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*Full Length Research Paper*

# Genetic constraints and associations among linear type traits in the first lactation of Holstein Dairy cows

**Nasim Karimi Alidoosti**

Young Researchers Club, Islamic Azad University, Khorasgan Branch, Isfahan, Iran. E-mail: nasim.karimi@gmail.com

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**The main objective of this study was to estimate the genetic parameters and relationships of 10 linear type traits in the first lactation of Holstein dairy cows. 3274 records for type traits was used (Ag, angularity; Sta, stature; Bdp, body depth; Rw, rump width; Rs, rear leg side view; Fa, foot angle; Fu, fore udder attachment; Ruh, rear udder height; Sl, suspensory ligament and Ud, udder depth) for the first lactation of Iranian Holstein cows collected during 1980 to 2004 at Animal Breeding Center of Iran. Estimations were performed using restricted maximum likelihood method under an animal model and estimated variance components from single-trait analysis using MATVEC software and covariance components from four-trait analysis using DF-REML software was obtained. Heritability estimates for type traits were low to moderate, from 0.075 for rear leg side (Rs) to 0.376 for rump width (Rw). Genetic correlations between type traits ranged from 0.72 for udder depth (Ud) and fore udder attachment (Fu) to 0.75 for foot angle (Fa) and rump width (Rw). The results of this study showed favorable and high genetic correlation among the mammary system traits such as Ud, Fu, Ruh and Sl. Body conformation traits such as Ag and Bdp were unfavorable and negative for the genetic correlation with mammary system traits including Fu, Ruh and Ud.**

**Key words:** Genetic parameter, type traits, Iranian Holsteins.

## INTRODUCTION

The concept of linear analysis of type traits was introduced in 1976 and the first programs for linear type trait evaluation were implemented and tested by 1979 (Lucas et al., 1984; Vinson et al., 1982). Today, all breed associations and virtually all artificial insemination (AI) organizations use some form of linear evaluation for conformation analysis of dairy cattle. Early analyses of these programs involved mainly parameter estimation because of the limited number of records available (Foster et al., 1988).

The Holstein Association (HA) began routinely scoring cows with a linear system as part of its herd appraisal program on January 1, 1983. Linear type traits are scored from one biological extreme to another using a continuous scale from 1 to 50 points (Funk and Hansen, 1991). All dairy breed associations and many AI organizations in the US have implemented linear type trait programs that are similar to the program described by Wilson (1979). The relationships of these traits to herd life and profitability, survival and workability, udder health and somatic cell score, and genetic defects have been investigated (Gengler et al., 1997). Dairy farmers, economists and geneticists recognize the importance of herdlife and lifetime performance. Herdlife and lifetime performance are primary factors influencing a cow's profitability.

Direct selection to reduce involuntary culling is of limited value due to increased generation intervals and possibly low heritabilities; therefore, selection on correlated traits that can be measured in first lactation may be warranted. Many researchers have hypothesized that a relationship exists between type or physical characteristics and length of herdlife or lifetime performance (Rogers et al., 1988). Information about conformation traits can also be used as a relatively early predictor of herd life. Some conformation traits are associated with longevity and are recorded early in life. Several countries are now using conformation scores of daughters to help predict the transmitting abilities of the sires for herd life (Boettcher et al., 1997). The breeding goal in dairy cattle is to increase lifetime profit per animal and unit of time. Profit is a function of production and the time that a cow remains in herd. Thus, profit can only be recorded when a cow is culled, and the selection of more profitable

**Table 2.** Significance of fixed effects for each of the type traits studied. Fixed effects of type traits that were statistically significant (P > 0.05) are indicated by .

| Type trait | Fixed effect | | | |
|---|---|---|---|---|
| | RYS | H (RYS) | BLD | TEC |
| Angularity (Ag) | | | | |
| Body depth ( Bdp) | | | | |
| Foot angle (Fa) | | | | |
| Fore udder attachment (Fu) | | | | |
| Rear leg side view (Rs) | | | | |
| Rear udder height (Ruh) | | | | |
| Suspensory ligament (Sl) | | | | |
| Stature (Sta) | | | | |
| Udder depth (Ud) | | | | |
| Rump width (Rw) | | | | |

RYS, fixed effect of region by year and season of evaluation; BLD, percent of Holstein heredity fixed; TEC, effect of technician.

