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Genetic parameters of milk and fat yield in normal and high yielding dairy cows

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***Abstract*— In order to estimate the genetic parameters of productive traits (milk yield and milk fat) and the genetic correlation among them in two groups of normal and high yielding Holstein dairy cows of Iran, 67830 and 32787 records of first lactation were used respectively. A bivariate animal model using DF-REML algorithm was applied to estimate the heritability of traits and also the genetic and phenotypic correlations among them. Also a comparison between these two groups was made for productive traits using T-test procedure. Results show that heritability for both traits are lower for high yielding cows. Also the genetic and phenotypic correlations between two productive traits are lower for high producing animals. This shows the importance of environmental factors on high producing animals. Also the lower diversity in uniform high yielding cows for production traits must be considered in constructing the selection indices for improving such traits. The higher phenotypic correlation in comparison to genetic one also indicates the importance of environment and management, especially in higher levels of production.**

Keywords-dairy cattle; high yielding; production trait; genetic parameter.

I. INTRODUCTION

The increasing population of developing countries is demanding for higher levels of milk production as a good source of essential nutrients. Milk yield and its contents like milk fat and protein are the most important traits in selection of high producing cows in dairy industry.

Improvement of production traits in dairy cattle has being performed by selecting superior parents for next generation. Dairy characteristics are composed of some productive, reproductive and type traits. Selection for production traits like milk yield and fat yield requires construction of a selection index which puts these two traits together based on their breeding values and correlations [7]. One of the most important parameters in determination of breeding values for such traits is heritability which shows the relative proportion of additive genetic variance to phenotypic variance. Heritability of each trait is specific to that time and population and must be estimated each time [5].

Several factors affect the production of cows. Of these factors, age of animal, days in milk after calving, level of nutrition, environmental factors like climate and management have more importance [9]. Most of modern farmers prefer to select and focus on high producing cows rather than animals with average levels of production. High yielding dairy cows require intensive cares; have more reproduction problems and their breeding programs need different genetic parameters to be estimated [2]. Of these genetic parameters used in constructing selection indices, heritability and genetic correlations are more important. Many researchers have studied these genetic parameters in recent years. Hansen et al. reported heritability of milk yield to be 0.16, 0.11 and 0.10 for first, second and third calvings respectively using Maximum Likelihood (ML) and Restricted Maximum Likelihood (REML) algorithms [6]. Using the same methods of analysis, studies report the heritability of milk and fat yield in first lactation to be moderate, ranging from 0.2 to 0.3 and the genetic correlation between these two traits varies from 0.6 to 0.8 in most of studies [1], [2], [3], [5] and [7].

In this study our aim is to compare the heritability and genetic and phenotypic correlations of two important traits of milk yield and fat yield in two groups of high and normal producing Holstein dairy cows.

II. MATERIAL AND METHODS

Total records of 67830 normal and 32787 high yielding lactating Holstein dairy cows of Iran were used for this study. Two production traits of 305 days, mature equivalent milk yield and milk fat of first lactation were studied. These records were collected during years 2000 to 2010. To determine high producing dairy cows, descriptive statistics of milk yield was calculated and cows producing one standard deviation higher than mean were chosen for this group. The significance of differences for each trait in two groups of high and normal producing cows was tested, using Student T-test.

Data were edited by Microsoft FoxPro 6. Microsoft SAS was applied for fitting all possible factors affecting the observations into a statistical model. Genetic parameters were estimated using Derivative Free REML (DF-REML) algorithm. Based on a bivariate animal model analysis, genetic correlation between milk yield and milk fat and also the heritability for each trait were estimated. The model used is as in (1).

$$y_{ijklm} = \mu + HYS_i + DIM_j + b(Age_k - \overline{Age}) + A_l + e_{ijklm} \quad (1)$$

Where Y_{ijklm}= Observation of any productive trait, μ= Population mean of each trait, HYS_i= Fixed effect of i^{th} herd-year-season class, DIM_j= Effect of j^{th} days in milk class, b= Regression coefficient of any observation on age of first calving, Age_k= Fixed effect of k^{th} age of first calving, A_l= Random effect of l^{th} animal and e_{ijklm}= Random residual effect of any observation.

III. RESULTS

Descriptive statistics of first lactation production is shown in table 1. Results show that there exist significant differences between high yielding and normal cows for mean of each trait (α=%5).

Heritability for each trait with its standard error is given in table 2 for both groups of cows. The heritability in normal producing cows is higher than high yielding cows for both productive traits. Genetic and phenotypic correlations between two traits are shown in tables 3 and 4 for each group of animals. Results indicate that both genetic and phenotypic correlations are higher for cows with normal levels of production comparing with those of high producing cows.

IV. DISCUSSION

Low heritability of milk yield in high yielding cows in comparison to average cows is considerable. The heritability of milk yield in normal animals (0.325) was the same as other studies. Pryce et al. reported the heritability of first lactation to be 0.47 [5] .Kadarmideen et al. reported this heritability equal to 0.32 for all animals [3]. The lower estimate of heritability of milk yield in high producing cows (0.165) may be due to selection of only a limited number of producing individuals from a larger population of normal dairy cows, which causes loss of variation in such a sub-population.

