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Genetic and Phenotypic Relationships Among Locomotion Type Traits, Profit, Production, Longevity, and Fertility in Spanish Dairy Cows

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ABSTRACT

The phenotypic and genetic relationships of 3 locomotion traits with profit, production, longevity, and fertility traits were studied to determine the importance of locomotion traits for dairy producers. Two data sets including official milk records and type classification scores of 62,293 cows, and reproductive records of 24,561 cows from the Basque and Navarra Autonomous Regions were analyzed. Higher scores for feet and legs (FL), foot angle (FA), and rear legs set (RLS) were positively related to production and functional traits, whereas fertility was not significantly affected. The cows that scored the highest for FL were $213/yr more profitable, produced 575 kg more milk per year, and remained in the herd for 307 more functional days than the cows scoring the lowest. Feet and legs was the trait most genetically correlated to profit, although a low value (0.10) was obtained, whereas RLS was the trait most correlated to milk production (0.12). Genetic correlations among FL, FA, RLS, and longevity traits (from –0.10 to 0.05) were low. Quadratic curves were the best fit for both profit and functional herd life for EBV of each of the 3 locomotion traits. Further studies dealing with profitability and lameness, instead of using conformation traits, could be performed directly if a larger data pool of lameness was routinely recorded.
Key words: breeding value, locomotion, profit, genetic relationship

INTRODUCTION

Locomotion traits are one of the most important selection criteria for dairy breeders. An animal with bad locomotion will not easily gain access to feed and the milking parlor, and therefore, profitability, labor, and animal welfare will be affected (Warnick et al., 2001). Moreover, the high price of semen for sires with high breeding values for feet and legs reflects the importance given to this trait by dairy producers. Foot and leg morphology contributes to hoof erosion and locomotion diseases (Boelling and Pollott, 1998a), commonly leading to lameness.

Lameness produces direct and indirect economic losses (Boettcher et al., 1998). Direct costs are due to treatment dispensed and the involuntary culling of cows with chronic lameness. The National Animal Health Monitoring System (2002) reported a 16.3% culling rate due to lameness, being the third most common reason for involuntary culling. However, lameness also contributes to other causes of culling, such as reproductive culls (Sattler, 2002). Booth et al. (2004) reported that lameness was associated with decreased survival, especially between 61 and 120 DIM or at the end of lactation. Indirect economic losses occur due to milk yield reduction and fertility deterioration. Green et al. (2002) estimated a 360-kg reduction in milk yield per 305-d lactation. Kossaibati et al. (1999) reported an average direct cost of £50 per case of lameness and an extra £86 loss due to fertility in the United Kingdom. The cost of each case of lameness was estimated at $302 in the United States (Sattler, 2002).

Several authors also have recorded lameness or locomotion scores in experimental settings to study relationships with conformation. Boettcher et al. (1998) found that foot angle (**FA**), rear leg set (**RLS**), and rump width were most highly correlated to clinical lameness. They also suggested that type traits could only provide an indication of susceptibility to locomotion diseases. Boelling and Pollott (1998a,b) found that some effects such as old age, deep udders, sickled legs, and long hoof diagonals tend to deteriorate locomotion. Results from Van Dorp et al. (2004) indicated that cows with better scores for feet and legs (**FL**), FA, RLS, and strong udder attachments had more favorable locomotion.

Lameness, foot and leg diseases, and locomotion scores are not routinely recorded on commercial farms. Recently, locomotion scores have been recorded in Spain, but data are insufficient for analysis. Thus, morphological traits related to locomotion such as FL, FA, and RLS were studied (Vollema and Groen, 1997; Pérez-Cabal and Alenda, 2002). These traits have low heritabilities and low genetic correlations with profit (Pérez-Cabal and Alenda, 2002) but positive relationships with

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longevity. Traditionally, type traits were thought to be linearly related to profit and longevity, but some studies showed significant quadratic relationships. Specifically, Norman et al. (1996) found phenotypic intermediate optima for FA and RLS, and Pérez-Cabal and Alenda (2002) reported quadratic curves from 3 locomotion traits in a study dealing with genetic relationships of 14 type-trait EBV with profit and longevity EBV.

