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TRUE AND FUNCTIONAL HERD LIFE IN THE SPANISH HOLSTEIN FRIESIAN

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INTRODUCTION

The objective of a dairy breeding program is to increase the profitability of the breed. The criteria to include in a selection index are controversial (Rogers, 1993). A selection index should include traits that increase productivity per unit of time and that assure that productivity for a long period of time.

Longevity can be measured as true herd life (THL) or as functional herd life (FHL). Ducrocq et al. (1988) defined THL as the ability of a cow to survive in a herd by delaying voluntary and involuntary culling and FHL as the ability of a cow to avoid involuntary culling.

Voluntary culling is basically made on yield traits. Recorded traits related with involuntary culling are type traits.

In 1991 a selection index named ICO was implemented in Spain to rank sires and cows based on yields and type traits. The relative weights for production to type traits are equal to 3:1. Production traits included in the ICO are .2 Milk yield .2 Fat yield, 1 Protein yield and .4 Percentage Protein . Type traits included in the ICO index are Final Score, 0.5 Capacity, Feet and Legs and Mammary Systems.

The objective of this study is to evaluate the relationship between longevity and type and production traits with FHL and THL in order to obtain a selection index more appropriate to improve involuntary culling.

MATERIALS AND METHODS

Data refer to 769282 lactations from the Spanish official milk recording and 235248 cows classified between 1984 to 1992 by official classifiers of the Spanish Friesian Associations (CONAFE). Type traits included in this study were Composite traits (Final score , Capacity, Feet and Legs and Mammary system) and linear traits. Linear traits were Loin strength, Rump width, Foot angle, Set of rear legs, Udder texture, Fore udder attachment , Rear attachment height, Median suspensory ligament, Udder depth, Fore teat placement and Rear teat placement.

Longevity data were composed of records from cows calving for the first time before 1988 in herds continuously enrolled in the recording program in order to allow for at least five years of productive life. THL was defined as months between first and last calving. FHL was calculated by adjusting THL by linear and quadratic regression of first lactation standardized milk yield.

The relationship between longevity and production and type traits was measured through estimates of correlations among those traits and regression equations of bulls EBV for longevity traits on bulls EBV for production and type traits.

Correlations estimates were obtained applying EM-REML to two-traits animal models. All traits were preadjusted for fixed effects other than contemporary group (herd-year) so that the same model could be used for every trait. A canonical transformation could then be performed to reduce computational efforts. Mixed model equation solutions for fixed effects from single trait animal models were used to preadjust the data. An approximation of the required traces of inverses of blocks of the MME coefficient matrix was used (Misztal et al., 1992). Standard errors for component estimates were approximated as in Van Raden (1986).

Number of records used to estimate correlations between longevity traits and production, composite and linear type traits were 21882, 31577 and 24794, respectively.

Variance components estimation was carried out on random samples of data of about 10.000 cows with records and 18.000 animals. Average of sample estimates are reported as global estimates.

Breeding values of 216 bulls with at least 20 daughters in 5 herds were used in the regression analyses.

RESULTS AND DISCUSSION

Average number of lactations, years of functional and total herd life were 3.32, 3.36 and 5.65, respectively. Heritabilities for FHL and THL were low but slightly higher than those reported by Bagnato (1993) and Boldman et al (1992) and similar to those reported by Short and Lawlor (1992). Heritabilities and standard errors are presented in table 1.

Genetic correlations between longevity (FHL, THL) and production and type traits (Composite and linear) are presented in table 2. After accounting for production, correlation between milk yield and FHL is zero indicating that functional life, as estimated in this study, is independent from milk production. Genetic correlations between milk yield and fat yield with THL is .43. This result indicates that low production is a reason for culling. Genetic correlations between THL and all type traits are moderate to null, ranging from .32 (Loin strength and Median suspensory ligament) and .28 (Final score and Fore udder attachment) to -.03 (Capacity) and 0 (Rump width).

Capacity is a trait included in the ICO index that is not correlated with FHL and THL. Final score, Mammary system and Feet and legs are moderately correlated with FHL (.23, .26 and .13 respectively). Genetic correlation between Final score and FHL is higher than that reported by Bagnato (1993) and Short and Lawlor (1992) for the grade population but lower than the value reported by Short and Lawlor (1992) for the registered population in the U.S.A..

