Journal of Animal and Veterinary Advances 7 (4): 512-515, 2008
ISSN: 1680-5593

Genetic Relationships among Longevity, Milk Production and Linear Type Traits in Iranian Holstein Cattle

[1]Z. Daliri, [1]S.H. Hafezian, [2]A. Shad Parvar and [1]G. Rahimi
[1]Department of Animal Sciences, Faculty of Animal and Aquatic Sciences, University of Mazandaran, Iran
[2]Department of Animal Sciences, University of Gilan, Iran

Abstract: The aim of this study was to explore the impact of production and type traits on the functional herd life of Iranian Holstein cows using multiple regression models. The data set consisted of 896,834 registered cows from 2005 herds calving from 1971-2003. The obtained records from these cows used to estimate the correlation coefficients between THL and FHL traits using milk production and 19 linear type traits. The data set related to registered Holstein cows were provided by NABC of Iran. Parameters were estimated using univariable animal model with the restricted maximum Likelihood method. Heritability and Breeding Value were estimated using univariable analysis for milk, fat and protein yield during 305 days. Heritability for these traits was calculated 0.25, 0.23 and 0.19, respectively. The Heritability values for THL and FHL ranged from 0.04-0.03, respectively. Among type traits, teat length had the lowest (0.007) and rear teat placement had the highest heritability (0.50) values. Phenotypic correlation between FHL and stature, body depth, rump width and udder characteristics was negative, which indicates the cows with smaller body, shorter stature have longer productive life. The phenotypic correlation between FHL and feet angularity, mammary ligaments, teat length and production traits (milk and fat yield) were positive. Feet and legs along with mammary system also had a strong relationship with functional longevity. Among the linear type traits, udder traits such as teat height and rear udder width were the most important, with a strong relationship with functional herd life of cows. The type traits of stature, size and rear udder height showed the lowest relationship with functional longevity. The obtained results at the present study shoed that the improvement of production along with type traits either through genetics or management would have a positive influence on the functional longevity of cows.

Key words: Functional herd life, true herd life, type traits, production traits, Holstein cattle, milk production

INTRODUCTION

In dairy production, herd life (longevity) is a highly desirable trait that considerably affects overall profitability. With increased longevity, the mean production of the herd increases because a greater proportion of the culling decisions are based on production and the proportion of mature cows, which produce more milk than young cows, is increased (VanRaden and Wiggans, 1995). However, genetic improvement of Herd Life (HL) is very hard to achieve because of its low heritability. Moreover, one must wait for the animal or its relatives to leave the herd before obtaining a direct measurement (Sewalem *et al*., 2004). According to the definition of Boldman *et al.* (1992), herd life has been divided into true (THL) and Functional Herd Life (FHL). True herd life defined as the number of days from first calving to death or culling. Correcting the length of true herd life of a cow for phenotypic milk production is used as an approximation for functional herd life (Ducrocq *et al*., 1988). Type traits have been used as indirect selection criteria for herd life (Weigel *et al*., 1998; Cruickshank *et al*., 2002). Type traits are recorded relatively early in life, most often in the first lactation and are more highly heritable than longevity (Kadarmideen and Wegmann, 2003), which makes selection on them relatively more efficient. To obtain reliable information for sires regarding the longevity of their daughters directly, it is necessary to wait until a minimum number of daughters are culled or die. Normally, these evaluations are available too late to be useful in breeding programs. Hence, genetic evaluations for direct longevity information based on number of culled cows should be combined with indirect information based on early predictors such as type traits. Knowledge of genetic relationships between type and longevity are required