TABLE 1. DESCRIPTIVE STATISTICS OF MILK AND FAT YIELD FOR EACH PRODUCTION LEVEL

Production Level	Trait	Heritability	Standard Error
High Yielding	Milk yield	0.165	0.018
	Fat Yield	0.142	0.021
Normal	Milk yield	0.325	0.015
	Fat Yield	0.27	0.010

Production Level	Trait	Mean (kg)	Standard Deviation (kg)
High Yielding	Milk yield	10580.32	1154.30
	Fat Yield	268.45	46.10
Normal	Milk yield	8754.56	601
	Fat Yield	263	32.03

TABLE 2. HERITABILITY OF TRAITS FOR EACH PRODUCTION LEVEL

Another reason for this reduction in heritability may be related to lower genetic diversity in uniform high producing animals due to selection which leads to lower response to selection for milk yield.

The heritability of fat yield in normal population of dairy cows was 0.27 which was similar to results of Costa et al. who reported it to be 0.25 and 0.22 for Holsteins of Brazil and U.S.A respectively [2]. Kadarmideen et al. found higher amount for this coefficient, equal to 0.4 [3]. The reason for having lower heritability of fat yield in high producing animals (0.142) may be same as those mentioned for milk yield. Low variation in milk fat in high producing animals shows the homogeneity of those individuals for this trait having high selection intensity and pressure on it in comparison to that of normal animals. Low heritability of a specific trait means that the trait is mainly under the control of environmental factors like nutrition and management.

Genetic and phenotypic correlation between milk yield and fat yield was lower in high yielding animals compared to those of normal animals. Albuquerque et al. found the genetic and phenotypic correlations between milk yield and fat yield to be 0.63 and 0.75 respectively using a multi trait REML in normal cattle [8]. The low genetic correlation (0.12) in high producing cows may be caused by a decrease in content of fat in milk when production increases, which may be seen in higher levels of production. The phenotypic correlation in this group is higher than the genetic correlation which resembles the effect of environmental factors, i.e. common environmental factors mainly cause the correlation among traits. The difference between genetic and phenotypic correlation in normal producing animals is lesser, indicating the effect of environment on high producing dairy cattle. Even in normal animals phenotypic correlation was higher than genetic correlation which was similar to results of Chauhan and Hayes showing the important role of environmental factors on such traits [10].

TABLE 3. . GENETIC (UPPER DIAGONAL) AND PHENOTYPIC (LOWER DIAGONAL) CORRELATION IN NORMAL DAIRY COWS

Traits	Milk Yield	Fat Yield
Milk Yield	-	0.53
Fat Yield	0.66	-

TABLE 4. GENETIC (UPPER DIAGONAL) AND PHENOTYPIC (LOWER DIAGONAL) CORRELATION IN HIGH YIELDING DAIRY COWS

Traits	Milk Yield	Fat Yield
Milk Yield	-	0.12
Fat Yield	0.41	-

V. CONCLUSION

In animal breeding, improving animals for high levels of milk and fat production leads to decrease of their heritability

which shows the effect of environmental factors on such traits. Selection for more than one trait simultaneously requires construction of a selection index.

This index consists of breeding values of all traits which may be estimated according to heritability of each trait, regarding their genetic and phenotypic correlations. Heritability and genetic correlation is different in high producing dairy cows and must be considered separately. These animals have less diversity and are more influenced by environment rather than normal animals.

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REFERENCES

[1] C. M. B. Dematawewa and P.J. Berger, "Genetic and phenotypic for 305-days yield, fertility and survival in Holstein, " 1998, J. Dairy Sci. 81:2700-2709.

[2] C. N. Costa, R. W. Blake, E. J. Pollak, P. A. Oltenacu, R. L. Quaas, and S. R. Searl, "Genetic analysis of Holstein cattle populations in Brazil and the United States, " J. Dairy Sci, 2000, 83:2963-2974.

[3] H. N. Kardarmideen, N. R. Thompson and G. Simm, "Linear and threshold model genetic parameters for disease, fertility and milk productionin dairy cattle, " 2000, J. Anim. Sci. 71:411-419.

[4] I. M. Anderson-Ranberg, G. Klemetsdal, B. Heringstad and T. Steine, "Heritabilities, genetic correlations and genetic change for female fertility and protein yield in Norwgian dairy cattle, " 2005, J. Dairy Sci. 88:348-355.

[5] J. E. Pryce and G. Simm, "The relationship between bpdy condition score and reproductive performance, " J. Dairy Sci. 2001, 84:1508-1515

[6] L. B. Hansen, A. E. Freeman and P. J. Berger, " Variances repeatabilities and age adjustment of yield and fertility in dairy cattle, " 1983, J. Dairy Sci. 66:281-292.

[7] L. B. Hansen, "Consequences of selection for milk yield from a geneticist viewpoint, " 2000, J. Dariy Sci. 83:1145-1150.

[8] L. G. Albuquerque, G. Dimov and J. F. Keown, "Estimaes of (co) variances using an animal model for yields of milk, fat and protein for firs lactation of Holstein cows in California and Newyork, " 1995, J. Dairy Sci. 78:1591-1596.

[9] M. C. Lucy, "Reproductive loss in high producing dairy cattle: where will it end?, " 2001, J. Dairy Sci. 84:1277-1293.

[10] V. P. S. Chauhan and J.F. Hayes, "Genetic parameters for first lactation milk production and composition for Holstein using multivariate restricted maximum likelihood, " J. Dairy Sci. 1991, 74:603-610.