International Journal of

Dairy Science

ISSN 1811-9743

Academic
Journals Inc.

www.academicjournals.com

International Journal of Dairy Science 6 (2): 142-149, 2011
ISSN 1811-9743 / DOI: 10.3923/ijds.2011.142.149

Genetic Parameters and Trends of Milk and Fat Yield in Holstein's Dairy Cattle of West Provinces of Iran

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ABSTRACT

Investigation of genetic parameters and trend of milk and fat yield traits is main goal of this study. This study used 2213 records of first lactation Holstein's dairy cattle of west provinces of Iran for estimate of genetic and phonotype trend. These data get from Animal Breeding Center from 1996-2006 then analyzed. Annual Genetic and phonotype trend for milk and fat yield traits was 19.61, 0.171, 71.99 and 1.401, respectively. Estimation of the variance-covariance traits and hereditability of the traits of milk production and the milk fat content were made using the single trait animal model and the DFREML software. Heritability of milk and fat yield was 21.02±0.06 and 0.086±0.005, respectively. The components of variance additive genetic, phonotypic and error were 505272.69, 2403771.14 and 1806194.70 for milk yield and 185.84, 2256.74 and 2160.98 for fat yield, respectively.

Key words: Genetic trend, genetic parameters, dairy cattle, Holstein's, hereditability, REML method, DFREML software

INTRODUCTION

There has been a concerted effort to increase milk production in Iran for the past 30 years. This effort has been a combination of government policies, importation and widespread use of Holstein semen and extensive use of high percent Holstein sires generated in different province of Iran. In this study, we decision to investigate of this breeding program. In this study genetic trend for milk and fat yield estimated 19.61 and 0.171, respectively. Genetic trends in the Holstein and other breeds dairy cattle population in Central Thailand from 1991 to 2005 were small for MY and near zero for FY and FP (Koonawootrittriron *et al*., 2009). Roman *et al*. (1999) reported genetic trend for milk yield in jersey breed during 1967-1979 years, 57 kg. Freeman and Lindberg (1993) estimated genetics trend for milk yield 135 kg.

Main problem in animal breeding research is determining genetic gain that resulted from performing animal breeding programs during several years. In a population, which selection has carried out and mating between animal designed based on genetic characteristics, deal of changes that obtained in several years from animal breeding programs must investigated, thus genetic trend of selected traits in population estimated. Estimation of genetic trend may be providing investigation of animal breeding methods (Wilson and Willham, 1986; Kovac and Groeneveld, 1990).

The change in production per unit of time due to change in mean breeding value is called the genetic trend (Harville and Hendeason, 1966). For the estimation of efficient selection, the best parameter is genetic trend (Falconer and Mackay, 1996). Genetic changes in a population should be checked in the case of selection on more traits at the same time because that is the most powerful analysis to evaluate the selection work in a population. Dairy cattle have a long generation interval end low reproductive rate. In addition, it is costly and time-consuming to carry out dairy cattle selection on a large experimental scale. Methods to determine variance component have been greatly improved over the lat three decades (Mashhadi *et al.*, 2008).

The estimation of genetic trend is the best tool to follow genetic changes in a population (Potocnik1 *et al.*, 2007).

Several researchers (Burnside and Legates, 1967; Lee *et al.*, 1985; Meinert and Pearson, 1992; Powell *et al.*, 1977; VanVleck *et al.*, 1986) have studied genetic trends in dairy cattle. Most of these researchers estimated genetic trends over periods of less than 20 year. The precision of genetic trend estimates is enhanced greatly as the number of years studied increases (Burnside and Legates, 1967).

Deb *et al.* (1974) investigated first lactation records of jersey cattle; they found that the phenotypic increase in milk yield was 36 kg per year and annual increase mature equivalent mean milk yield was 0.9%. The phenotype trend for fat yield was 1 kg per year with no genetic change. Percentage of fat declined 0.02% per year. Annual genetic trends were for Holsteins: 33 kg milk, -0.034% fat and -0.7 kg fat; for Jerseys, 22 kg, 0.008% and 1.3 kg; for Guernsey, 92 kg, -0.048% and 2.8 kg. Environmental trends for milk yield were positive for Holsteins (57 kg) but negative for Jerseys and Guernsey (10 and 23 kg) (Verde *et al.*, 1972).

