Proceedings, 10th World Congress of Genetics Applied to Livestock Production

Genetic Analyses of Conformation Traits and their Relationships with Reproductive Traits in Holstein Cows

M. Rabbani-khourasgani, S. Ansari-Mahyari and M. A. Edriss
Department of Animal Science, College of Agriculture, Isfahan University of Technology, Isfahan *84156-83111*, Iran

ABSTRACT: This study was conducted to estimate genetic parameters of type traits and their relationships with reproductive traits in Iranian Holstein dairy cows. For this purpose, 16837 records provided by *Shir VA Gousht* Dairy Farm Company were used. The data was obtained in years 1990 to 2010 and analyzed by average information restricted maximum likelihood method (AIREML). Genetic relationships were estimated using multivariate analysis. Rear legs side view and udder cleft had the highest correlations with lower number of insemination (-0.16, -0.15, respectively) while the rear legs rear view and teat placement, had the highest correlations with lower dystocia (-0.71, -0.64, respectively). The genetic trends of type traits showed that teat lengths are becoming shorter and statures are becoming taller. Most of the genetic trends of the type traits were considered desirable. For reproductive traits the genetic trend was small but undesirable.
Keywords: type traits; genetic trend; Holstein

Introduction

The correlation between fertility and production is generally unfavorable in dairy cows (Wall et al. (2003)). Consequently, in the absence of any direct selection pressure on fertility, there has been a downward genetic trend in fertility associated with selection for yield (Royal et al. (2000))

Ideally, female fertility indices include 1 or both of the following types of measurement: 1) a measure of conception success following insemination, and 2) reproductive rate measured by intervals, such as calving interval (CI). The heritabilities of these aspects of reproductive performance are low (typically <0.05); consequently, the reliability of bull evaluations for fertility is generally lower than other traits, such as milk production, when estimated from the same number of daughters(Wall et al. (2003)).

Even though direct recording of fertility in national milk recording schemes is generally more open to measurement error and is less widespread, fertility traits are genetically correlated with traits that are either well recorded or more heritable, such as yield, condition score (Wall et al. (2003), BW (lee et al. (2002)), and linear type traits (Toghiani et al. (2009)).

Evaluation of cattle conformation is an important element of breeding work conducted on this species and in many countries it is included in the selection index (Kruszyński et al. (2013)). Cue et al. (1990) pointed out that relationships between conformation traits and calving ease exists. Since conformation traits are well documented and moderately heritable, such traits may be of aid in selection decisions (Waurich et al. (2010)).

The aim of this study was to estimate genetic parameters for some conformation traits and their genetic relationships with some selected reproductive traits. Besides, the genetic trends of type traits were studied.

Materials and Methods

Data. The data were provided by *Shir VA Gousht* Dairy Farm Company and were obtained from animals born in years 1990 to 2010. Total number of records was 16837 and for type traits 6125 record was used. Number of inseminations per conception, (INS) and calving ease (CE) were considered as reproductive traits. The CE scores observed were modified as 1, 2, 3, 4, 5 and 6 for natural parturition, no assistance, minor assistance, major assistance, major assistance with physical damage, or caesarian, respectively. Type traits analyzed were included fore udder attachment (FU), rear udder height (RUH), rear udder width (RUW), udder cleft (UC), udder depth (UD), teat placement (TP), teat length (TL), stature (ST), angularity (ANG),strength (SG), rump width (RW), rump angle (RA), rear legs rear view (RLRV), rear legs side view (RLS) and foot angle (FA) that were evaluated as points between 1 to 100. The values greater than 100 were assigned as missing values.

Statistical analyses. The genetic parameters for all traits were estimated using DMU software (Madsen and Jensen (2010) and BLUP. Data were studied using univariate animal model for estimation of heritabilities and predicting breeding values of traits and 3-variate animal model for estimation of genetic correlations between type traits and reproductive traits. Model for type traits in a simplified scalar notation was as follows:

$$Y = HYS + Age\ (ap) + A + E,$$

where Y denoted type traits such as FU, RUH, … or FA, HYS was fixed herd-year-season effect, Age (ap) was fixed effect of appraising age by days as covariate, A was random animal effect, and E was random residual error effect. The following model was used for reproductive traits.

$$Y = HYS + Age\ (p) + A + E,$$

The model for reproductive traits included fixed herd-year-season effect (HYS), fixed effect of Parturition age by year (Age (p)), random animal effect (A), and a random residual error effect (E).

