Study of the phenotypic associations in some components of the lactation curve in grade Friesian dairy cattle

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Abstract

The study was based on 208 lactation records of 49 grade Friesian heifers and 79 grade Friesian dairy cows from Bunda Dairy Farm. Early lactation yields in week 1 and 2 and peak milk yields were correlated with total (305-day) lactation yields. Peak yield factors were computed based on total lactation yields and peak yields.

To predict peak yields from average daily yields of week 1 and week 2, factors ranging from 1.1 to 1.5 were observed. Correlation coefficients for heifers of average daily milk yield in week 1 and week 2 with peak yield were, respectively, 0.75 and 0.89 and for cows they were 0.60 and 0.92 and high ($p < 0.001$). Correlation coefficients for heifers of the average daily yield in week 1 and week 2 with total 305-day lactation yield were respectively, 0.69 and 0.80 and those for cows were 0.51 and 0.73 ($p < 0.001$). The correlation coefficients between peak yield and 305-day lactation yield for heifers and cows were similar, 0.84 and 0.83 respectively, and high ($p < 0.001$). The predicted increase in total 305-day lactation yield was 190kg and 169kg per kg increase in peak yield. Peak yield factors were 214 for heifers and 196 for cows.

It is concluded that early lactation yields, especially those in week 2 can be used to predict peak yields. Both week 2 and peak yields can also be used to predict 305-day lactation yields. Heifers can, therefore, be selected or retained into the milking herd using early lactation yields after initial selection based on pedigree.

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Introduction

In the feeding, management and breeding of dairy cattle, farmers are expected to group cows and manage them according to their genetic potential for milk production. To do this, the farmers could use certain generalisations to help them make early decisions on the type of action to take. Recording early lactation (5-14 days post-calving) is, therefore, essential in order to calculate regression and correlation coefficients which may be used to assess the potential for milk yield.

Assessment of the cow milking potential and peak yield can be obtained by using the close association between milk yield on day 14 or average daily milk yield of days 5-14 after calving with subsequent production, for example, peak yield and total lactation yield (Strickland, 1971; MAFF, 1983). In order to predict peak yield, factors of 1.20-1.31 times the average daily yield for cows and factors of 1.10-1.39 times the average daily yield for heifers have been used (Strickland, 1971, 1983; MAFF, 1975; Marsh, 1982). Using linear regression analysis, Blaxter (1950) and Broster (1972, 1974) demonstrated that the total lactation yield increase was 200kg per kg increase in peak yield. This value has been used by other workers in feeding systems (Castle and Watkins, 1979; McDonald, Edwards and Greenhalgh, 1981; Wilson and Brigstocke, 1981; Taylor and Leaver, 1984). Marsh (1982) noted that the relationships among lactation records are affected by nutrition of the individual cow, its nutritional history, health and general management.

Almost all of the studies quoted on relationships of some components of the lactation curve have been conducted on temperate, high-yielding dairy cattle. The use of these results in tropical areas on low yielding dairy cattle may lead to inaccurate relationships between early lactation yield, peak yield and total lactation yield which could be used in long-term feeding plans for dairy cattle. This study was carried out to determine the degree of association between early (week 1 and 2 and peak) and total 305-day lactation yields of grade Friesian dairy heifers and cows.

Materials and methods

Data were collected from records at Bunda College Farm where grade Friesian cattle were kept for milk production. These animals depended on grazing of planted Rhodes grass pastures with silage supplementation during the dry season. A concentrate was offered to cows during milking. The composition of the concentrate is presented in Table 1.

Table 1. Estimated composition of the concentrate offered

Ingredient	Proportion (kg as fed)
Maize germ	318
Maize meal	91
Groundnut haulm meal	68
Bean hay meal	68
Cotton seed cake	114
Chicken manure	114
Leucaena meal	68
Meat and bone meal	68
Monocalcium phosphate	7
Salt (NaCl)	7
Dry matter (g/kg)	913
Crude protein (g/kg)	209
Metabolisable energy (MJ/kg DM)	9.87

Milk yields were recorded daily and weekly records were maintained on a lactation transfer card. Two hundred and eight completed lactation records of 49 first calf heifers and 79 cows were used in the study. Individual cow lactation records numbered from one to five. Records with less than 120 days lactation period and those from sick animals were ignored.

