

yield from the nine-hr separation group was intermediate between the six- and 12-hr separation groups. These data suggest that more milk is produced in the first six hr of separation time than the latter six hours.

Butterfat and total solid content of the milk also exhibited a decreasing pattern from the six-hr to 12-hr separation groups. Milk obtained from cows in the six-hr separation group was higher in lb of butterfat (+.16 lb/day), butterfat percent (+.28 percent) and total solids percent (+.57 percent) than estimates from milk of cows in the 12-hr separation group. Nine-hr group estimates were intermediate. Time of cow-calf separation did not significantly affect protein content of the milk in this study. These data suggest that it may be important to consider time of cow-calf separation when estimating milk yields and milk composition of beef cattle.

Table 3 relates lactational performance of the cow to her calf's growth performance by phenotypic correlations. A moderate correlation was observed between 24-hr milk yield and calf average daily gains (.29) while a negative correlation (-.34) was estimated between protein percent of the milk and calf average daily gain. Other correlations between milk traits and calf performance were small and not significant.

These data suggests some relatively large differences between crossbred cow groups in milk yield and milk composition. It also suggests some differences in estimated milk yield and composition due to the time period of cow-calf separation allowed before milking. Consequently the length of the calf separation period should be considered in designing studies to determine lactational performance of range cows.

Factors Affecting Calving Difficulty and the Influence of Pelvic Measurements on Calving Difficulty in Percentage Limousin Heifers

D. R. Belcher and R. R. Frahm

Story in Brief

Pelvic measurements were taken on 1,426 half (1/2) and three-quarter (3/4) Limousin heifers ranging from 354 to 481 days of age and a calving difficulty score was determined for 918 heifers observed during calving.

Factors significantly affecting calving difficulty were sex of calf, sire of calf, calf birth weight, age of heifer at first calving and pelvic size. Male calves from 1/2 Limousin heifers were 2.4 lb heavier, gestated .62 days longer and resulted in 18 percent more births requiring assistance than female calves. Male calves from 3/4 heifers were 5.4 lb heavier, gestated 1.45 days longer and resulted in 28 percent more births requiring assistance than female calves. Calves born unassisted were 6.7 lb lighter than those that required assistance. Heifers that calved unassisted had 7.4 sq cm larger pelvic areas and were 5.7 days older at calving than heifers requiring assistance.

Of the 1/2 Limousin heifers with small pelvic areas (121 to 164 sq cm), 15 percent calved unassisted compared to 69 percent for heifers with large pelvises (208 sq cm or larger). Heifers with small pelvises required more than 85 percent assistance when calves weighed more than 65 lb. Heifers of intermediate pelvic size (165 to 207 sq cm) required limited calving assistance when calves weighed less than 85 lb. Only heifers with large pelvises (208 to 250 sq cm) appeared capable of having calves weighing more

than 85 lb at birth without excessive calving problems. Implications were that pelvic measurements could be effective as a management tool to aid in reducing calving problems.

Introduction

Calf death loss represents a severe economic loss to cow-calf producers. Research has shown that the major calf loss occurs at or shortly after birth and calving difficulty is a primary cause of early calf mortality. Furthermore, studies have shown that heifers experiencing difficulty at calving have poorer reproductive performance the following breeding season than heifers not experiencing calving difficulty.

Reduction in the amount of calving difficulty and subsequently lower calf mortality would be of economic value to the beef herd. Thus, it would be highly desirable to identify factors associated with calving difficulty. Such information could be beneficial in determining procedures to identify and cull heifers with a high likelihood of being difficult calvers and developing management techniques to minimize calving problems in the breeding herd.

Research has generally shown that heifers with small pelvic openings have a higher rate of calving difficulty than heifers with larger pelvic openings. Although a significant association exists between pelvic size and calving difficulty, use of pelvic measurements to predict calving difficulty has had limited success.

