program is used in which calving begins about February 15. The type of forage is range or bermuda. An 88 percent calf crop with 400-lb weaning weights is considered average for cows raising their calves. Rations I, II, and III are priced at $186, $175, and $159/ton, respectively. The ingredient prices used to arrive at the ration costs are shown at the bottom of Table 4. A $20/ton markup is included.

The feasibility of early weaning is evaluated under four situations:

a. There is adequate standing roughage, and the cow's nutrient requirements can be met with cottonseed meal and some supplemental hay during periods when ice and snow covers forage.

b. There is a shortage of standing roughage, but grass hay will be fed along with cottonseed meal to meet the cow's nutrient requirements.

c. There is inadequate standing roughage, but the hay supply is inadequate to meet the cow's requirements. Cows will be in poor condition at breeding in the spring of 1981.

d. Same as c, but we will early wean at 6-8 weeks of age in the spring of 1981.

For cows we intend to early wean, we will maintain sufficient condition to insure that the cows can calve and nurse for 6 weeks.

Note that for 1981, early weaning about breaks even with purchasing grass hay in situations where forage is scarce. Assuming a 98 percent calf crop the following year from early weaned cows along with their lower wintering cost, early weaning shows a $48 advantage for the 2-year period over purchasing hay in 1980-81. Early weaning netted a $104 advantage over living through poor conception rates with underfed cows.

The most likely place for early weaning is in a situation where poor condition rates are expected. Depending on concentrate and hay prices, early weaning might be profitable when large amounts of hay must be purchased for the cow.

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Influence of Month of Calving on Daily Milk Yield: Progress Report on Development of a Model of a Cow-calf System

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Story in Brief

Daily milk yields of 2-, 3- and 4-year-old Holstein, Holstein-Hereford cross and Hereford cows were used to develop equations to describe the lactation curve. Then, the equations were used to predict the average daily milk yield for different weeks of the lactation. Breed, year and month of calving affected average daily milk yield for each week of lactation.

Introduction

Milk yield is affected by environmental factors such as season of calving and age of cow, but how some of these environmental factors affect the shape of the lactation curve is uncertain. Therefore, the purpose of this paper is to report the influence of month of calving on the shape of the lactation curve.

Experimental Procedure

Hereford, Holstein x Hereford cross and Holstein cows that were maintained on tallgrass native range or under completely confined drylot conditions weaned calves in 1971, 1972 and 1973 as 2-, 3- and 4-year-olds at the Southwestern Livestock and Forage Research Station. Within each breed, groups of cows were fed a moderate or high level of winter supplement, and, in addition, a group of Holstein cows received a very high level of winter supplement. Moderate, high and very high levels represented the amount of winter supplement believed essential to maintain a high level of reproduc-

Table 1. Number of cows in drylot used in estimating lactation curves

Breed	Year calf was weaned	Month of calving				Total
		November	December	January	February	
Holstein	1971	2	7	3		12
	1972	1	7	6	1	15
	1973	2	4	5	3	14
	Total	5	18	14	4	41
Holstein-Hereford cross	1971	2	4	4		10
	1972		4	4	1	9
	1973		3	5	1	9
	Total	2	11	13	2	28
Hereford	1971	2	6	2		10
	1972		4	5	1	10
	1973		5	4		9
	Total	2	15	11	1	29

Table 2. Number of cows on range used in estimating lactation curves

Breed	Year calf was weaned	Month of calving				Total
		November	December	January	February	
Holstein	1971	6	16	10		32
	1972		11	4	1	16
	1973	2	7	10	13	32
	Total	8	34	24	14	80
Holstein-Hereford cross	1971	7	12	6	1	26
	1972		12	7	2	21
	1973	1	3	10	10	24
	Total	8	27	23	13	71
Hereford	1971	2	10	10	2	24
	1972		11	9	2	22
	1973	1	2	8	16	27
	Total	3	23	27	20	73