Corresponding Author: G. Rahimi, Department of Animal Sciences, Faculty of Animal and Aquatic Sciences, University of Mazandaran, Iran

and therefore, a proper identification of type traits to be used as early predictors is essential (Sewalem *et al*., 2005). Economically, having long herd life due to decreasing costs related to alternative heifer and relative increase of mature cows in a herd which have more milk yield (production) is beneficial. Increasing herd life also will cause decreasing non-arbitrary exclusion (exclusion due to reproductive or health problems) and increasing the opportunity of exclusion (caused by yield or production decrease) and as a consequence, will result in increasing selection intensity (Boettcher *et al*., 1997; 1999). Entering herd life into selection index directly, has a limitation such as: being low of heritability of herd life traits, measurability only in cows, non-repeatability and having only one record for each cow. Due to the mentioned reasons, genetic improvement of herd life using direct evaluation is difficult (Short and Lawlor, 1992; Harris *et al*., 1993). Indirect evaluation of herd life is done using the correlated traits, such as type traits which are recordable in first period of lactation and productive traits which have genetic correlation with herd life (Cruickshank *et al*., 2002). The objective of the present study was to calculate the heritability of true and functional herd life, type traits and to evaluate the impact of linear descriptive type traits on functional longevity in the Iranian Holstein breed.

MATERIALS AND METHODS

The data set related to 896,834 Holstein cows were provided by NABC (National Animal Breeding Center) from 2005 herds. The data file consisted records on reproductive, productive and type traits. All animals were herd book-registered and born between 1971 and 2003. Information consisted of animal identification, test-day milk and fat production, reproductive records and management records obtained during the monthly visit of the technician. Length of herd life was defined as time (days) from one calving to the next calving, death, or culling. A herd life record was considered to be completed if the cow received a termination code, indicating that the cow was removed for any reason. Primary data file included of 686,601 records which after editing it was changed to 611,988 records. Records associated with missing sire identification, incorrect calving dates and age at first calving outside an 18-40 month range were excluded from the analysis. Type information consisted of phenotypic type scores of 19 linear descriptive traits evaluated on a 1-9 point scale. A general linear model was used for estimating the fixed environmental and genetic effects for all type, production and herd life traits. The following linear animal model was used for the analysis of all traits:

$$Y_{ijk} = \mu + HYS_i + Age_k + A_j + e_{ijk}$$

Where,

Y_{ijk} = Production or type traits records.
HYS_i = Fixed effect of ith herd-by-year-by-season.
Age_k = Fixed effect of age related to kth animal.
A_j = Additive genetic effect related to jth animal.
e_{ijk} = Residual random error term. Heritability was estimated by REML using DFREML algorithm (Meyer, 1991).

Breeding values for different traits were calculated using the unitrait analysis. Regression coefficients between heritability values of different traits were estimated by multiple regression models using SAS program (SAS, 1998). FHL was calculated based on THL corrected by milk production traits using the method of Harris *et al.* (1993).

RESULTS AND DISCUSSION

The estimated heritability values for phenotypic means and standard deviations of milk production, herd life and type traits are given in Table 1. Heritability for traits related to body stature, body size and body depth were in the range of 0.20-0.38. The range of estimated heritability was 0.21-0.26 for udder traits, 0.08-0.13 for leg and feet and 0.23-0.49 for rump traits. For milk production traits, estimates of heritability were 0.25 for milk and 0.23 for fat and 0.19 for protein yield. Druet *et al*. (2003) found the heritability for milk yield ranged from 0.16-0.39 using a random regression test day model from field data. Strabel and Misztal (1999) found a slightly lower heritability for milk yield, in the range of 0.13-0.17 and

Table 1: Estimating heritability coefficients for different production, Herd Life and type traits in Holstein cattle

Trait	Heritability	S.D.
Feet angularity	0.13	0.013
Body depth	0.20	0.012
Chest width	0.25	0.013
Leg angle	0.08	0.011
Fore-teat attachment	0.29	0.012
Fore-teat placement	0.44	0.012
Rear-teat placement	0.50	0.010
Loin	0.29	0.012
Rump angle	0.41	0.015
Rump width	0.49	0.011
Rump length	0.23	0.013
Rear-legs placement	0.18	0.013
Rear-udder height	0.26	0.014
Rear-udder width	0.20	0.013
Teat length	0.007	0.003
Body size	0.24	0.012
Mammary ligament	0.43	0.011
Size and stature	0.38	0.012
Udder depth	0.21	0.011
Milk production	0.25	0.011
Fat production	0.23	0.012
Protein production	0.19	0.020
True herd life	0.04	0.007
Functional herd life	0.03	0.006