The objectives of this study were (1) to identify factors most highly associated with calving difficulty and (2) to evaluate the relationship between pelvic measurements taken on heifers prior to breeding and subsequent calving performance.

Experimental Procedures

Data utilized in this study involved records of 1,426 percentage Limousin heifers produced in an upgrading program on a Colorado ranch.

Limousin bulls were mated by artificial insemination (AI) to primarily Hereford, Hereford x Angus and Angus cows to produce half Limousin calves in the spring of 1972, 1973 and 1974. Half (1/2) Limousin heifers from these matings were retained in the herd and mated AI to produce three-quarter Limousin calves in the spring of 1974, 1975, 1976 and subsequent years. Three-quarter (3/4) Limousin heifers from these matings were retained in the herd and used in the upgrading program to produce seven-eighths Limousin calves.

Heifers were under similar management each year. Heifers ran with their dams until weaning and following weaning were placed on pasture and managed to be of adequate size for breeding at approximately 15 months of age. Averaged over years, heifers gained 1.53 lb per day from weaning to breeding and weighed 684 lb at one year of age.

Pelvic measurements were taken each year just prior to the breeding season with all heifers in a year group being measured the same day. Pelvic measurements were adjusted to a standard age of 450 days (15 months) for all heifers.

Heifers were closely watched during the calving season and given a subjective calving score by the herdsman of 1 = no assistance, 2 = easy pull, 3 = hard pull, 4 = caesarean or 5 = abnormal presentation.

Records were edited to include only those heifers that had pelvic measurements and subsequent calving performance. Records with a calving score of 5 were also deleted from the analysis.

Results and Discussion

Heifers ranged from 354 to 481 days of age at the time pelvic measurements were taken. Estimates of pelvic growth over this period were calculated and used to adjust pelvic size of all heifers to a constant age of 450 days. Average daily growth was .011 cm

per day for pelvic height, .014 cm per day for pelvic width and .331 sq cm per day for pelvic area.

Factors used in the analysis of calving difficulty were breed of heifer, sire of heifer, sire of heifer's first calf, sex of calf, calf birth weight, gestation length, age of heifer at first calving and pelvic size. Those factors found to significantly influence calving difficulty were sire of calf, sex of calf, calf birth weight, age of the heifer at calving and pelvic size.

Average birth weight and gestation length of male and female calves are presented in Table 1 by calving difficulty scores for each breed of heifer. Male calves from 1/2 Limousin heifers averaged 2.4 lb heavier at birth and experienced 18 percent more calving difficulty than female calves. Sixty-six percent of the heifers having male calves experienced some calving difficulty while only 48 percent of those heifers having female calves required assistance. Calves from 1/2 Limousin heifers that calved unassisted were 6.8 lb lighter at birth than calves from heifers having difficulty at calving (74.3 vs 81.1 lb). Birthweight of calves increased by 4.4, 3.0 and 1.4 lb for each increment of increased calving difficulty score from 1 to 4, respectively. These data would suggest that at heavier birth weights, smaller increases in calf birth weight were required to cause an increased level of calving difficulty. Some of the heavier birth weights and subsequent increased calving difficulty was likely due to the increased gestation lengths observed for each increasing level of calving difficulty.

The same general patterns were observed for 3/4 Limousin heifers. Male calves averaged 5.43 lb heavier at birth and resulted in 28 percent more calving difficulty than female calves and had 1.45 days longer gestation. Calves from 3/4 Limousin heifers that calved unassisted were 6.5 lb lighter than calves from heifers that required assistance. Although the same pattern of birth weight and gestation length differences between calving scores was observed, differences were inconsistent probably due to limited observations in each calving score category.

The average adjusted pelvic measurements and average age at first calving are presented in Table 2. In general, pelvic measurements of 1/2 and 3/4 Limousin heifers that calved unassisted were larger than pelvic measurements of heifers experiencing calving difficulty and those heifers that had difficulty at calving were younger.