For each cow or heifer, average daily yield for weeks 1 and 2 and peak yields were calculated. Total 305-day lactation yield adjusted to a 305-day lactation period was calculated. Assessment of the cow and heifer potential and other relationships were done by using regression analysis. Average daily yields in weeks 1 and 2 and after combining week 1 and 2 were related to peak yield and 305-day lactation yield with the former three being independent variables. Peak yield (independent variable) was also related to 305-day lactation yield. To obtain the peak yield factors, inverses of the regression coefficients were taken from relationships of weeks 1 and 2 separately with peak yield (Marsh,1982). To get an indication of lactation persistence (Marsh, 1982), the 305-day lactation yield was divided by peak yield to give peak yield factors for each group of animals.

To predict peak yields from early (weeks 1 and 2) lactation yields, peak yields factors can be used. The 305-day milk yields may be predicted by using 305-day yield/peak yield factors.

Results

Tables 2 and 3 present the correlation coefficients among early lactation yields and subsequent milk yields, and regression coefficients between peak yield and early lactation yields.

The average daily milk yield of weeks 1 and 2 showed significantly high ($p < 0.001$) correlations with peak yield. However, the average daily milk yield of week 2 showed a much greater correlation with peak yield in both heifers and cows than the average milk yield of week 1. Combining the average daily yield of week 1 and 2 in a multiple linear regression did not reveal any change in correlation coefficients for heifers, but was intermediate for cows.

The average daily milk yield for cows in week 1 was less correlated with peak yield, but the coefficient was significantly high ($p < 0.01$). Calculated peak yield factors which can be used to predict peak yields were higher than 1.1 when using average yields in week 1, but equal to 1.1 when in week 2 for both the heifers and the cows. The week 1 factor for cows was much higher (1.5) than for the heifers (1.3).

The correlation coefficients between average milk yield and 305-day yield were significantly high ($p < 0.01$). The correlation coefficients between the average daily milk yield and 305-day lactation yield were lower in week 1 than in week 2 for both heifers and cows,

Table 2. Correlation coefficients of subsequent milk yields and those in early lactation including peak yield factors

Early lactation yield	Peak yield	305-day lactation yield	Peak yield factors
Heifers			
Week 1 daily average	0.75***	0.69***	1.3
Week 2 daily average	0.89***	0.80***	1.1
Combined weeks 1 and 2 daily average	0.90***	0.79***	1.2
Peak average yield		0.84***	
Cows			
Week 1 daily average	0.60***	0.51***	1.5
Week 2 daily average	0.92***	0.73***	1.1
Combined weeks 1 and 2 daily average	0.72***	0.73***	1.3
Peak average yield		0.83***	

Significance: *** $P < 0.001$

although they were still significantly high ($p < 0.01$). The correlation coefficients between peak yield and total lactation yield for both heifers and cows were almost the same.

The increase in total lactation yield per kilogram (kg) increase in peak yield was 190.5kg for heifers and 169.5kg for cows (Table 3). The value for heifers was 12% higher ($p < 0.001$) than that for cows.

The overall total lactation yield/peak yield factor for the heifers is higher (213.8) than for all the cows (195.5) by 9% ($p < 0.01$). There was also a fall in factors in both groups as the peak yield increased, although the fall is less apparent for the heifers (Table 4). Heifers peaking between 7 and 13kg showed a less dramatic fall in the factors. The factors for cows peaking above 11kg yield were below 200 while all the factors for heifer are consistently above 200.