Table 2: Multiple linear regression coefficients of FHL breeding values based on heritability values of type and production traits at first lactation in Holstein cattle

Variable	Regression coefficient	Standard error	Partial explanation coefficient
Width from matrix	7.670	0.7670	-
Milk	0.036	0.0030	0.0800
Fat	0.671	0.1180	0.0050
Feet angularity	14.52	6.5237	0.0009
Body depth	-33.01	4.3373	0.0100
Stature	-1.712	-1.7121	0.0008
mammary ligament	5.851	1.0943	0.0085
Teat length	24.71	9.3463	0.0015
Rear-udder width	-9.271	1.7657	0.0033
Rear-udder height	-3.527	1.2032	0.0020
Body size	2.983	0.5280	0.0022
Rump width	-4.090	1.1961	0.0027

explained that this was because of the low production levels. Karacaören *et al*. (2006) found a heritability of 0.18-0.30, using daily random regression models. Visscher and Goddard (1995) concluded that heritability of productive traits in Jersey cows is more than Holstein. Among type traits, teat length had the lowest (0.007) and rear teat placement had the highest heritability (0.50) values.

In our study the heritability estimates for THL and FHL ranged from 0.04-0.03, respectively. However, genetic improvement of herd life is very hard to achieve because of its low heritability. In previous studies heritability estimates range from 0.03-0.05 (Van Doormaal *et al*., 1985; Jairath *et al*., 1998) using a linear model and estimates from survival analysis using Weibull proportional hazards models range from 0.10-0.20 (Roxstrom *et al*., 2003). Prediction of breeding values and multiple regression coefficients for FHL was calculated by REML method using univariable animal model. The calculated parameters are presented in Table 2. The Phenotypic correlation between THL and FHL was estimated as 0.42. Phenotypic correlation between FHL and stature, body depth, rump width and udder characteristics was negative (Table 2), which indicates the cows with smaller body, shorter stature have longer productive life. The phenotypic correlation between FHL and feet angularity, mammary ligaments, teat length and production traits (milk and fat yield) were positive (Table 2).

CONCLUSION

At the present study, genetic relationship was used to investigate the effect of production and linear type traits on the FHL in Iranian Holstein cows. Based on the results presented herein, the production parameters had the greatest contribution to the risk of culling. Feet and legs along with mammary system also had a strong relationship with functional longevity. Among the linear type traits, udder traits such as teat height and rear udder width were the most important, with a strong relationship with functional herd life of cows. The type traits of stature, size and rear udder height showed the lowest relationship with functional longevity. As a conclusion, with the obtained results at the present study, it can be stated the improvement of production along with type traits either through genetics or management would have a positive influence on the functional longevity of cows. Therefore, by choosing the right type traits, the functional herd life of cows can be effectively predicted.

ACKNOWLEDGEMENT

The authors would like to acknowledge the National Animal Breeding center of Iran for providing the data sets and assistance throughout the project.

REFERENCES

Boettcher, P.J., L.K. Jairath, K.R. Koots and J. Dekkers, 1997. Effect of interaction between type and milk production on survival traits of Canadion Holsteins. J. Dairy Sci., 80: 2984-2995.

Boldman, K.G., A.E. Freeman, B.L. Harris and A.L. Kuch, 1992. Prediction of sire transmitting abilities for herd life from transmitting abilities for linear type traits. J. Dairy Sci., 75: 552-563.

Bottcher, P.J., L.K. Jairath and J. Dekkers, 1999. Comparison of methods for genetic evaluation of sires for survival of their daughters in the first three lactation. J. Dairy Sci., 82: 1034-1044.