Palmer *et al.* (1972) estimated genetic trends for milk and fat yields and fat percentage in an Experiment Station Jersey Herd. They found that genetic and phonotype trends were 37.5±6.4 kg, 1.45±0.31 kg and -016±0.004%, 23.4±4.6, 1.16±0.19 and 0.001±0.002 for milk and fat yields and fat percentage, respectively.

The objective of this study was to estimate Genetic Parameters of Milk and fat yield for milk and fat yields. These parameters were needed to plan out future breeding programs as well as to predict breeding values. However, development and realization of animal breeding plans require knowledge of genetic parameters of the traits considered. In this study means of yields of milk and fat were 5939.27 and 199.58 kg, respectively. Heritability of milk and fat yield in current study were 21.02±0.06 and 0.086±0.005, respectively. Ojango and Pollot (2001) estimated heritability for milk yield 0.25.

MATERIALS AND METHODS

In this study, 2213 records of milk production and fat content of the first milking of Holstein cattle in west Iranian provinces (Ilam, Kurdistan, Kermanshah and Hammedan) being collected by the Iranian Animal Breeding Center from 1996 to 2006 were used. In this study, the records of 305 days and twice milking per day were used. Animals with the age from birth beyond the range of 22-36 months and those lacking a record were discarded from the study.

The statistical model

Single trait model: The estimation of the variance-covariance traits and hereditability of the traits of milk production and the milk fat content were made using the single trait animal model and the DFREML software. The statistical model being used was the same for both traits, as follows:

$$y_{ijklm} = \mu + HYS_i + b\,(Age)_j + C_k + M_l + a_j + e_{ijklm}$$

Where:

y_{ijklm}	=	Trait value
μ	=	Mean of trait in population
b	=	Liner dependence coefficient for first calving
Age	=	The effect of age in first lactation
HYS_i	=	The effects of herd-year- season of calving
C_k	=	The random effect due to sire k
M_J	=	The effect of calving season in first caling
a_j	=	Random additive genetic effect of animal j
e_{ijklm}	=	The residual effect

Estimate of genetic trend: To estimate genetic trend, after calculating breeding values of any trait, calculated average of breeding values of animals for that trait on that year. Obtain one number per year that is average of breeding value of animals on that year. With help of Excel 2003, software design graphs that show genetic trend. Analyze regression model of SAS software (SAS Institute Inc., 2001) were used to determine of signification of genetic trend. Genetic gain for any trait estimated based on average the breeding values of animals so that difference between averages of breeding values of population for one trait at the end of period and its value in beginning of period, indicates genetic gain (Hanford *et al*., 2003).

Estimation of R2: (divergence of independent variant on dependent variant): We calculate breeding value linear regression equation for milk and fat yield. This equation was:

$$y = bx+a$$

Where:

b	=	Genetic trend
x	=	Linear regression equation (line slop)
a	=	Genetic gain (difference between averages of breeding values of population for one trait at the end of period and its value in beginning of period)

RESULTS AND DISCUSSION

Components of variance and genetic parameters estimated and summarized in Table 1, hereditability of milk and fat yield were 21.02±0.06 and 0.086±0.005, respectively. Van Vleck and Suzuki (1994) estimated the hereditability of the trait of milk production and milk fat content for the first period of lactation in Japanese Holstein cattle as 0.3 for both traits. Roman *et al.* (2000) estimated the hereditability of the trait of milk production and milk fat content in Jersey cattle as 0.26 and 0.31, respectively. Gacula *et al.* (1968), Wilcox *et al.* (1972), Benya *et al.* (1976), Sharma *et al.* (1983) and Moya *et al.* (1985) estimated the hereditability of the trait of milk production in Jersey cattle as 0.38, 0.25, 0.26, 0.26 and 0.31, respectively. They also estimated the hereditability of the trait of milk fat content, which were 0.31, 0.2, 0.41, 0.27 and 0.48, respectively.

