Relationships between Milk Yield in the First Lactation, Age at First Calving and Stayability in Dairy Cattle

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THIS study was designed to evaluate the influence of age at first calving and the first lactation yield on stayability traits. Data were obtained from the Milk Marketing Board of England and Wales and included 21012 first lactation records of British Friesian-Holstein cows.

The effect of age at first calving on the length of herdlife was highly significant (P < .01). Its effect on survival up to the second lactation was significant (P < .05) while the effect on survival up to the third lactation was found to be nonsignificant. The relationships between milk yield in the first lactation and stayability traits were highly significant. First lactation milk yield seemed to explain more of the total variation in stayability traits than the age at first calving.

The partial regression coefficients showed that an increase in milk yield of 90 kg is equivalent to a reduction of one month in age at first calving in affecting the length of herdlife.

Selection on the basis of age at first calving and milk yield in the first lactation would lead to an increase in the length of herdlife.

The economic returns from dairy cattle depends mainly upon the ability to produce and reproduce for a long time and upon the animal efficiency to convert the feeds into milk. Increasing milk yield and the length of productive life is desirable in cows in promoting the net profit. Early selection is also desired for the maximization of the genetic progress.

A reduction in age at first calving will minimize the cost of raising the heifers, shorten the generation interval and maximize the number of lactations per cow.

Many workers (e.g. Gill and Allaire, 1976; Freeman, 1981) pointed out that herdlife contributes to profitability of both cows and sires. So, any relationship between milk in the first lacta-

tion, age at first calving and herdlife would have an advantage on the evaluation of dairy cattle (White and Nichols, 1965; Hoque and Hodges, 1980).

Robertson and Barker (1966) reported that the length of herdlife is an important overall measure for stayability.

The relationship between stayability and first lactation milk yield was found to be positive in many investigations (e.g. Ashmawy, 1984; Hogue and Hodges, 1980; Van Vleck, 1964; White and Nichols, 1965). A negative correlation was found between age at first calving and stayability defined as the number of lactations completed up to the fifth lactation. Hague and Hodges (1980) found that late calving cows had fewer lactations during their productive life than early calving cows.

The objective of this present study was to investigate the association between milk yield in the first lactation, age at first calving and stayability in British Friesian-Holstein cattle.

Material and Methods

Data were obtained from the Milk Marketing Board of England an Wales (MMB) and included 21021 first lactation records of British Friesian-Holstein cows. Data included only the cows which had the opportunity to have completed five lactations. In each record : age at first calving, milk yield during a lactation period of 200 to 305 days, the number of lactations completed up to the fifth lactation (NLC), survival up to the second lactation (S1) and up to the third lactation (S2) were available.

More information on the data and parameters measured in this study was given in detail by Ashmawy (1984).

The general linear model procedure of cross-classified non-interacting random effects of LSML 76 (Harvey, 1977) was used to study the relationship between the variables under study :

$$Y_{ijk} - U + h_j + F_j + c_{ijk}$$

were Yijk : the survival up to 2nd lactatio nor up to 3rd lactation or the number of lactations completed up to the fifth lactation,

h_i : herd — year — season absorbed

F_j : partial regressions for continuous independent variables (milk yield and/or age at first calving).

Results and Discussion

Means, standard deviations (SD) and coefficient of variability (C.V.) for milk yield and stayability traits are given in Table 1. Means for milk yield in the first lactation was 4160 kg with standard deviation of 650.9 kg. The coefficient of variability for milk was 15.6%. These estimates were nearly similar to those obtained by Hill, Edward, Ahmed and Thompson (1983) on another set of British Friesian-Holstein cattle. The coefficient of variability for stayability as expressed as the number of lactation completed up to the fifth lactation was lower than the estimate of 66.7% obtained by Hogue and Hodges (1980) using Canadian records of Holstein cows. The average age at the first calving was 32 mo with standard deviation of 2.8 mo and coefficient of variability of 8.8% (Table 1). This value of the mean was slightly larger than that reported by White and Nichols (1965). This difference is partially due to the upper limit of 34 mo for age at first calving placed on their data.

