (0.39) and Khattab *et al.* (2003) (0.25). Abubaker *et al.* (1986) opined that the larger sire variance in AFC is due to confounding of sire with management. Naturally, reduction in AFC could be achieved by improved management practices, nutrition (El-Khidir *et al.*, 1979).

The moderate heritability estimates for 305 dMY and high estimates for AFC suggested that efforts could be made to bring about improvement in those two important economic traits through sire selection as well as better managerial practices.

Correlations: Estimates of genetic correlations (r_g) and phenotypic correlations (r_p) between different traits are presented in Table 4. The genetic correlation between 305 dMY and AFC was negative (-0.09) and not significant different from zero. Also, the phenotypic correlation between the two traits was very low (0.09). Abubaker (1986) and Khattab and Sultan (1991) arrived at similar results in Friesian cows.

The genetic and phenotypic correlations between 305 dMY and LP were moderate and being 0.38 (Table 4). These estimates are within the magnitude of those obtained by Basu *et al.* (1982), Abubaker *et al.* (1986), Khattab and Sultan (1991), Atay *et al.* (1995), Atil and Khattab (2000) and Khattab *et al.* (2003) on different breeds of dairy cattle. These correlations suggest that selection for higher yielding cows in their first lactation would cause a correlated increase in their first lactation period. The genetic correlation between AFC and LP was positive (0.06) and insignificant (Table 4), while, the phenotypic correlation between LP and AFC was negative (-0.001) and insignificant. The results were quite expected and lead to suggest that selection for higher productivity would be correlated with longer LP younger AFC. A reduction of AFC is desirable goal of dairymen and will help in minimizing the cost of raising breeding heifers, shorting the generation interval and maximizing the number of lactations per cow.

Table 4: Estimates of heritability (on diagonal), genetic correlations (below diagonal) and phenotypic correlations (above diagonal) for 305 Day Milk Yield (305 dMY), Lactation Period (LP) and Age at First Calving (AFC)

Traits	305 dMY	LP	AFC
305 dMY	0.47 (0.08)	0.38	0.09
LP	0.38 (0.15)	0.18 (0.05)	-0.001
AFC	-0.09 (0.13)	0.06 (0.17)	0.53 (0.08)

Table 5: Selection indices (I's) for different traits of Holstein Friesian cows, Expected Genetic gain (EG) in each trait, correlation of index with aggregate genotype (R_{IH}), by using one standard deviation.

	Variable							
	305 dMY, kg		LP, d		AFC, mo			R_{IH} (Atil *et al.*, 2005)
	b	EG	b	EG	b	EG	R_{IH}	
I_1	0.677	346	0.06	3.37	-135.59	-1.62	0.77	0.75
I_2	0.552	402	1.30	5.78			0.63	0.43
I_3	0.572	321			-137.29	-1.75	0.72	0.73
I_4			2.89	10.29	-112.71	0.62	0.66	0.55

Selection indices: Four selection indices were constructed (Table 5) by using relative economic weight as a one standard deviation, which were described in detail by Falconer and Mackay (1996). The original index (I1), included all the three variables (i.e., 305 dMY, LP and AFC) to be used for improving the aggregate genotype of the three traits, while, the reduced indices (I2, I3 and I4) included only two variables to select aggregate genotype.

The expected genetic gain per generation in each variate (305 dMY, LP and AFC) assuming a selection intensity 1 given in Table 5. The expected genetic change per generation (EG) ranged from 321 and 402 kg for 305 dMY and 3.37 to 10.29 d for LP and 0.62 to -1.62 mo, for AFC. The present results are lower than those reported by Atil *et al.* (2005) using another set of that herd and used actual economic values for and ranged from 363 to 411 kg for 305 dMY, 16.78 to 29.92 d for LP and from -0.35 to -0.65 mo for AFC. Also, in this respect Khattab and Sultan (1991) working on Friesian cow in Egypt, using actual economic values found that the expected genetic gain per generation ranged from 88 to 235 kg for 305 dMY, from 21 to 27 d for LP and from -0.26 to -1.96 for AFC.

The index not including AFC (I2) showed a reduced accuracy (0.63). Including AFC with 305 dMY (I3) closest in accuracy to II (Table 5). Similar results were obtained by Khattab and Sultan (1991) and Atil *et al.* (2005). Basu *et al.* (1982) concluded that including AFC and milk yield in an index increase the accuracy of selection.

Compare of selection indices indicates that index II, which incorporated 305 dMY, LP and AFC was the best (R_{IH}= 0.77, Table 5). The expected genetic gain in 305 dMY increased by 346 kg/generation, LP increased by 3.37 d/generation and AFC decreased by -1.62 mo/generation. Hence, it would be desirable to reduce AFC in an index incorporating 305 dMY and LP. Also, it is recommended for Holstein Friesian selection at the end of the first lactation. This index is very simple and very easy to construct. Similar results were obtained by Khattab and Sultan (1991) and Atil *et al.* (2005) working on Friesian cows in Egypt and Turkey, respectively.

Atil *et al.* (2005) working on the same herd and calculated the actual economic values, using the same four indices and found the same trends of the accuracy of the indices (Table 5). Then the two different methods of economic values (actual and one standard deviation) are succeeded in constructed different selection indices, but the one standard deviation is easier in calculation.

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