There are numerous problems involved in separation of environmental and genetic trends in populations subjected to selection. One of the most troublesome arises from the fact that

Table 1: The components of variance and hereditability of milk yield and milk fat yield.

Trait	σ^2_a	σ^2_e	σ^2_p	H^2
Milk yield	505272.69	1806194.70	2403771.14	21.020±0.06
Fat content	185.84	2160.98	2256.74	0.086±0.005

Table 2: The genetic and phonotypic trend and R^2 value

Trait	Genetic trend	R^2	Phonotypic trend	R^2
Milk yield	19.61	0.869	71.99	0.660
Fat content	0.171	0.655	1.401	0.479

environmental changes in factors affecting milk yield from year to year are confounded with genetic change from year to year in such a way as to make their exact separation difficult. A number of approaches are possible, one of which is least squares (Palmer *et al*., 1972).

Ilatsia *et al*. (2007) show that for milk production and fertility traits, phenotypic trends were close to environmental trends and suggesting that decline in performance was a result of the environment. Peixoto *et al*. (2006) carried out an investigation for genetic trend of milk and fat yield in Brazilian Guzerat herds between 1997 until 2004 years. In this study, they found that annual genetic trend in estimated breeding values of cows for P305 was 7.09±0.71 kg between 1987 and 2004 and 6.47±2.35 kg between 1997 and 2004. For cows born and raised in the Multiple Ovulation and Embryo Transfer (MOET) nucleus, this trend was 36.46±24.54 kg year^{-1} 183.14±47.94 kg year^{-1} between 1997 and 2000 and 9.13±19.19 kg year^{-1} between 2001 and 2004.

Genetic trend for milk and fat yield presented in Fig. 1 and 2 and Table 2, the estimated value for direct genetic trend for these traits was significant at $p<0.01$ and were estimated 19.61 and 0.171, respectively. A little decrease in average breeding value for milk yield trait at 1996 to 1997 and 2005 to 2006 maybe due to environmental effects or use of sires with low average breeding value. Considerable breeding value decline for this trait at 2002 to 2003 maybe due to severe effect of environment condition, year (improper climate conditions) or lack of correct selection.

Intense fluctuation in average breeding value for fat yield in comparison with milk yield at 1996 to 1997 maybe due to selection measure was not determined or extra selection intense based on milk yield and also improper environmental and nutrition condition, hygienic level, interaction between genetic and environment and herd management were effect too.

Legates and Myers (1988) using control population estimated genetic trend for milk and fat yield 120.6 and 4.2 kg per year respectively. Roman *et al*. (1999) estimated genetic trend of 305 days milk yield for first lactation 39.9 kg. Ezra and Weller (2004) studied on Holstein cattle and reported genetic trend for milk and fat yield 53.7 and 2 kg, respectively. Result from this study show that genetic gain for animal's production traits were more for milk yield in comparison with fat yield. Difference between estimated genetic trend values for these traits in comparison with other studies in general is due to difference in animal breeding standard and follow that different program selection, difference between models and calculation method and also effects of environmental and breed factors (Shrestha *et al*., 1996; Shaat *et al*., 2004; Jurado *et al*., 1994).

Honarvar *et al*. (2010) investigated effect of length of productive life on genetic trend of milk production and profitability (A simulation study); found that Herd genetic merit for milk increased by simulation years because cows and heifers were bred to sires with milk genetic trend of 150 kg per year. Increasing mean LPL (Length of Productive Life) of herd from 35 to 65 months