Table 3. Predicted average daily milk yield of cows in drylot

		Calves weaned in 1971 and born in month			Calves weaned in 1972 and born in month				Calves weaned in 1973 and born in month			
Breed	Week of lactation	Nov	Dec	Jan	Nov	Dec	Jan	Feb	Nov	Dec	Jan	Feb
Holstein	4	25.4	22.0	25.4	30.9	20.9	11.9	22.8	33.6	27.7	24.9	15.9
	8	29.6	26.8	27.5	33.7	24.1	20.6	26.4	28.9	28.8	25.6	24.7
	12	29.4	27.4	27.3	35.7	26.4	26.7	29.8	26.6	28.7	25.4	27.3
	16	27.5	26.0	26.2	37.4	28.4	30.9	33.4	25.1	28.1	24.8	26.3
	20	24.8	23.7	24.7	38.8	30.2	33.5	37.1	24.1	27.3	24.1	23.5
	24	21.8	21.1	23.0	40.2	31.9	34.9	41.2	23.3	26.3	23.2	20.1
	28	18.9	18.4	21.2	41.5	33.5	35.4	45.6	22.7	25.2	22.3	16.5
	32	16.3	15.9	19.5	42.7	35.1	35.1	50.3	22.3	24.1	21.3	13.3
Holstein-	4	24.1	20.2	23.6		17.8	12.1	19.2		23.8	21.9	18.2
Hereford	8	24.2	21.6	21.6		19.4	16.4	17.2		26.0	21.1	19.2
cross	12	22.7	21.1	19.3		20.3	18.6	16.6		25.7	20.3	19.2
	16	20.7	19.8	17.1		20.9	19.7	16.5		24.4	19.4	18.8
	20	18.6	18.3	15.1		21.3	19.9	16.6		22.6	18.5	18.2
	24	16.5	16.6	13.2		21.5	19.7	16.8		20.7	17.7	17.4
	28	14.6	15.0	11.5		21.7	19.1	17.2		18.7	16.8	16.6
	32	12.8	13.4	10.0		21.8	18.3	17.7		16.8	16.0	15.8
Hereford	4	10.8	11.7	14.4		17.0	14.5	14.6		18.7	15.2	
	8	12.5	14.2	14.8		16.5	15.2	20.9		17.0	17.6	
	12	11.8	13.9	13.6		15.5	15.3	22.1		16.2	17.5	
	16	10.3	12.4	11.8		14.4	15.3	20.7		15.7	16.3	
	20	8.5	10.6	10.1		13.3	15.1	18.2		15.3	14.7	
	24	6.9	8.8	8.5		12.3	14.8	15.3		15.0	13.0	
	28	5.4	7.1	7.0		11.3	14.6	12.5		14.8	11.3	
	32	4.2	5.6	5.8		10.3	14.2	10.0		14.6	9.7	