Table (1): Means, standard deviations (SD) and coefficient of variation (C.V) of traits

Trait	Mean	SD	C.V %
Milk (kg)	4160	650.9	15.6
Age at first calving (mo)	32	2.8	8.8
NLC [+]	2.8	1.32	47.1
S1 [++]	0.70	0.383	54.7
S2 [+++]	0.49	0.421	85.9

+ NLC : number of lactations completed up to the fifth lactation.

++ S1 : survival up to the second lactation.

+++S2 : survival up to the the third lactation

Results of analysis of variance performed on the present data indicated that the effect of age at first calving on the length of herdlife was highly significant. Its effect on survival up to the 2nd lactation was significant while the effect on survival up to the 3rd lactation was found to be nonsignificant (Table 2). The simple correlations between each of NLC. S1 and S2 and age at first calving were — .0426, — .0196 and — .0165, respectively. The negative sign of the correlations indicates that there is a trend for a decrease in NLC, S1 and S2 as the age at the calving increased. Hoque and Hodges (1980) found that the late calvers had a shorter herdlife than those that calved at a young age. Regressions of NLC, S1 and S2 on calving age were — .0201 lactation, — .0027 unit and — .0025 unit, respectively, for each month increase in age at first calving (Table 3).

Table(2): Analysis of variance for stayability treits; age at first calving as a concomitant variable.

S.O.V	df	MS^a		
		NLC	S1	S2
Herd-year-season	9014	3.47^{++}	.291^{++}	.346^{++}
Regresson on age	1	37.81^{++}	.674^{+}	.581
Residual	11996	1.73	.147	.177

$^{++}$ highly significant (at P <.01).
$^{+}$ significant (at P <.05).
^{a} NLC : number of lactations completed up to the fifth lactation.
  S1 : survival up to the second lactation.
  S2 : survival up to the third lactation.

The analysis of variance in Table 4 indicated that the regression coefficients of stayability traits on the first lactation milk yield were highly significant. The highly significant regression coefficient of NLC on milk yield was .0004 lactation for each kilogram increase in milk yield. White and Nichols (1965) estimated the simple intrsire — herd — period regression on first lactation milk yield as .0003 lactation per one kilogram milk. Their estimate was also highly significant. The present results indicated that high producing cows in their first lactation remained in the herd longer than the lower producer ones. De Lornzo and Everett (1982), Hoque and Hoges (1980), Van Vleck (1964), White and Nichols (1965) and others came to the same conclusion.

Table (3): Regression coefficients ($\pm$ SE) for stayability traits on milk and/or age at first calving[a]

Milk (kg) (M)	Age (mo)	M^2	R^2 %
	NLC		
3.6E-4 ($\pm$ 1.8E-5)[++]			3.2
3.9E-4 ($\pm$1.8E-5)[++]		-1E-7 ($\pm$1E-8)[++]	4.4
	-.02008 ($\pm$4.295E-3)[++]		.2
3.9E-4 ($\pm$1.8E-5)[++]	-.03518 ($\pm$4.279E-3)[++]		4.1
	S 1		
9E-5 ($\pm$5E-6)[++]			2.4
1E-4 ($\pm$5E-6)[++]		3E-8 ($\pm$ 0.0)[++]	3.7
	2.68E-3 ($\pm$ 1.249E-3)[+]		.04
1E-4 ($\pm$5E-6)[++]	6.44E-3 ($\pm$1.251E-3)[++]		
	S 2		
1.1E-4 ($\pm$6E-6)[++]			2.8
1.2E-4 ($\pm$6E-6)[++]		3E-8 ($\pm$0.0)[++]	3.7
	2.49E-3 ($\pm$1.375E-3)		.03
1.1E-4 ($\pm$6E-6)[++]	6.89E-3 ($\pm$1.374E-3)[++]		3.1

[a] The symbol E-C indicates the number to left is multiplied by 10^{-C}

NLC : number of lactations completed up to the fifth lactation.

S 1 : survival up to the second lactation.

