area and cutability of 51.1 percent. The average Warner-Brazler shear force value of 13.5 lb indicated a very desirable level of tenderness. A high level of consumer acceptability would be anticipated for meat from these carcasses.

An economic evaluation of feedlot performance of Charolais and Limousin sired steers and heifers is presented in Table 4. Feed costs, overhead costs and carcass sale value were based on prevailing prices for January 7, 1980. Limousin sired steers returned $11.16 more per head above feedlot expense than Charolais sired steers. Conversely, Charolais cross heifers returned $36.98 more per head than Limousin cross heifers.

There is no apparent reason for the relatively large differences in feedlot performance and carcass traits between Limousin cross steers and heifers as compared to the Charolais cross steers and heifers. Additional data will be required to clarify these sex differences.

Although these Charolais and Limousin bulls were mated to a diverse group of crossbred cows, calves produced were quite uniform in muscling and conformation, performed adequately in the feedlot and yielded very desirable carcasses. These data would suggest that either sire breed could be successfully utilized in a terminal cross mating system. The choice of available bulls within each of these breeds may be as important as the selection of breed to sire the calves.

Comparison of Machine Milkout and Calf Nursing Techniques for Estimating Milk Yields of Various Two-Breed Cross Range Cows

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Story in Brief

Milk yields were estimated monthly from April through September by machine milkout and calf nursing techniques for 71 4-year-old, two-breed cross cows. Overall, average milk yield estimates were 16.18 lb/day by machine milkout and 12.79 lb/day by calf nursing with a difference of 3.38 lb/day. The two methods were similar for comparing cow group differences; however, machine milkout estimates averaged 27 percent more milk than calf nursing estimates. The correlation between estimates of milk yield by machine milkout and by calf nursing averaged over crossbred cow groups was .47. Correlations between machine milkout and calf average daily gain (ADG) or weaning weight were .29 and .20, respectively, while correlations between calf nursing and ADG or weaning weight were .16 and .09, respectively.

Introduction

The importance of milk production is directly reflected by calf average daily gains and weaning weights. Therefore, estimating the yield of milk produced by various breeds and crossbreds is important to characterize biological differences that do exist between breed types. This information can aid producers in selecting breeds and crossbreds that will optimize production efficiency.

When evaluating estimates of milking ability, it is important to consider how the estimates were obtained. The majority of milk yields for beef cows have been estimated by machine milkout (with or without an oxytocin injection prior to milking) or calf nursing (weigh-suckle-weigh) methods. The objective of this study was to compare machine milkout (with oxytocin) and calf nursing techniques for estimating milk yields of various two-breed cross cows under range conditions. This study is a portion of an extensive research program to compare lifetime productivity of various two-breed cross cows mated to a bull of a third breed.

Experimental Procedures

The data used in this study were obtained from 71 4-year-old crossbred cows and their calves in the summer of 1978. Eight crossbred cow groups were involved: Hereford x Angus (HA), Angus x Hereford (AH), Simmental x Angus (SA), Simmental x Hereford (SH), Brown Swiss x Angus (BA), Brown Swiss x Hereford (BH), Jersey x Angus (JA) and Jersey x Hereford (JH). Nine cow-calf pairs from each crossbred group were identified for estimating lactational performance, with the exception of SH, which had only eight cow-calf pairs available.

The calves were born from late January through early April. Half of the calves produced by each cow group were sired by Charolais bulls and the other half by Limousin bulls. All calves remained with their dams on native and bermudagrass pastures until weaning at an average age of 205 days.

Lactational performance was determined monthly from April through September by machine milkout and calf nursing on each cow-calf pair. In order to determine the effect of cow-calf separation time on 24-hr milk yield estimates, three cows of each crossbred group were allocated to one of three cow-calf separation times: 6, 9 or 12 hours. Thus, there were a total of 24 cows assigned to each time group, with the exception of the 9-hour separation period, which had only 23 cows.

