AN INDEX OF LACTATION PERSISTENCY BASED ON MULTIVARIATE FACTOR ANALYSIS

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INTRODUCTION

Persistency of lactation is a functional trait of great economic importance, allowing for the use of cheaper feeds and for the reduction of health costs (Dekkers *et al*., 1998). However, a widely accepted measure of lactation persistency has not been achieved so far (Gengler, 1996). A possible reason can be found in the *a priori* connotation of the several proposed measures, that refer to a standard shape of lactation curve regardless of the effective (co)variance structure of the original variables, i.e. Test Day (TD) records taken at different time intervals from calving. Aims of this work are : i) to find a measure of lactation persistency that originates directly from the (co)variance structure of data ; ii) to check the ability of this index to discriminate lactation patterns with different persistency ; iii) to analyse on phenotypic level the effect of some environmental factors on persistency.

MATERIAL AND METHODS

Factor analysis is a multivariate method that models the (co)variance matrix of original data (**S**) in the form **S= BB' + E**, where **B** is the matrix of the coefficients (b) of the decomposition of original variables (Y) into a linear combination of common factors (X) :

$Y_1 = b_{11}X_1 + ….+ b_{1m}X_m + e_1$

…….

$Y_p = b_{p1} + …….+ b_{pm}X_m + e_p$

E is a residual (co)variance matrix. Unlike principal component or canonical decomposition that factorise **S** with a simple mathematical transformation (i.e. axes rotation), the factor (co)variance model assumes that a few latent variables are able to explain the (co)variance structure of original data. The usefulness of factor analysis is related to the ability of a few common factors to explain a relevant quota of original (co)variance, and to their clear interpretation in terms of relationships with the original variables. In this study, factor analysis was carried out to check the existence of a common factor controlling a relevant quota of the original (co)variance structure of TD measures and correlated with TD records of the last part lactation (Macciotta *et al*., 1999 ; Wilmink, 1987). Data were lactations of 19,752 Italian Simmental cows, with seven records each and an average length of 318 days. Each of the seven records per cow was considered as different variable (MILK1, MILK2, …; MILK7). Factor score, used as a new index of persistency, was calculated for each animal and analysed with the following mixed linear model

PERS = PAR + H + SEA + YEAR + PREG + PROD + E

where PERS is the factor score corresponding to the persistency factor, PAR is fixed effect of the parity class (1, 2,…, 6), H is the random effect of the herd (1, …, 1393), SEA is the fixed effect of the season of calving (1=jan-feb,…, 6=nov-dec), YEAR is the fixed effect of year of calving (1=1989,.., 11=1999), PREG is the fixed effect of the pregnancy status (1=<100 DIM, 2>100 DIM), PROD is the covariate represented by the 305d yield, E is the random residual.

RESULTS AND DISCUSSION

Two common factors were able to explain about 80% of the original (co)variance of TD records. In table 1 are reported the factor loadings, i.e. the correlation coefficients between common factors and original variables.

Table 1. Common factor loadings

Variable	Factor 1	Factor 2
MILK1	0.83	0.24
MILK2	0.88	0.34
MILK3	0.81	0.47
MILK4	0.70	0.61
MILK5	0.57	0.74
MILK6	0.38	0.85
MILK7	0.21	0.77
Variance explained (%)	45	38

Factor 1 is mainly correlated with the first four TD records of the lactation and can interpreted as a level of production index (Wilmink, 1987). Factor 2 is mainly related with the last three TDs of the lactation. Then scores of Factor 2, calculated for all the cows in the data set, can be considered as an index of lactation persistency. Actually, they are able to separate lactation curves with different persistency (Figure 1).

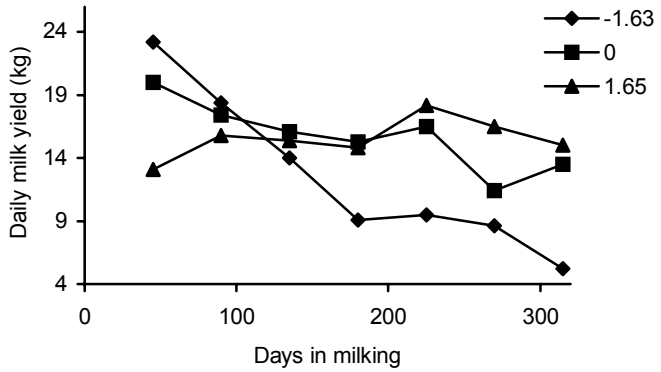

Figure 1. Lactation curves with different values of Factor2 scores

The distribution of Factor 2 scores is mound-shaped with mean zero and standard deviation 0.93 (Figure 2).

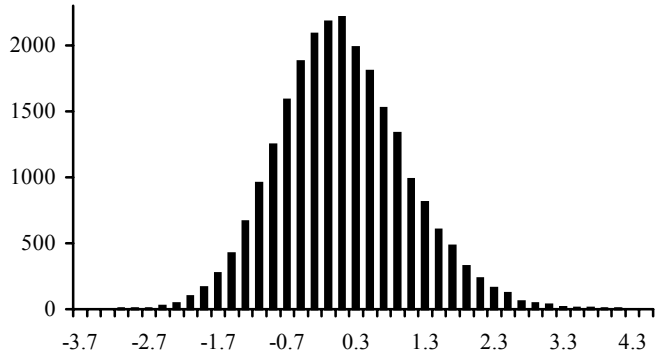

Figure 2. Distribution of the factor 2 scores

Factor 2 scores were affected significantly by all fixed effects considered in the mixed model (Table 2) except from pregnancy status. The random effect of the HERD explained a small quota of the total phenotypic variance (less than 8%).

Table 2. Main effect least square means of mixed model

	Parity			Calving	Season		Pregnancy	status
	Mean	Stderr		Mean	Stderr		Mean	Stderr
1	0.35	0.014	1	-0.30	0.015	1	-0.12	0.010
2	-0.18	0.014	2	-0.43	0.015	2	-0.13	0.008
3	-0.30	0.015	3	-0.30	0.016			
4	-0.31	0.016	4	-0.09	0.016			
5	-0.31	0.019	5	0.05	0.016			
6	-0.34	0.022	6	-0.01	0.015			

As expected, first parity cows had the highest persistency, that progressively decreased in higher parities. Furthermore cows calving in September-October were the most persistent, probably because they had the end of lactation in spring, i.e. when environmental conditions (pastures, climate) are better; on the contrary, lowest persistency has been observed for cows calving March-April, that had the final part of lactation in summer. Finally, no differences in persistency between cows pregnant before and after the first 100 days of lactation were highlighted. In fact the effect of gestation on lactation persistency is not clearly defined in literature and some authors suggest that it can be detected mainly in first parity cows (Gengler, 1996).

CONCLUSION

The multivariate Factor analysis of TD data within lactation allows for the calculation of a common factor that can be interpreted as an objective index of persistency. This index originates directly by the (co)variance structure of data and it is able to separate lactation curves with different flatness. The suitability of this persistency index has been further confirmed by the results of the phenotypic analysis.

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