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D. A. Marshall
South Dakota State University

W. R. Parker

C. A. Dinkel

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Agricultural Experiment Station

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Introduction

There has been a great deal of interest in recent years in the relationship between cow size and efficiency. Researchers have determined that maintenance feed requirements are greater for large cows. This finding has furthered the belief that efficiency through weaning is highly dependent upon cow size. It must be pointed out, however, that other studies have generally shown heavier cows produce heavier calves at weaning. It is the purpose of this report to examine feed requirements to produce a unit of weaning weight with regard to size and breed of cows.

Procedures

Angus, Charolais, Angus x Charolais and Charolais x Angus cows were produced at the South Dakota State University Beef Breeding Unit from 1970 through 1972. Production of these females was the objective of an earlier part of the crossbreeding experiment at Brookings. In phase I, 90 straightbred Angus heifers and 90 three-fourths or higher percentage Charolais heifers purchased from around the state were randomly mated artificially to one Angus or one Charolais sire to produce the females for the present study. Thus, Angus and Angus x Charolais were half-sibs as were Charolais and Charolais x Angus breed groups. Since the primary objective of this experiment was to study cow efficiency, this mating plan was used to minimize sire differences among cows of different size and breeding. Because each breed is represented by only one sire, the results should not be used in evaluating breed differences.

Heifer calves of the four breed groups were randomly assigned to either a drylot or pasture management regime at weaning in 1970, 1971 and 1972. The pasture group grazed on improved pasture in the summer and wintered in drylot under typical management conditions. Drylot heifers were randomly allotted to individual feeding pens and fed and managed in drylot throughout the year. Drylot heifers received weighed amounts of chopped alfalfa hay and alfalfa pellets. Pellets were supplied free-choice and hay was limit-fed until approximately 18 months of age. Thereafter hay and pellets were limit-fed. During lactation, grain was also supplied. The amount of feed a drylot cow was given depended on her monthly weight change. This weight change was compared to the average of her contemporary breed-age group under pasture management. The

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purpose in this was to simulate pasture conditions in the drylot feeding regime. Thus, if an individual cow lost or gained more weight than pasture contemporaries over each 28-day period, her diet was increased or decreased accordingly.

Data for this report come from records of the individually fed drylot cows and their calves produced in 1972, 1973 and 1974. All cows were bred artificially to the same Polled Hereford sire in the first and third years of the study and another bull of the same breed sired the 1973 calf crop. The mating scheme by year, cow age and sire is presented in table 1.

Table 1. Mating Scheme by Cow Age, Year and Sire

	Year		
Cow age	1972	1973	1974
2	PH_1	PH_2	PH_1
3	---	PH_2	PH_1
4	---	---	PH_1

PH_1 and PH_2 are two different Polled Hereford sires.

Cows were allowed access twice daily to individual feeders at which time their calves were allowed to nurse. These were the only times cows and calves were together. Calves had access to individual creep feeders during the night and ran together in drylot during the day. Bull calves were castrated three weeks prior to weaning.

All cows were weighed every 28 days and wither height measurements were taken at calving and weaning. The average of thirteen 28-day weights taken from weaning through weaning the following year served as the measure of cow weight in this analysis. Cow weight-wither height ratios were used as an indicator of cow condition or degree of fatness. Means and ranges for these and other traits describing the drylot cows are listed in table 2.

Milk production levels were determined by the calf-weight-change method in which calves were weighed, allowed to nurse their dams and weighed again. The difference in these two weights taken twice a day 12 hours apart is considered as the daily total of milk produced. In this study, the total of four such measurements taken through lactation were utilized as an indicator of milk production for the year.

Due to the traits studied, only records of cows weaning calves were analyzed for weaning efficiency. Table 3 shows the distribution of records by year and breed of dam.

Table 2. Means and Ranges of Drylot Cow and Calf Traits

Trait	Mean	Range
Average cow weight (lb)	960	791 - 1194
Cow weight at calving (lb)	949	707 - 1134
Cow weight at weaning (lb)	1046	793 - 1278
Cow weight ÷ height at calving (lb/in)	20.5	16.5 - 23.9
Cow weight ÷ height at weaning (lb/in)	21.9	17.8 - 25.9
Actual calf weaning weight (lb)	492	335 - 663
Calf age at weaning (days)	201	155 - 237
Milk production (lb)[a]	43.1	4.4 - 73.8

[a]Sum of four days' measurements.

