

The factors affecting the lactation curve of Irish dairy cows

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Introduction

Since Ireland joined the EU the Irish dairy industry has grown, become stronger and has advanced quickly. In 1978, Killen and Keane examined the lactation curve for Irish dairy cows. In 1988, Crosse et. al. examined it again but the data was limited to four herds attached to Moorepark Research Centre over a two-year period. In 1999 Olori and Galesloot did some work on projecting partial lactation records; however, this did not examine the factors which influence lactation curves. The purpose of this study is to examine the lactation curve for Irish dairy cows using considerably more data than was available heretofore. It will also examine the mathematical equations which have been derived elsewhere, test their suitability to the Irish situation and if necessary, propose new models.

Materials and Methods

The data used in this paper mainly come from the Teagasc Farm Fertility Survey. It consists of monthly recordings from 10,277 lactations in 75 commercial herds of varying genetic makeup, weekly recordings from 1,408 lactations in four experimental spring calving herds, and 281 lactations from two experimental autumn calving herds, which belong to Moorepark Research Centre. In the first instance, a general linear model of the following form was examined:-

$$Y = \beta_0 + \beta_1 X_1 + \dots + \beta_n X_n + \varepsilon$$

to determine which categorical variables (e.g. lactation number, calving date, breed, represented by X_i 's) significantly affect total milk yield, represented by Y .

A literature search has revealed a total of 14 potential models to represent the shape of the lactation curve. Each of these has been fitted using the data, and it has been found that five of these models are useful in the Irish context.

Results

The results of the fitting of the general linear model confirm the well-documented effects of certain categorical variables in explaining variation in milk yield. It has been found that lactation number, calving month, feed and breed significantly affect milk yield. For example, the following equation was determined:

$$Y = 5868 .7 + 546 .1 X_1 - 383 .5 X_2$$

where Y = total milk yield
 X_1 = lactation number
 X_2 = calving month

The values of the coefficients (which are very highly significant) demonstrate the positive effect of lactation number and negative effect of later calving month on total yield.

In fitting the various lactation curve models cited in the literature, the data have been treated as pooled cross-

sectional and time series (which was not possible in study by Killen and Keane in 1978). This has led to considerable improvement in fit, as measured by R^2 value, in the case of the model of Wood (1967), which was used in that study. This model takes the following form:

$$y_n = an^b e^{cn}$$

where y_n = yield in week n of lactation and b and c represent the upward and downward slope of the curve respectively. The values of b and c are higher for all lactations (1, 2 and 3+), than in the study by Killen and Keane, indicating that the curves are steeper than found previously. (See Table 1).

Table 1: Comparison of Parameters for Wood's Linear Model

Study	Lactation	b	c
Killen & Keane	1	0.284	-0.048
	2	0.338	-0.059
	3+	0.371	-0.067
This Study	1	0.638	-0.057
	2	0.685	-0.066
	3+	0.729	-0.071

Four other models have also been fitted, the best fit (R^2 value of 0.92 when applied to the spring-calving data) being found using the five parameter model of Ali and Schaeffer. Still further improvements in fit have been achieved by fitting a model which combines the attributes of several models cited in the literature. (See Table 2)

Table 2: Combination of Models

Combinations	R -square
Ali & Schaeffer + Wilmink	0.927
Ali & Schaeffer + Guo & Swalve + Wilmink	0.936

Conclusions

It has been possible to arrive at well-fitting, and therefore reliable, models of the shape of the lactation curve for Irish dairy cows. This is particularly relevant to studies of seasonality in milk supply for processors as with these results it is possible to assess the impact any change in calving pattern would have on the seasonal pattern of milk supply.

Acknowledgements

We would like to acknowledge Teagasc Moorepark for funding this project.

References:

- Ali, T.E., Schaeffer, L.R., (1987) *Can. J. Anim. Sci.* 67:637-644
- Crosse, S., Van Heijst, G., O'Donovan, S. (1988) *Ir. J. Agri. Res.* 27:31-38
- Guo, Z., Swalve, H.H. (1995) *Interbull Meeting Prague, Czech Republic 7-8 September, 1995.*
- Killen, L., Keane, M. (1978) *Ir. J. Agric. Res.* 17:267-82
- Olori, V.E., Galesloot P.J.B. (1999) *Proc. 1999 Interbull Meeting, Zurich, Switzerland, 26-27 August 1999. Interbull Bulletin* 22:149-154
- Wilmink, J.N.M., (1987) *Livestock Production Science* 16:335-348
- Wood P.D.P., (1976) *Anim. Prod.* 22:35-40