Table 3. Coefficients of regression of 305-day lactation yield on peak yields

Group	Regression coefficients (r)	Standard error
Heifers	190.5	17.7***
Cows	169.5	12.8***
Significance of r difference	***	

*** p <0.001

Table 4. Total lactation yield/peak yield factors of heifers and cows

Peak yield (kg)	No. animals	305-day yield/ Peak yield factors	Standard deviations
Heifers			
4-7	3	278.2	19.3
8-10	15	210.8	30.0
11-13	20	210.5	27.5
14-16	11	205.8	29.2
All	59	213.8	32.2
Cows			
4-7	—	—	—
8-1	16	204.8	28.2
12-14	33	195.2	23.9
15-17	24	190.2	23.7
18-20	6	193.5	6.2
All	79	195.5	24.1

Discussion

The significantly high correlation coefficients between average daily yields in early lactation (weeks 1 and 2) with peak yields and 305-day lactation have been observed by others (Strickland, 1971; 1979; Cheema and Basu, 1993; MAFF, 1983). Strickland (1979) observed that the yield on day 14 is almost as accurate a predictor of peak yield as the average yield of days 5-14. In this study, average daily yields of week 1 and week 2 separately have been used to assess the potential of the cows and both show a close relationship with peak and total yield. However, using average daily yields, the relationship is closer for week 2 in predicting peak yields, than when the average yields of week 1 are used. It is, therefore, recommended that week 2 yields be used as a criterion for selection to improve the peak as well as the 305-day milk yield in grade Friesian dairy cattle.

Peak factors obtained for week one (1.3 for heifers and 1.5 for cows) are similar to those observed by Marsh (1982). The value for cows is higher than for heifers probably due to the lower yields in relation to peak yields. However, the factors for both heifers and cows when week 2 was used are equal and are in agreement with those used by MAFF (1975) or those obtained by Strickland (1983). These results indicate that for the dairy herd at Bunda College Farm, the factors are equal (1.1) for both cows and heifers when yields in week 2 are used, but greater and different when yields in week 1 are used. This emphasises that week 2 yields should be used when predicting peak yield factors.

The close relationship between average daily peak yield and total 305-day lactation yield and also between the average daily milk yield in week 2 and 305-day milk yield is in agreement with Blaxter (1950), Broster (1972, 1974), Reynolds, DeRouen and Bellows (1978), Robinson, Yusuf and Dillard (1978) and MAFF (1983). The correlation coefficients for heifers and cows between the average daily yield in week 1 and total 305-day lactation yield are rather poor and contribute only between 26 and 48% to the total variation in total 305-day milk yield. Multiple linear regression analysis, using both week 2 and peak yields to predict 305-day milk yields, did not reveal any improvements over either week 2 average daily yield or peak yield when used individually. This probably shows reduced accuracy of the multiple linear regression as opposed to better methods like Bayesian estimation (Goodall and Sprevak, 1985) used to predict the total lactation curve. Early lactation yields (week 2 and peak) can be used individually as selection criteria for 305-day milk yields.

The predictions for total 305-day lactation yield were 190.5kg for heifers and 169.5kg for cows per kg increase in peak milk yields. These are much lower values than reported by Wilson and Brigstocke (1981) and Taylor and Leaver (1984). This might probably be due to differences in breed, nutrition and general management (Marsh, 1982). It may be showing a lower yield potential of the grade Friesians than the purebred temperate Friesians. Since records of sick animals were ignored, health of the cows and heifers could not be one of the factors affecting these values.

The overall 305-day yield/peak yield factors calculated in this study are not different from those calculated by Marsh (1982). The factor for heifers is higher than that for cows indicating that the heifers have a more persistent lactation curve. There is, like in Marsh's study, a fall in the factors as peak yield increases, indicating a fast decline in the lactation curve for cows and for heifers with high peak yield, although this decrease is less apparent with heifers peaking between 7 and 13kg yield. Most of the factors for cows are below 200 showing a faster decline than in heifers. The factors for heifers are consistently above 200 while those for cows peaking above 11kg are less than 200 indicating a shortfall in nutrition or general management for both at higher levels of peak yields. Cheema and Basu (1983) observed heritability of 0.51 for peak yield with expected direct response of 1.1kg in peak yield and 98kg in total 305-day yield. Therefore, peak yield could also be chosen as a criterion for selecting and retaining heifers for improved total lactation yield after initial selection based on pedigree.
Although these estimates are simple mathematically, they are useful generalisations for long term planning of the feeding of the lactating cattle to allow farmers to predict the performance of their animals. Selection of heifers for retention in the herd could also be based on early lactation performance. These are, therefore, quick and simple tools for use in practical situations.

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