Because of time and labor requirements for milking range cows by machine, it was necessary to divide the herd and do machine milking on two different days. One group of 36 cows (balanced as nearly as possible by calf separation time and crossbred cow group) were milked 1 day per month and the other group of 35 cows milked the following week. Calf nursing techniques were less time consuming; therefore estimates of milk yield for all time groups and crossbred cow groups were obtained in one day during the interim period between machine milkouts. Prior to machine milkout or calf nursing, calves were separated from the cows 6 hours, placed with their dams to suckle and separated again for 6, 9 or 12 hours, depending on the respective cow-calf separation time group.

For machine milkout, approximately 15 minutes prior to milking, cows were given an intramuscular injection of 10 to 30 mg of the tranquilizer ace promazine depending on cow size. Immediately prior to milking, cows were injected with 1.5 mg of syntocin, a synthetic oxytocin, in the jugular for milk letdown. Cows were milked out by a portable vacuum pump milking unit. Milking time per cow varied from 5 to 10 minutes. Each cow's udder was stripped out by hand to assure a complete milkout. The milk was weighed and two samples taken for milk composition analysis.

For calf nursing, calves were weighed, placed with their dams, allowed to suckle and then reweighed. The difference in the two calf weights represents milk consumed and was the estimate of milk yield. Calf nursing was conducted at two successive 6-hour, one 9-hour or one 12-hour interval. The two 6-hour estimates were added together, then doubled and the 9- and 12-hour estimates were multiplied by 2.67 and 2, respectively, to obtain 24-hour milk yields.

Results and Discussion

All means presented have been adjusted for appropriate significant main effects and two factor interactions. Table 1 presents adjusted means for milk yields of each crossbred cow group averaged over months. The two methods were similar for comparing cow group differences; however, machine milkout estimates averaged 26.5 percent more milk than calf nursing estimates. Overall, average milk yield estimates were 16.8 lb/day by machine milkout and 12.79 lb/day by calf nursing with a difference of 3.38 lb/day. The difference between the two methods was consistent, varying from 2.16 to 3.80 lb/day, with the exception of the BH cow group (difference of 5.51 lb/day). By machine milkout, Jersey crosses and BA cows were similar, averaging 3.16 lb/day more milk than HA reciprocal crosses, and other groups were intermediate. By calf nursing, Jersey crosses, BA and SA cows were similar, averaging 3.54 lb/day more milk than HA reciprocal crosses with SH and BH groups intermediate. Milk yields and milk composition traits by crossbred cow groups have been summarized in more detail in the 1979 Animal Science Research Report MP-104:132-136.

Table 2 presents adjusted means for milk yield by month averaged over crossbred cow groups. The difference in milk yields by the two procedures was not significant in April. During May and June, months of peak lactational performance, due to stage of lactation and improved forage conditions, the difference between the two methods averaged 6.17 lb/day, indicating the calves were perhaps not consuming all of their

Table 1. Adjusted means for milk yields for each crossbred cow group.

Crossbred cow groups[1]	No. of cows	Method of estimation: Machine milkout (lb/day)	Method of estimation: Calf nursing (lb/day)	Difference[2] (lb/day)
HA	9	$14.01 \pm .87^{d}$	$10.36 \pm .82^{c}$	$3.80 \pm .93$
AH	9	$14.73 \pm .89^{cd}$	$11.21 \pm .84^{bc}$	$2.88 \pm .96$
SA	9	$16.25 \pm .87^{abcd}$	$14.88 \pm .82^{a}$	$2.16 \pm .98$
SH	8	$15.29 \pm .93^{bcd}$	$12.01 \pm .87^{bc}$	2.99 ± 1.00
BA	9	$17.51 \pm .92^{ab}$	$14.73 \pm .87^{a}$	$2.99 \pm .96$
BH	9	$16.61 \pm .89^{abcd}$	$11.43 \pm .83^{bc}$	$5.51 \pm .93$
JA	9	$18.15 \pm .87^{a}$	$14.60 \pm .82^{a}$	$2.96 \pm .96$
JH	9	$16.92 \pm .89^{abc}$	$13.10 \pm .84^{ab}$	$3.72 \pm .93$
Overall	71	$16.18 \pm .31$	$12.79 \pm .29$	$3.38 \pm .33$

[a,b,c,d]Means in the same column that do not share at least one superscript in common are significantly different ($P<.05$).

[1]A=Angus, H=Hereford, S=Simmental, B=Brown Swiss and J=Jersey.