Table 4. Predicted average daily milk yield of cows on range

Breed	Week of lactation	Calves weaned in 1971 and born in month				Calves weaned in 1972 and born in month			Calves weaned in 1973 and born in month			
		Nov	Dec	Jan	Feb	Dec	Jan	Feb	Nov	Dec	Jan	Feb
Holstein	4	29.0	25.9	20.0		26.6	18.8	34.4	24.2	26.5	28.3	23.7
	8	24.1	23.3	24.0		31.5	31.8	41.3	23.3	29.3	31.0	28.2
	12	22.9	22.6	25.5		33.4	37.0	39.8	23.7	29.6	30.9	28.8
	16	23.0	22.7	25.9		33.9	37.1	35.1	24.6	28.8	29.6	27.6
	20	23.8	23.2	25.7		33.6	34.1	29.5	25.8	27.5	27.8	25.7
	24	25.1	24.0	25.0		32.8	29.8	24.0	27.3	25.8	25.8	23.3
	28	26.9	25.0	24.1		31.7	25.1	19.2	29.0	24.1	23.7	20.8
	32	29.0	26.2	23.0		30.4	20.6	15.0	31.0	22.3	21.6	18.4
Holstein-	4	27.3	20.3	18.7	18.0	21.7	19.6	21.9	23.0	21.0	20.6	17.1
Hereford	8	20.1	18.6	18.9	21.5	22.6	24.2	22.6	20.1	20.4	24.4	20.7
cross	12	17.9	18.0	18.5	21.8	22.8	25.1	22.6	19.1	20.2	24.8	21.5
	16	17.2	17.8	17.9	20.8	22.6	24.2	21.8	18.8	20.2	23.8	21.0
	20	17.2	17.8	17.2	19.1	22.2	22.5	20.7	18.8	20.2	22.1	19.8
	24	17.7	18.0	16.5	17.1	21.7	20.4	19.5	19.1	20.3	20.1	18.3
	28	18.6	18.2	15.7	15.1	21.1	18.2	18.1	19.5	20.4	18.0	16.7
	32	19.7	18.5	15.0	13.2	20.5	16.0	16.8	20.0	20.5	15.9	15.0
Hereford	4	14.6	12.1	14.7	17.6	14.7	12.7	17.8	14.7	17.4	16.4	15.3
	8	11.8	12.0	14.8	15.2	14.8	16.5	19.1	14.4	18.1	16.7	17.0
	12	10.9	11.9	14.4	13.8	14.5	17.2	17.3	14.0	16.5	15.8	16.4
	16	10.7	11.8	13.6	12.9	14.0	16.3	14.6	13.5	14.3	14.4	15.0
	20	10.7	11.7	12.8	12.1	13.4	14.7	12.0	13.0	12.0	13.0	13.3
	24	10.9	11.6	12.0	11.5	12.7	12.9	9.5	12.4	9.9	11.5	11.6
	28	11.3	11.5	11.2	11.0	12.1	11.0	7.5	11.9	8.1	10.1	9.9
	32	11.8	11.3	10.4	10.5	11.4	9.3	5.8	11.4	6.5	8.9	8.4

tion in Hereford, Holstein x Hereford cross and Holstein cows, respectively. The performance of these cows is summarized, and the detailed description of management practices is presented by Kropp *et al.* (1973a), Kropp *et al.* (1973b), and Holloway *et al.* (1975).

Seven estimates of daily milk yield obtained at approximately 1-month intervals were obtained and used to estimate (non-linear least squares procedure) the parameters a, b and c of the Gamma function, $Y = a\, n^{b} e^{-cn}$, where Y is the average daily milk yield during the n^{th} week of lactation. The a, b and c parameters determine the shape of the lactation curve. The Gamma function was used because the estimation of the parameters is relatively easy, and the sum of the squared differences between actual and predicted values is smaller with the Gamma function than with other equations (Wood, 1967; Cobby, 1978). Average daily milk yields per cow for Week 4 through Week 32 of lactation were predicted with the developed equations. In the analysis of the predicted average daily milk yields for Weeks 4 through 32 of lactation, breed, year and month influenced milk yield each week of the lactation while level of winter supplement did not significantly influence predicted milk yields. Then, the averages of the predicted daily milk yields for each breed, year of weaning and month of calving subclasses were used to estimate the parameters a, b and c of the Gamma function. Thus, an equation describing the lactation curve of each breed, year of weaning and month of calving was developed.

Results and Discussion

The majority of the cows calved in December or January (Tables 1 and 2). When examining the predicted average daily milk yield of cows in drylot (Table 3) and on range (Table 4) several trends were apparent:

1. Breed influenced the average daily yield, with Holsteins producing the largest amount.
2. Year influenced the average daily yield, with year 1972 having the largest production. However, year effects are confounded with age of cow and breed of the calf's sire.
3. Cows on range calving in January produced more milk than cows calving in December during the middle part of lactation (approximately Weeks 8 through 20). Some of the predictions for cows on range calving in November and December indicate an increase in milk production at the end of lactation. Month of calving influenced milk yield of cows in drylot, but a consistent trend was not noted.

Development of equations that describe the lactation curve is one phase of the development of a model to describe a cow-calf system. These equations will be used to simulate milk yield.

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