The highest genetic correlations between FHL and linear type traits are for Fore udder attachment (0.30) and Udder depth (0.26). This is also reported by Bagnato (1993), Boldman et al (1992) and Short and Lawlor (1992). Loin strength, Udder texture and Fore teat placement are other linear traits with moderate genetic correlations with FHL (0.23, 0.21, 0.18 respectively). This suggests that udder characteristics may be useful to improve the opportunity for a cow to remain in the herd.

Fore udder attachment and Udder depth could be more efficient traits than the composite trait Mammary system to improve FHL.

Predicted breeding value for THL and FHL based on EBV for production and composite and linear type traits are shown in tables 3 and 4, respectively. Production traits, milk and fat yield, account for 22.7% of the total variation of THL, while the composite type traits account for 14.4% Genetic evaluation for production plus all type traits account for 28.6% to 30.6% of the total variation of THL. Milk yield and udder traits (Udder depth and Udder texture) may be useful to improve the longevity of a cow.

Variability in genetic evaluations for type traits account for 9.2% to 12.0% of the FHL variability. Linear traits give slightly better predicted equation than composite traits (Table 4). Udder traits (Udder depth, Udder texture and Rear attachment height) are predictors of FHL. Rump width has a genetic correlation close to zero with THL and FHL but it is present in most predicted equations. This is probably due to the positive genetic correlations with udder traits.

CONCLUSIONS

Given the traits used in this study,

1.- Milk production was the most important trait in determining THL.

2.- Udder traits may be useful to improve THL and FHL.

3.- Some linear udder traits (Udder depth and Udder attachment traits) could be more efficient to improve THL and FHL than the composite udder trait Mammary system.

4.- Capacity and Feet and legs traits may not be useful to improve THL and FHL.

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Table 1. Heritabilities (h^2) and standard errors (s.e) of production, longevity and type traits

Traits	h^2	s. e
Milk Yield	.30	.027
Fat Yield	.26	.029
Protein Yield	.25	.029
Protein Percentage	.32	.029
T H L	.09	.027
F H L	.07	.029
Final Score	.28	.028
Capacity	.33	.025
Feet and legs	.17	.029
Mammary system	.27	.027
Loin strength	.12	.036
Rump width .	.13	.036
Foot angle .	.08	.037
Set of rear legs	.13	.036
Udder texture	.17	.036
Fore udder attachment	.17	.035
Rear attachment height	.19	.032
Median suspensory ligamen	.14	.035
Udder depth	.17	.034
Fore teat placement	.22	.032
Rear teat placement	.16	.034

Table 2 .- Genetic correlations between THL and FHL with production and type traits

Traits	T H L	F H L
Milk yield	.43	.00
Fat yield	.43	.20
Protein yield	.32	.02
Protein percentage	-.12	.03
Final Score	.28	.23
Capacity	-.03	-.06
Feet and legs	.13	.13
Mammary system	.32	.26
Loin strength	.32	.23
Rump width	.00	.02
Foot angle	.01	.01
Set of rear legs	.21	.17
Udder texture	.26	.21
Fore udder attachment	.28	.30
Rear attachment height	.24	.13
Median suspensory ligament	.03	-.08
Udder depth	.13	.26
Fore teat placement	.20	.18
Rear teat placement	.08	-.02

Table 3. Regression equations to predict THL based on production and type breeding values*

Equation	R^2 (%)
Production traits	
T H L = .239 MY + .254 FY	22.7
Composite traits	
T H L = .510 F S C - .310 C A P	14.4
Production + Composite traits	
T H L = .406 MY + .234 M S Y	26.3
Production + Composite + Linear traits	
T H L = .474 MY + .175 UTX + .203 UDD - .116 RUW	30.6
T H L = .557 MY + .296 UDD - .100 RUW	28.6
T H L = .389 MY + .189 FY + .289 UDD - .100 RUW	29.5

Table 4. Regression equations to predict FHL based on type breeding values*

Equation	R^2(%)
F H L = .347 MSY - .158 RUW	9.2
F H L = .218 RAH + .150 UDD - . 186 $(RAH)^2$	10.0
F H L = .272 UTX + .117 UDD - . 131 RUW	11.1
F H L = .322 UTX - .184 $(RAH)^2$	12.0

* Based on breeding values of 219 bulls with at least 20 daughters in 5 herds

MY = Milk yield; FY = Fat yield; FSC = Final Score; CAP = Capacity; MSY = Mammary system; UTX = Under texture; UDD = Udder depth; RUW = Rump width; RAH = Rear attachment height.