The mean annual genetic trend for the type traits analyzed was estimated using linear regression, as a coefficient of the regression of the breeding value of animals born in a given year against time.

The statistical analyses (means, standard deviations for the traits analyzed, normality of distribution for conformation values and estimation of genetic trends) for all of the data collected were performed using the procedures (proc MEANS, proc UNIVARIATE, proc REG) from the statistical package SAS (2003)

Results and Discussion

General means and heritabilities. Table 1 provides a summary of the data and descriptive statistics of all traits. The average number of recorded services per conception was 2.11 that was a relatively large number. The average values of type traits ranged between 42.8 and 53.2 that the highest and lowest averages were found for stature and teat placement, respectively.

Table 1. Means, standard deviations (SD), minimum, maximum and genetic trends of type traits and reproductive traits.

Trait	$\bar{x}$	sd	Min	max	trend
INS	2.11	1.44	1	14	0.00
CE	1.87	0.82	1	6	0.00^{***}
FU	46.07	19.38	1	99	0.04
RUH	50.34	17.09	1	99	-0.03^{***}
RUW	51.06	16.95	5	99	-0.00
UC	49.97	20.49	1	100	0.05
UD	45.34	18.91	1	95	0.12^{***}
TP	42.81	16.74	1	95	0.06^{**}
TL	52.73	14.52	5	99	-0.20^{***}
ST	51.76	14.68	2	99	0.16^{***}
ANG	48.73	16.84	1	95	0.05^{***}
SG	46.24	16.56	1	95	-0.00
RW	50.87	14.90	1	95	-0.02^{*}
RA	51.01	14.83	1	95	0.14^{***}
RLRV	49.88	15.26	4	95	0.03^{***}
RLS	53.22	16.06	1	99	0.09^{***}
FA	49.02	14.33	1	95	0.09^{***}

* p≤ 0.05, ** p≤ 0.01, *** p≤ 0.001

Heritability estimates (table 2) were low for reproductive traits (INS = 0.10 and CE =0.003) and low to moderate for type traits. The heritability obtained for INS was greater than 0.02 presented by wall et al. (2003) perhaps because of differences in dataset size and accuracy. In this study cows were allowed to remain in the herd after several unsuccessful inseminations, in order to retrieve their fertility. So data recording had been done accurately and without censoring. A heritability of 0.003 was found for CE. This estimate was lower than those obtained in previous studies by Lee (2002) and Eaglen et al. (2011) probably because of this reason that the number of categories for this trait in present study was more than earlier cited studies and levels of these categories could have overlaps to each other and consequently affect on accuracy of data recording.

Heritability for type traits was between 0.05 for foot angle and 0.33 for stature. These findings were in agreement with other researches (Bakhtiarizadeh et al. (2008); Campos et al. (2012)). Heritability of angularity obtained 0.07 that was considerably lower than heritabilities reported for this trait in other studies (Pahlevan and Moghimi (2010); Campos et al. (2012)). However it was closer to 0.16 obtained by Pahlevan and Moghimi (2010) for Iranian Holsteins in comparison with 0.24 of Campose et al. (2012) for Brazilian Holsteins. Angularity is not a true linear type trait, is a descriptive trait and it is not possible for this trait to be measured in a linear scale directly, and consequently, different individuals may have different evaluations for this trait that may lead to difference of results. Other heritabilities were in range of other studies (Bakhtiarizadeh et al. (2008); Campos et al. (2012)).