Table 3. Distribution of Weaning Records

	Breed of dam				
Year	Angus	Charolais[a]	Angus x Charolais	Charolais x Angus	Total
1972	10	4	9	8	31
1973	11	7	7	11	36
1974	14	12	14	15	55
Total	35	23	30	34	122

[a]7/8 or higher.

Least squares procedures were used to determine the effect of several factors on energy intake of cows and calves, weaning weight and weaning efficiency. Efficiency to weaning was defined as the ratio of TDN intake by the cow and calf to actual weaning weight of the calf. Cow TDN intake was calculated as the total from weaning time the previous year until weaning of the calf. Calf TDN intake was that derived from creep feed. Reproductive traits of all drylot cows were also analyzed to estimate net weaning efficiency.

Results and Discussion

Least squares means of efficiency related traits for breed of dam classes are presented in table 4. The means for efficiency were adjusted for sex of calf, year, age of calf, milk production of the dam, cow weight and cow condition differences. A smaller value for efficiency is more desirable. Age of dam and reproductive status prior to and following the year of record were also considered but accounted for very small differences in the efficiency measure. No significant breed group differences in weaning efficiency existed in these

data before or after adjustment for milk production, weight or condition. It is of interest that straightbred cows weaning calves tended to be more efficient than crossbreds, but this difference was not significant. Although breed groups were significantly different in total TDN consumption, differences in this trait were apparently counterbalanced by differences in weaning weight when both characteristics were considered in the efficiency measure.

Table 4. Least Squares Means for Efficiency Traits

	Breed of dam			
Trait	Angus	Charolais[a]	Angus x Charolais	Charolais x Angus
Cow TDN intake (lb)	4883	4949	5059	4927
Calf TDN intake (lb)	586	570	570	581
Total cow-calf TDN intake (lb)	5469	5542	5632	5518
Calf weaning weight (lb)	491	496	496	485
Total cow-calf TDN intake / Calf weaning weight	11.3	11.2	11.4	11.5

[a] 7/8 or higher.

Calf sex, calf age at weaning, milk production level and year caused highly significant differences in TDN requirement per unit of weaning weight in this analysis. Cows weaning bull calves were nearly 8% more efficient than those weaning heifer calves. As calf age increased over the range studied, efficiency also improved. In addition, cows producing more milk were more efficient. Although cow condition was not an important factor affecting efficiency in these data, fatter cows tended to be less efficient.

Cow weight significantly affected all measures of TDN consumption and weaning weight but not weaning efficiency when all other important sources of variation were held constant. Heavier cows and their calves ate more feed but also produced more weaning weight. Evidently, these differences in TDN requirement and weaning weight cancelled each other when both were included in the efficiency ratio. In other words, larger cows produced enough more weaning weight to offset their greater feed intake. In these data, cows with greater average weights did tend to be more efficient when adjusted for breed, calf sex, year, calf age, milk production and condition differences. This relationship was very low.

Further analysis was undertaken to determine the usefulness of cow weight, cow condition and milk production in predicting weaning efficiency. Results presented in table 5 indicate milk production is much more important than cow weight or condition in accounting for efficiency differences. Cow weight and condition were poor predictors of weaning efficiency in these data.

Table 5. Predictability of Weaning Efficiency

Trait(s)	Predictability (%)
Milk production, cow weight and condition	24
Milk production and cow weight	23
Milk production and condition	23
Cow weight and condition	4
Milk production alone	23
Cow weight alone	less than 1
Condition alone	less than 1

These relationships just discussed probably represent the biology of efficiency but they do not provide the producer with a means of predicting the efficiency of individual cows. Calf actual weaning weight, age and sex and cow condition, weight and milk production, traits that a producer might use to predict efficiency, were included in another analysis. Results (table 6) indicate that all six predictors combined had a predictability of 74%, while predictability of weaning weight alone was 62%. Weaning weight and age had a predictability of 68% and adding cow condition raised the predictability to 74%.