S 2 : survival up to the third lactation.

Partial regression coefficients are significantly different from zero at 5% (+) and 1% (++) probability.

When the model included milk and (milk)^2 in the first lactation as a linear and quadratic regressions, the two corresponding partial regression coefficients were 3.9×10^{-4} and -1×10^{-7},

1×10^{-4} and -3×10^{-8}, and 1.2×10^{-4} and -3×10^{-8} for NLC, S1 and S2, respectively (Table 3). Although the coefficients of determination (R^2) were larger when considering linear and quadratic form of the milk yield than those of linear form alone (4.4 vs 3.2, 3.7 vs 2.4 and 3.7 vs 2.8% for NLC, S1 and S2, respectively), the magnitude of R^2 was still very low (below 5%). The quadratic regression coefficient indicates that a reduction in the length of herdlire (NLC) is expected when milk yield in the first lactation exceeds 3953 kg. This value is slightly larger than the estimate of 3400 kg obtained by Bakels (1959) on German brown cows, but is smaller than 6300 kg reported by White and Nichols (1965).

Table (4): Analysis of variance for stayability traits; milk yield as a concomitant variable

S.O.V.	df	MS^a		
		NLC	S 1	S 2
Herd-year-season	9014	3.54^{++}	$.294^{++}$	$.352^{++}$
Regression on milk	1	659.82^{++}	42.387^{++}	58.621^{++}
Residual	11996	1.68	.143	.172

++ highly significant (at P < .01).

^{a}NLC : number of lactation completed up to the fifth lactation.

   S 1 : survival up to the second lactation.

   S 2 : survival up to the third lactation.

A model including regression on age at first calving and milk yield in the first lactation indicated that the partial regressions of all stayability traits in this study were highly significant and they all had the same trends (Table 3). The multi-

ple correlation coefficients between each of NLC, S1 and S2 and both age at first calving and milk yield were highly significant (.20, .17 and .18, respectively. These findings indicated that while both age at first calving and milk production in the first lactation may be important variables in affecting stayability they are of little predictive value. First lactation milk yield seemed to explain more of the total variation in stayability traits than the age at first calving as indicated in Table 3 by R^2. The partial regression coefficients showed that an increase in milk yield of 90 kg is equivalent to a reduction of one month in age at first calving in affecting the length of herdlife (NLC).

From the highly significant relationships prevailing between stayability traits and age at first calving and milk production in the first lactation, selection on the basis of the two latter traits would lead to an increase in the length of herdlife and cows would produce more offspring. The early selection is essential for minimum generation interval and subsequently maximum genetic progress.

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العلاقة بين كمية اللبن فى الموسم الأول والعمر عنـــد أول ولادة والحياة الانتاجية فى ماشيه اللبن

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أجريت هذه الدراسة لتقييم تأثير العمر عند أول ولادة وكمية اللبن فى الموسم الأول على صفات الحياة الانتاجية . واشتملت البيانات على ٢١٠١٢ سجل للموسم الأول لابقار هولستين ــ فريزيان البريطانية .

كان تأثير العمر عند أول ولادة على طول الحياة الانتاجية معنوى جدا . أما تأثيره على البقاء الى الموسم الثانى فيمعنوى فى حين كان تأثيره على البقاء الى الموسم الثالث غير معنوى . العلاقة بين كمية اللبن فى الموسم الأول وصفات الحياة الانتاجية معنوية جدا . وقد ظهر واضحا ان كمية اللبن فى الموسم الأول تفسر الاختلافات فى صفات الحياة الانتاجية أكثر من العمر عند أول ولادة .

وظهر من معاملات الانحدار الجزئية ان زيادة محصول اللبن فى الموسـم الأول بمقدار ٩٠ كجم تكافىء انخفاض العمر عند أول ولادة بمقدار شهر وذلك من حيث تأثيرها على طول الحياة الانتاجية .

الانتخاب الذى يعتمد على العمر عند أول ولادة وكمية اللبن فى الموسـم الأول سوف تؤدى الى زيادة فى طول الحياة الانتاجية .