Cruickshank, J., K.A. Weigel, M.R. Dentine and B.W. Kirkpatrick, 2002. Indirect prediction of herd life in Guernsey dairy cattle. J. Dairy Sci., 85: 1307-1313.

Druet, T., F. Jaffrézic, D. Boichard and V. Ducrocq, 2003. Modeling lactation curves and estimation of genetic parameters for first lactation test-day records of French Holstein cows. J. Dairy Sci., 86: 2480-2490.

Ducrocq, V.P., R.L. Quaas, E.J. Pollak and G. Casella, 1988. Length of productive life of dairy cows. 2. Variance component estimation and sire evaluation. J. Dairy Sci., 71: 3071-3079.

Harris, B.L., A.E. Freeman and E. Freeman, 1993. Economic weights for milk yield traits and herd life under various economic condition and production quotas. J. Dairy Sci., 75: 1147-1153.

Jairath, L., J. Dekkers, L.R. Schaeffer, Z. Liu, E.B. Burnside and B. Kolstad, 1998. Genetic evaluation for herd life in Canada. J. Dairy Sci., 81: 550-562.

Kadarmideen, H.N. and S. Wegmann, 2003. Genetic parameters for body condition score and its relationship with type and production traits in Swiss Holsteins. J. Dairy Sci., 86: 3685-3693.

Karacaören, B., F. Jaffrézic and H.N. Kadarmideen, 2006. Genetic parameters for functional traits in dairy cattle from daily random regression models. J. Dairy Sci., 89: 791-798.

Meyer, K., 1991. Derivative-free restricted maximum likelihood (DFREML). Computer programs and user guide. University New England, Australia.

Roxstrom, A., V. Ducrocq and E. Strandberg, 2003. Survival analysis of longevity in dairy cattle on a lactation basis. Genet. Sel. Evol. 35: 305-318.

SAS, 1998. Users Guide, Release 6.12. SAS. Institute Inc., Cary, NC.

Sewalem, A., G.J. Kistemaker and B.J. Van Doormaal, 2005. Relationship between type traits and longevity in Canadian Jerseys and Ayrshires using a Weibull proportional hazards model. J. Dairy Sci., 88: 1552-1560.

Sewalem, A., G.J. Kistemaker, F. Miglior and B.J. Van Doormaal, 2004. Analysis of the relationship between type traits and functional survival in Canadian Holsteins using a Weibull proportional hazards model. Dairy Sci., 87: 3938-3946.

Short, T.H. and T.J lawlor, 1992. Genetic Parameters of conformation traits, milk yield and herd life in Holsteins. J. Dairy Sci., 75: 1987-1998.

Strabel, T. and I. Misztal, 1999. Genetic parameters for first and second lactation milk yields of Polish Black and White cattle with random regression test-day models. J. Dairy Sci., 82: 2805-2810.

Van Doormaal, B.J., L.R. Schaeffer and B.W. Kennedy, 1985. Estimation of genetic parameters for stability in Canadian Holsteins. J. Dairy Sci., 68: 1763-1769.

VanRaden, P.M. and G.R. Wiggans, 1995. Productive life evaluations: Calculation, accuracy and economic value. J. Dairy Sci., 78: 631-638.

Visscher, P.M. and M.E. Goddard, 1995. Genetic parameter for milk yield, Survival, work ability and traits for Austeralian dairy cattle. J. Dairy Sci., 78: 205-220.

Visscher, P.M. and M.E. Goddard, 1995. Genetic parameter for milk yield, Survival, work ability and traits for Austeralian dairy cattle. J. Dairy Sci., 78: 205-220.

Weigel, K.A., T.J. Lawlor, P.M. VanRaden and G.R. Wiggans, 1998. Use of linear type and production data to supplement early predicted transmitting abilities for productive life. J. Dairy Sci., 81: 2040-2044.