Half Limousin heifers that calved unassisted had pelvic areas 5.6 sq cm larger than heifers requiring only slight assistance. Heifers requiring minor assistance had 5.2 sq cm larger pelvic areas than those requiring major assistance and the difference in pelvic area of heifers requiring major assistance or caesarean was 5.1 sq cm. The difference in pelvic area of 3/4 Limousin heifers that required no assistance, minor assistance or major assistance was less than that observed in 1/2 Limousin heifers averaging only 3.26 sq cm. None of the 3/4 Limousin heifers required a caesarean.

To better observe the relationship between pelvic size and calving difficulty, heifers were placed into categories based on pelvic area. Categories were determined by finding the total range in pelvic area from smallest to largest and dividing this range into thirds (small, intermediate and large). However, 83 percent of the heifers had pelvises in the intermediate range of 165 to 207 sq cm. Consequently, this category was subdivided into halves to give a low and high intermediate group. Thus, there were four pelvic area categories: small = 121 to 164 sq cm, low intermediate = 165 to 186 sq cm, high intermediate = 187 to 207 sq cm and large = 208 to 250 sq cm.

The percentage of 1/2 Limousin heifers within each pelvic category that had a calving score of 1, 2, 3, or 4 is presented in Figure 1. The percentage of heifers that calved unassisted continually increased for each larger pelvic area category ranging from 15 percent for heifers with small pelvises (121 to 164 sq cm) to 69 percent for heifers with large pelvic areas (208 to 250 sq cm).

Eighty-five percent of the heifers with small pelvic areas required some degree of calving assistance and 45 percent required major assistance or caesarean. Of the heifers

Table 1. Average calf birth weight and gestation length for each calving difficulty score.

Breed of heifer (N)		Calving difficulty score ¹			
		1	2	3	4
<u>1/2 Limousin heifers (706)</u>					
Calf birth weight (lb)	<u>male</u>	74.9	79.3	82.1	83.8
	<u>female</u>	73.6	77.9	81.3	82.3
Gestation length (days)	<u>male</u>	287.3	287.9	289.6	291.0
	<u>female</u>	286.9	288.1	288.7	289.0
<u>3-4 Limousin heifers (112)</u>					
Calf birth weight (lb)	<u>male</u>	70.0	74.4	74.2	-
	<u>female</u>	65.4	68.4	79.8	-
Gestation length (days)	<u>male</u>	288.0	288.5	287.8	-
	<u>female</u>	287.1	284.7	287.3	-

¹ Calving scores were 1 = unassisted, 2 = easy pull, 3 = hard pull and 4 = caesarean.

Table 2. Average pelvic height, width, area and average age at calving for each calving difficulty score.

Breed of heifer (N)	Calving difficulty score ¹			
	1	2	3	
<u>1/2 Limousin heifers (706)</u>				
Adjusted pelvic height (cm)	14.7	14.6	14.3	4.2
Adjusted pelvic width (cm)	13.0	12.7	12.5	2.2
ADJUSTED PELVIC AREA (sq cm)	190.3	184.7	179.5	4.4
Age at first calving (days)	726.8	726.5	722.5	6.4
<u>3/4 Limousin heifers (112)</u>				
Adjusted pelvic height (cm)	14.7	14.6	14.6	-
Adjusted pelvic width (cm)	12.6	12.6	12.3	-
ADJUSTED PELVIC AREA (sq cm)	186.1	184.4	179.6	-
Age at first calving (days)	757.9	755.4	747.5	-

¹ Calving scores were 1 = unassisted birth, 2 = easy pull, 3 = hard pull and 4 = caesarean.