**Table 3.** Estimates of variance components and heritability for type traits.

| Type trait | Additive genetic variance | Residual variance | Heritability (±SE) |
|---|---|---|---|
| Stature (Sta) | 2.57 | 8.00 | 0.24±0.116 |
| Body depth (Bdp) | 0.37 | 0.73 | 0.34±0.033 |
| Angularity (Ag) | 0.22 | 0.77 | 0.23±0.031 |
| Fore udder attachment (Fu) | 0.31 | 1.28 | 0.20±0.047 |
| Rear udder height (Ruh) | 2.55 | 25.45 | 0.10±0.025 |
| Udder depth (Ud) | 0.27 | 0.83 | 0.25±0.033 |
| Rump width (Rw) | 0.88 | 1.45 | 0.38±0.040 |
| Foot angle (Fa) | 0.19 | 1.27 | 0.13± 0.04 |
| Rear leg side view (Rs) | 0.068 | 0.845 | 0.075± 0.026 |
| Suspensory ligament (Sl) | 0.26 | 2.04 | 0.114±0.06 |

Additional pairs of traits with high genetic correlations were angularity with body depth (0.41), body depth with rump width (0.56), body depth with stature (0.50), rump width with stature (0.56) and suspensory ligament with stature (0.42). Positive genetic correlations indicate that selection for increased scores in one trait will be accompanied by increased scores in the correlated trait, regardless of the direction of the score that improves the trait. The genetic correlation between fore udder attachment and rear leg side view, suspensory ligament and stature was almost null (0.07, 0.06 and -0.004, respectively). Additional pairs of traits with null genetic correlations were angularity with suspensory ligament (0.02), body depth with rear udder height (-0.06), rump width with rear udder height (0.02), rear udder height with stature (0.06) and stature with udder depth (0.07).

Body conformation traits such as Ag and Bdp were unfavorably correlated with udder traits including Fu, Ruh and Ud, which means that bigger and thinner cows will have a strong ligament in the fore udder attachment and the udder will have a proper distance from the hock and this means that proper distance should be above the hock. Consequently, mastitis suffering probability could be low for these cows.

## Conclusion

Genetic parameters, especially correlations, should be estimated for every breed and country to avoid biasing genetic evaluations because of inappropriate (co) variance components. In this study, heritability estimates for type traits were low to moderate. Genetic correlations between type traits showed favorable and high genetic correlation between mammary system traits. The magnitude of heritability for linear traits, combined with genetic correlations between traits, gives an indication of the rate of change expected in scores when selection is performed on these traits. Information provided in this study could be used to create specific selection indices that

**Table 4.** Genetic correlations (above diagonal) and environmental correlations (below diagonal) among conformation traits.

| Parameter | Ag | Bdp | Fa | Fu | Rw | Ruh | Rs | Sl | Sta | Ud |
|---|---|---|---|---|---|---|---|---|---|---|
| Angularity (Ag) | | 0.41 | 0.27 | -0.15 | 0.18 | -0.24 | 0.31 | 0.02 | 0.24 | -0.54 |
| Body depth (Bdp) | 0.25 | | 0.15 | -0.10 | 0.56 | -0.06 | 0.30 | 0.37 | 0.50 | -0.44 |
| Foot angle (Fa) | 0.03 | 0.01 | | -0.14 | 0.15 | -0.23 | -0.75 | 0.28 | 0.21 | -0.20 |
| Fore udder attachment (Fu) | 0.02 | 0.002 | 0.11 | | -0.21 | 0.26 | 0.07 | 0.06 | -0.004 | 0.72 |
| Rump width (Rw) | 0.03 | -0.02 | -0.02 | -0.006 | | 0.02 | -0.11 | 0.18 | 0.56 | -0.32 |
| Rear udder height (Ruh) | -0.08 | 0.02 | 0.06 | -0.12 | 0.10 | | 0.19 | 0.30 | 0.06 | 0.41 |
| Rear leg side view (Rs) | 0.01 | 0.10 | -0.19 | -0.11 | 0.02 | -0.02 | | -0.65 | -0.12 | -0.59 |
| Suspensory ligament (Sl) | 0.08 | -0.03 | -0.07 | 0.13 | -0.05 | -0.10 | 0.06 | | 0.42 | 0.18 |
| Stature (Sta) | 0.12 | 0.03 | -0.02 | -0.06 | 0.21 | 0.20 | -0.05 | -0.05 | | 0.07 |
| Udder depth (Ud) | -0.24 | -0.24 | 0.12 | 0.26 | 0.05 | -0.14 | -0.13 | 0.17 | -0.04 | |

would reflect the optimal conformation of dairy cows in each region in terms of functional longevity. Although these estimates should be useful in multiple- trait animal evaluation and in studying selection responses in multiple traits, further investigation is required to improve the functionality and the longevity of the animal for dairy production. Investigation of genetic and phenotypic associations between type traits and longevity is required.

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