[2]Overall F-test not significant ($P>.05$).

Table 2. Adjusted means for milk yield by month[1].

Month	No. of cows	Method of estimation: Machine milkout (lb/day)	Method of estimation: Calf nursing (lb/day)	Difference (lb/day)
April	69	16.81±.39	16.63±.50	.02±.44
May	71	20.42±.46	13.96±.55	6.26±.76
June	71	20.38±.57	14.18±.50	6.07±.64
July	71	16.66±.49	14.12±.46	3.23±.65
August	71	14.07±.38	12.05±.60	2.03±.69
September	71	8.77±.26	5.22±.27	2.88±.36

[1]Pooled over adjusted crossbred cow group means.

mothers' milk. The differences between the techniques declined through the remainder of the lactation from 3.23 lb/day in July to 2.03 and 2.88 lb/day in August and September, respectively.

Techniques for estimating milk yield in other studies varied concerning separation times of cow and calf prior to obtaining estimates. In this study, estimates were taken by both methods following 6, 9 or 12 hours of cow-calf separation. Machine milkout and calf nursing estimates of 24-hr milk production were highest for the 6-hour time group (17.33 and 13.45 lb/day, respectively) and lowest for the 12-hour time group (15.05 and 12.08 lb/day, respectively) with similar differences between methods at each separation time group (averaged 3.38 lb/day). Both methods indicate more milk is produced during the first 6 hours of separation than later hours.

Phenotypic correlations between milk estimation techniques and calf performance traits are presented in Table 4. The correlations are averaged over crossbred cow groups. The correlation between the two methods was .47. Correlations between machine milkout and calf average daily gain (ADG) or weaning weight were .29 and .20, respectively, while correlations of calf nursing and ADG or weaning weight were .16 and .09, respectively, indicating the machine milkout technique is perhaps more positively correlated with calf performance traits. In general these correlations are smaller than those reported from other studies. This may be partially due to the fact that in this study correlations were calculated within a crossbred group, then averaged over groups. Because the variation within a crossbred group is smaller than over the entire group, the correlations were reduced. For example, when crossbred groups were ignored, correlations were .42 and .30 for machine milkout and ADG or weaning weight, respectively, and .31 and .19 for calf nursing and ADG or weaning weight, respectively. In addition the cows in this study are moderate to heavy milkers and perhaps most calves have adequate levels of milk to consume. Thus, variation between calf gains and weaning weights may be due to other sources of variation with a smaller portion due to variation in the cows' milking abilities.

Each method of obtaining milk yield estimates has advantages and disadvantages. Machine milkout allows for milk composition traits such as butterfat, protein and total solid content to be estimated; however, more time is required per animal with machine milkout than with calf nursing. Machine milkout has less stress on the calf, but more

stress on the cow than calf nursing. This study indicates machine milkout and calf nursing are comparable for evaluating crossbred group differences; but machine milkout estimates of milk yield are higher. Which technique is more accurate in determining pounds of milk available to the calves is not known. Therefore, when evaluating estimates of milk yields from various research stations, it is important to consider the methodology utilized in obtaining those estimates.

Table 3. Adjusted means for milk yields by cow-calf separation time prior to milking.

Separation time	No. of cows	Method of estimation: Machine milkout (lb/day)	Method of estimation: Calf nursing (lb/day)[1]	Difference (lb/day)
6 hr	24	17.33±.54[a]	13.45±.51	3.98±.58
9 hr	23	16.17±.55[ab]	12.83±.52	3.37±.59
12 hr	24	15.05±.54	12.08±.51	2.78±.57

[a,b]Means in the same column that do not share at least one superscript in common are significantly different ($P<.05$).
[1]Overall F-test not significant ($P>.05$).

Table 4. Phenotypic correlations between milk yields and calf performance[1].

Traits	Calf nursing (lb/day)	Calf ADG (birth to weaning)	205-day weaning weight
Machine milkout (lb/day)	.469**	.291*	.204
Calf nursing (lb/day)		.157	.086
Calf ADG (birth to weaning)			.935**

[1]Pooled over crossbred cow groups.
**,*Correlations significantly different from zero at the .01 and .05 probability levels, respectively.