Table 2. Heritabilities and genetic correlations between type traits, insemination per conception and calving ease

Trait	h^2	INS	CE
INS	0.10 ± 0.00	-	0.28 ± 0.25
CE	0.00 ± 0.00	0.28 ± 0.25	-
FU	0.24 ± 0.02	0.13 ± 0.06	-0.01 ± 0.25
RUH	0.08 ± 0.02	0.02 ± 0.10	-0.44 ± 0.33
RUW	0.13 ± 0.02	0.04 ± 0.08	-0.51 ± 0.34
UC	0.21 ± 0.02	-0.15 ± 0.06	-0.19 ± 0.26
UD	0.26 ± 0.02	-0.02 ± 0.06	-0.22 ± 0.25
TP	0.22 ± 0.02	0.08 ± 0.06	-0.64 ± 0.39
TL	0.33 ± 0.02	-0.10 ± 0.05	0.05 ± 0.23
ST	0.33 ± 0.02	0.18 ± 0.05	-0.16 ± 0.23
ANG	0.07 ± 0.01	0.05 ± 0.10	0.37 ± 0.41
SG	0.12 ± 0.02	0.21 ± 0.08	0.35 ± 0.35
RW	0.09 ± 0.02	0.13 ± 0.09	-0.05 ± 0.33
RA	0.24 ± 0.02	-0.06 ± 0.06	0.10 ± 0.26
RLRV	0.07 ± 0.01	0.16 ± 0.10	-0.71 ± 0.36
RLS	0.10 ± 0.02	-0.16 ± 0.08	0.08 ± 0.31
FA	0.05 ± 0.01	0.17 ± 0.12	0.56 ± 0.36

These results for heritabilities suggest that a moderate response to selection can occurs for type traits and the type traits correlated with reproductive traits can help to improve reproduction.

Genetic trends. Genetic trend of reproductive traits were positive and very low so that for INS the genetic trend (0.0006) wasn't significant and for CE the genetic trend was 0.0002 score per year that was statistically significant. These results show that an undesirable direction exists for genetic trend of calving ease.

The annual genetic trends of type traits were positive for a majority of traits. Exceptions were teat length, rear udder height and rump width. The highest increase was recorded for the stature (by 0.16 points per year). For many years, it was believed that more productive cows were those of a larger size; however, evaluation of Irish herds showed that this is not strictly true, since smaller cows can produce as efficiently as those of greater size (Campos et al. (2012)). Obtained genetic trend for stature may remark the regard of breeders to this trait in breeding programs. In the other hand the positive genetic correlation between stature and milk production also may have been effective on this genetic trend. Positive genetic trend for stature is reported in other studies (Theron and Mostert (2004); Kruszyński et al. (2013)). After stature, the positive genetic trends was observed for rump angle, udder depth, foot angle, rear legs side view, teat placement and rear legs rear view, respectively. These results indicate that breeding programs in recent years have been successful for most of type traits.

Negative genetic trends was obtained for teat length, rear udder height and rump width, respectively. The highest negative genetic trend was found for teat length that was in agreement with the results of Theron and Mostert (2004). A negative genetic correlation between teat length and milk production have reported by Kruszyński et al. (2013). Therefore, the negative genetic trend for teat length may be due to negative genetic correlation between teat length and milk production. Kruszyński et al. (2013) have reported a positive genetic trend for teat length. For the remaining traits the mean annual values for the genetic trend proved to be very small.

Most of the genetic trends of the type traits were considered desirable. Exceptions were teat length, rear udder height and probably rump width. Pe´rez et al. (1999) found negative correlation between rump width and profit, and Eaglen et al. (2011) found positive correlation between rump width and calving ease that both of noted correlations are not desirable. Hence, increase in genetic values of this trait is questionable.

Genetic correlations. Genetic correlations between type traits and INS showed that taller and stronger cows need more insemination per conception. Foot angle also found to be related with higher number of insemination per conception. Highest negative genetic correlation (-0.16) was found for rear legs side view. This effect can be through changes in the slope of the reproductive system. Udder cleft also had a negative correlation with INS (-0.15) suggesting that cows with stronger central ligament have a higher fertility. Genetic correlations of other type traits with INS were relatively small.