Table 6. Accuracy of Prediction of Efficiency by Different Combinations of Traits

Traits included	Predictability (%)
For herds with:	
Weaning weight, age, sex, cow weight, cow condition and milk production	74
Weaning weight and age	68
Weaning weight	62
Suggested prediction equation Efficiency = 11.97 - (.019 x weaning wt.) + (.021 x age) + (.197 x cow condition in lb/in)	74
For herds with:	
Weaning weight, age, sex and cow weight	71
Weaning weight, age and cow weight	71
Efficiency = 13.71 - (.019 x weaning wt.) + (.023 x age) + (.0023 x cow wt.)	
For herds with:	
Weaning weight and age	68
Efficiency = 16.35 - (.018 x weaning wt.) + (.018 x age)	

Since milk production and cow condition will not be available in many herds, these two were deleted in the next analysis. The four remaining predictors had a predictability of 71% while weaning weight, age and cow weight equalled this accuracy.

The high predictability obtained with weaning weight and age suggested that adjusted weaning weight might be a good predictor of efficiency. Weaning weight adjusted for age, sex and age of dam according to Beef Improvement Federation recommendations proved to be less accurate (47%) than the actual weaning weight and age (68%) of the previous analysis. This is probably due to the opposite effects that weight and age have on efficiency and to the adjustment for age of dam which according to the first analysis has little effect on efficiency. Increases in weight improve efficiency, whereas increases in age decrease efficiency. In most herds the following equation including weaning weight and age will be most useful:

Efficiency = 16.35 - (.018 x weaning weight in lb.) + (.018 x calf age in days).

Since only records of cows weaning calves could be included in the estimates of efficiency, a more complete view of net weaning efficiency was obtained by analyzing the reproductive performance of all drylot cows. Least squares breed group means for percent calves born (fertility) and weaned (livability) are shown in table 7. These means were calculated holding other important causes of variation constant. Important breed group differences existed for both fertility and livability. Angus and crossbred cows were more fertile and weaned significantly more calves than Charolais cows. However, differences in these traits between Angus and crossbred cows were not significant. Crossbred dams were 6.5% superior in fertility and weaned 7.5% more calves than the average of the straightbred groups. Heterosis estimates were 7.7% and 10.2%, respectively, for these two traits. Means listed in table 7 should not be combined with the breed group means for efficiency in table 4, since accurate estimates of nonlactating cow TDN intake are still to be formulated.

Table 7. Reproductive Performance of Drylot Cows

	Breed of dam			
Trait	Angus	Charolais[a]	Angus x Charolais	Charolais x Angus
Calves born (%)	92	76	87	94
Calves weaned (%)	83	64	72	90

[a] 7/8 or higher.

In this study, cow weight increases tended to increase both fertility and livability. A higher relationship with livability existed. The importance of weight on these reproductive traits was greatly reduced when condition was held constant.

It was also of interest to analyze the effect of milk production levels on fertility during the year of record, because higher milk levels were desirably associated with weaning efficiency. No significant relationship existed between milk production and calves born the following year. The trend was for higher milk producers to have higher fertility. However, it must be emphasized that, in these drylot conditions, stress situations which could influence reproduction of higher milking cows probably did not exist.

Results presented in this report are preliminary and will be updated as more information becomes available. Individual feeding data from three more calf crops will be collected through 1977. Efficiency to weaning, however, is not the complete story, since calves produced must also satisfy the beef industry requirements after weaning. Calves from these cows are being carried through postweaning and carcass studies, from which net efficiency of beef production will be studied and presented at a later date.

Summary

Results of this analysis indicate breed of dam and cow weight had little effect on efficiency to weaning. From analysis of variables making up the efficiency ratio, it appears heavier cows produced enough heavier calves to balance their higher feed requirements. Milk production was the most important factor affecting efficiency. Important breed group differences were present for reproductive traits in these data. Cow weight and milk production level did not have important effects on reproduction but were positively related to the traits studied.