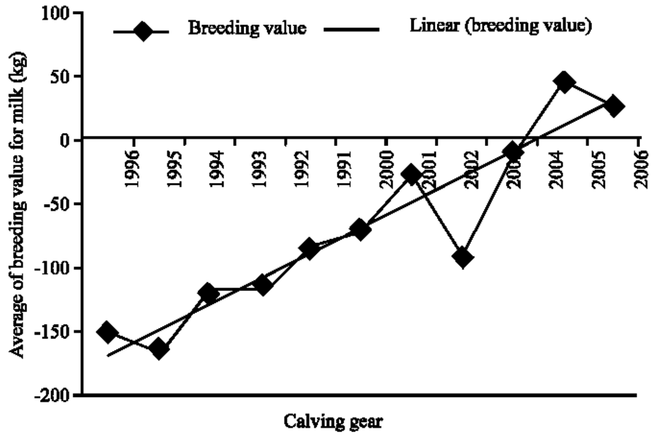

Fig. 1: Genetic trend for milk yield that measured based calving year

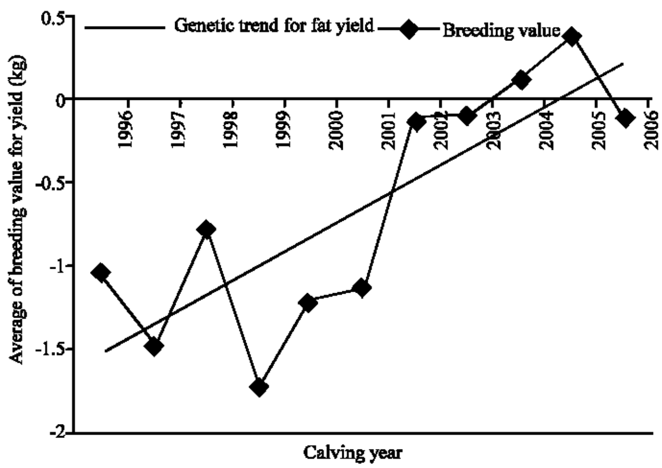

Fig. 2: Genetic trend for fat yield that measured based calving year

over 20 years resulted in decreased herd genetic merit of milk from 2025 to 1751 kg that was due to prolonged generation interval over years.

In general, X coefficient (line slope) is linear regression equation (Y = bx+a) that show average of breeding value on year of birth and these graph indicates annual genetic trend for these traits. R^2 value is result of divergence of independent variant on dependent variant. R^2 indeed is explanatory that show dependent variants (birth year) explanation several percent of variance of independent variants (average of annual breeding value). Table 2 show that fat yield has severe fluctuations in comparison with milk yield that cause decline of R^2 value and this decline in R^2 value explains decrease genetic trend for these traits. These annual fluctuations for these traits, maybe due to sudden changes in climate condition, management changes, nutrition and hygienic levels or interaction between genetic and environment. Thus, to perform breeding programs, prior to any action optimal environment condition must provide for appearance herd's genetic potential (Lasslo *et al.*, 1985; Shaat *et al.*, 2004).

Moreover, increase in purebred cattle population policy in Iran and competition between managers and breeder for improvement of cattle farm, cause decline in selection intense in cattle. On other words, there is not optional elimination between cattle, major of productive heifers come to production phase without selection. thus it has negative effects on genetic gain but in the light of proper genetic gain in end of period (time of study in this investigation), presumably high intense selection between sire, apply and distribution of sperm with high breeding value in Iranian Holstein cattle population are effective positive agents on genetic gain.

CONCLUSION

Selection was effective for improving genetic merit for milk and fat yield. The estimated value for direct genetic trend for these traits was significant at $p<0.01$ and were estimated 19.61 and 0.171, respectively. annual fluctuations for these traits, maybe due to sudden changes in climate condition, management changes, nutrition and hygienic levels or interaction between genetic and environment. Fat yield has more fluctuations than milk yield. Moreover, increase in purebred cattle population policy in Iran and competition between managers and breeder for improvement of cattle farm, cause decline in selection intense in cattle.

ACKNOWLEDGMENT

The authors wish to thank Mr. Mostafa Lotfi for technical assistance and Department of Animal Science of Ramin University and School of Veterinary Medicine of Ilam University.

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