Contrary to expectations, the results of this study suggest a null correlation between calving ease and rump characteristics. It is notable that Eaglen et al. (2011) have reported a positive genetic correlation for these traits that means cows with wide and steep rumps have difficult calving. These results can be due to different means of type traits through these populations, in other words genetic correlations may differ for different ranges of type traits, such that per´ez et al. (2002) have found nonlinear genetic relationships between some type traits and profit and days of productive life.

The strongest genetic correlation was found between rear legs rear view and calving ease which suggests high scores for this trait is related with easier calving. Rear legs with high scores for this trait can provide more space for vaginal canal in delivery time which leads to easier calving. Teat placement showed a high negative genetic correlation with calving ease. Teat placement probably is related to strong abdominal muscles that retain the mammary system in proper situation and strength of abdominal muscles can lead to easier calving.

Genetic correlations observed between udder characteristics (height and width) and CE were negative and moderate, indicating bigger mammary systems are related to easier calving. For udder depth and stature genetic correlations with calving ease were close to zero. Eaglen et al. (2011) also did not found significant genetic correlations between these traits and calving ease. Foot angle also showed an intermediate genetic correlation with calving ease. A cow with more steep foot angles seems to have difficult calving. Remaining type traits had not any considerable correlation with calving ease. In general, some correlations between type traits and calving ease were moderate to high that indicate importance of type traits in improvement of calving ease.

Conclusions

Estimated heritabilities for reproductive traits were small that is indicator of small response to selection for this traits. In the other hand, type traits showed higher heritabilities in comparison with reproductive traits and some of type traits were genetically correlated to reproductive traits. These results suggest that type traits can be used to improve reproductive traits. Genetic trend of calving ease indicate that calving of cows is becoming more difficult in recent years. Genetic correlations were noteworthy. While strongest genetic correlations with calving ease was expected for rump characteristics, the results showed that rear legs rear view have the highest genetic correlation with calving ease, and rump characteristics are less important in calving ease. Genetic correlations between type traits and INS showed that taller and stronger cows need more inseminations per conception. In general, the results showed that a good genetic improvement have occurred for type traits during last generations.

Literature Cited

Bakhtiarizadeh, M. R., Moradi-shahrebabak, M., Pakdel, A., And Moghimi-esfandabadi, E. (2008). Iran. J. Anim. Sci. 3(3): 1-12

Campos, R. V., Cobuci, J. A., Costa, C. N. et al. (2012). R. Bras. Zootec. 41(10) :2150-2161.

Cue, R. I., Monardes, H. G., and Hayes, J. F. (1990). J. Dairy. Sci. 73:3586-3590.

Eaglen, S., Coffey, A. E., Woolliams, M. P. et al. (2011). Interbull. Bulletin No. 44: 26 – 29

Kruszyński, W., Pawlina, E. and Szewczuk, M. (2013). Archiv Tierzucht. 56 - 052 (provisional version).

Lee. D. H. (2002). Asian Aust. J. Anim. Sci. 15(8): 1085-1090

Madsen, P., and Jensen, J. A. (2010). DMU. Version 6, release 5

Pahlevan, R., and Moghimi-Esfandabadi, A. (2010). Specialized quartery of Anim. Sci 3(3): 1-12.

Pe´rez, M. A., Herna´ndez, D., Alenda, R. et al. (1999). Interbull. Bulletin No. 23:107–113.

Pe´rez, M., Cabal, A., Garca, C. et al. (2002). J. Dairy Sci. 89: 1776–1783.

Royal, M. D., Darwash, A. O., Flint, A. P. F. et al. (2000). Anim. Sci. 70: 487–501.

Theron, H.E., and Mostert, B.E. (2004). S. Afr. J. Anim. Sci. 34(Supplement 2): 47-49.

Toghiani-Pozveh, S., Shadparvar, A. A., Moradi-shahrebabak. M. et al. (2009). Livest. Sci. 125: 84-87

Wall, E., Brotherstone, S., Woolliams, J. A. et al. (2003) J. Dairy Sci. 86: 4093- 4102.

Waurich, B., Wensch-Dorendorf, M., Schafberg, R. et al. (2010). 9th Congress on Genetics Applied to Livestock Production.