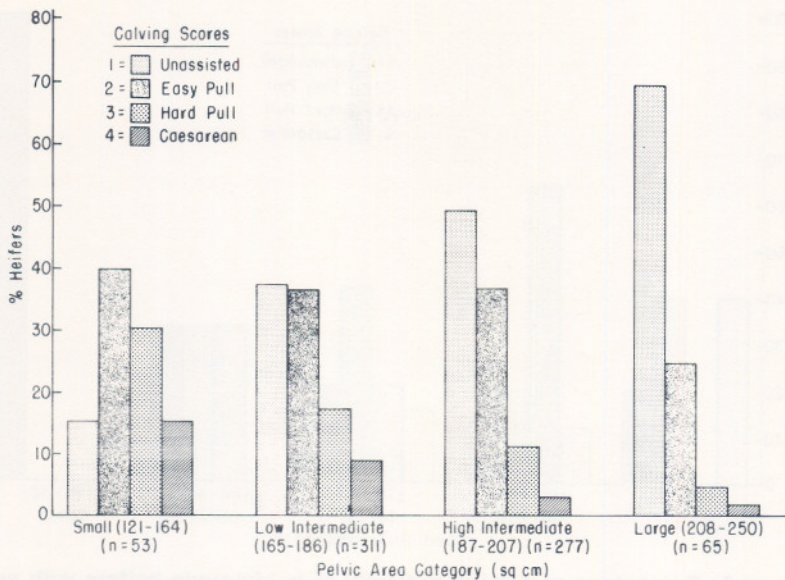


Figure 1. Percentage of calving difficulty of 1/2 Limousin heifers for each pelvic area category.

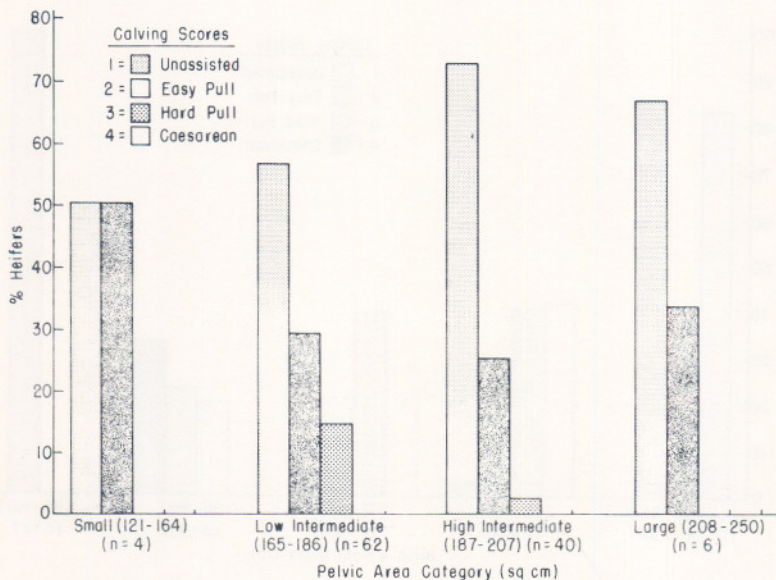


Figure 2. Percentage of calving difficulty of 3/4 Limousin heifers for each pelvic area category.

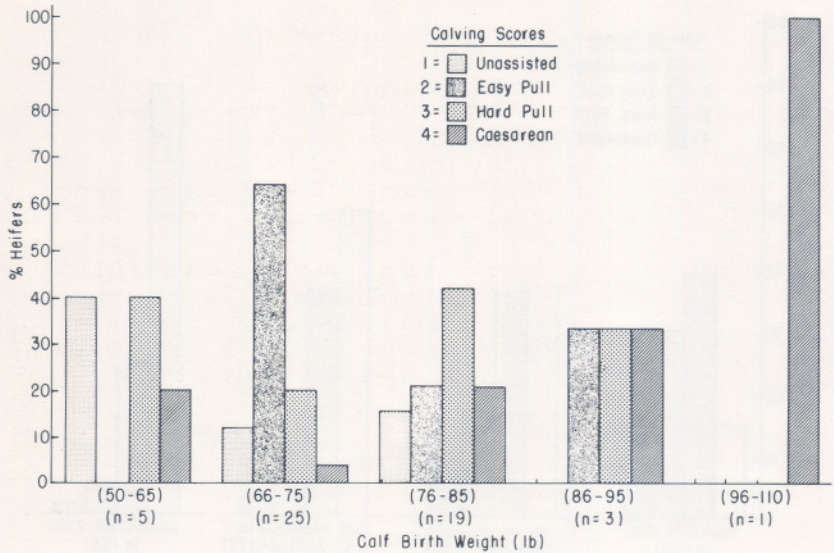


Figure 3. Percentage of calving difficulty of 1/2 Limousin heifers with small pelvic areas (121-164 sq cm) by calf birth weight.