To determine the importance of locomotion traits for dairy producers, the aims of this study were 1) to update the genetic parameters of 3 locomotion traits (FL, FA, and RLS) for a larger population and their genetic relationships with profit and longevity, but also with other traits such as production and fertility, and 2) to analyze the phenotypic relationships with longevity, production, fertility, and profit.

MATERIALS AND METHODS

Data

Official milk records and type classification scores (from 1979 to July 2003) and reproductive records (from 1986 to July 2003) of cows from the Basque and Navarra Autonomous Regions were provided by the corresponding Holstein Associations (EFRIFE and AFNA, respectively). The initial milk record file included 525,708 lactations of 186,877 cows distributed in 1,824 herds. The type classification file consisted of 112,166 scored cows. The reproductive file included inseminations of 120,713 cows. Original files were edited to obtain appropriate data sets for the statistical analyses. The requirements were that all animals had to belong to herds with continuous milk recording during a minimum of 3 yr to have at least 3 yr of productive life, to avoid censored data as much as possible. First calving was required to be before July 2000 for all cows and lactations had to be consecutive beginning with the first. Animals had to be between 18 and 40 mo at the age of first calving. Days in lactation had to range between 100 and 500 d, and calving interval between 300 and 550 d.

Three locomotive traits were studied: 2 standard linear traits (FA and RLS), scored from 1 to 9, and a general characteristic (FL) classified into 6 main categories: poor (**P**), fair (**F**), good (**G**), good plus (**GG**), very good (**VG**), and excellent (**EX**), each of which had 3 subcategories. Thus, cows are classified into 18 FL classes, but only the 6 main classes were analyzed in this study. Cows are scored once, preferably at first lactation (76% of cows in the data) and if not possible, at second. Only cows from third lactation can be reclassified as EX.

Economic data used in this study were the average values for 1999 from 239 representative herds of Basque Autonomous Region, provided by EFRIFE management services. Economic data considered were prices of milk and calves, feeding costs (for cows and heifers), and other costs such as housing and labor (Pérez-Cabal and Alenda, 2003). Based on 1999 prices, profit per cow per year (**PROF**) was calculated as the difference between income and costs for the entire productive life of each cow, and was expressed per year of productive life as described in Pérez-Cabal and Alenda (2002). In PROF calculations, actual milk yield was used, whereas for phenotypic and genetic studies, the production trait was 305-d kg of milk in first lactation (**M305**). Longevity traits included number of lactations, days of productive life (measured as days between first calving and the last day of the last lactation), and functional herd life (**FHL**), obtained as days of productive life adjusted by production level following Pérez-Cabal and Alenda (2003). Other traits analyzed were average DIM per lactation, percentage of DIM, (i.e., ratio between total DIM and days of productive life), and average dry days per lactation (**DD**). Average calving interval (**CI**) and average number of inseminations per lactation (**ANI**) were considered as fertility traits.

For both phenotypic and genetic analyses, complete data for production, type classification, profit, longevity, and fertility were required. A total of 62,293 cows were used for analyses between locomotion traits and profit, production and longevity. Because reproductive data were fewer than milk records, analyses of fertility with type traits included only 24,561 cows.

Phenotypic Analysis

Phenotypic relationships were analyzed with the GLM procedure of SAS (SAS Institute, 2001). The following fixed model was applied for PROF, DD, and DIM:

$$y_{ij} = HY_i + LT_j + e_{ij}$$

For longevity and M305, fixed models were

$$y_{ijkl} = HY_i + Mc_j + AFC_k + LT_l + e_{ijkl}$$

For fertility traits, fixed models were

$$y_{ijkl} = HY_i + Mc_j + LA_k + LT_l + e_{ijkl}$$

where HY is fixed effect of herd-year of first calving (7,263) levels, LT is each 1 of the 3 locomotion traits (FL, FA, or RLS), Mc is fixed effect of month of first calving (12 levels), AFC is fixed effect of age at first calving (4 levels: 18 to 24 mo, 25 to 28 mo, 29 to 33 mo, 34 to 40 mo), LA is fixed effect of lactation-age of cow (3 levels). Additional analyses with M305 as a covariate