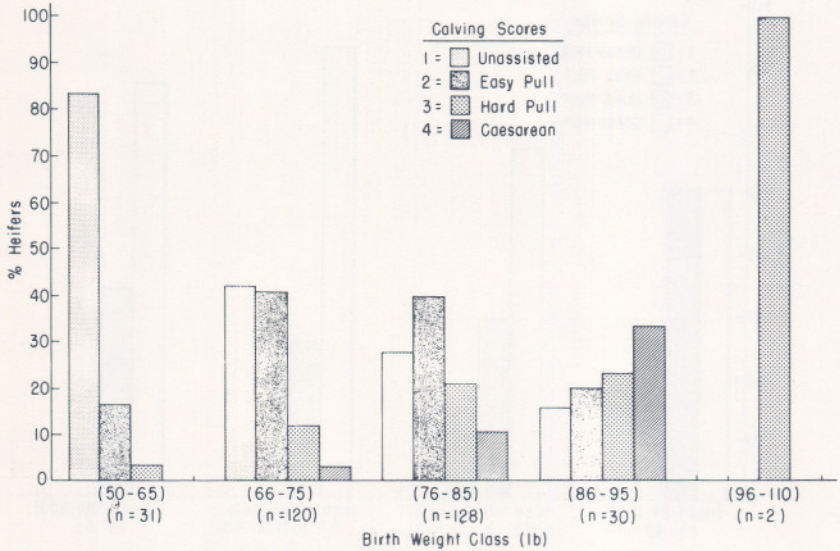


Figure 4. Percentage of calving difficulty of 1/2 Limousin heifers with low intermediate pelvic areas (165-186 sq cm) by calf birth weight.

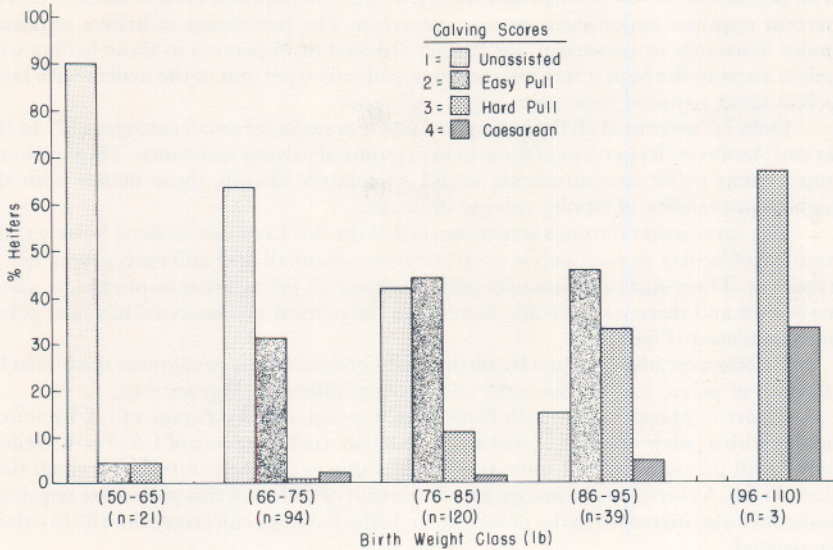


Figure 5. Percentage of calving difficulty of 1/2 Limousin heifers with high intermediate pelvic areas (187-207 sq cm) by calf weight.

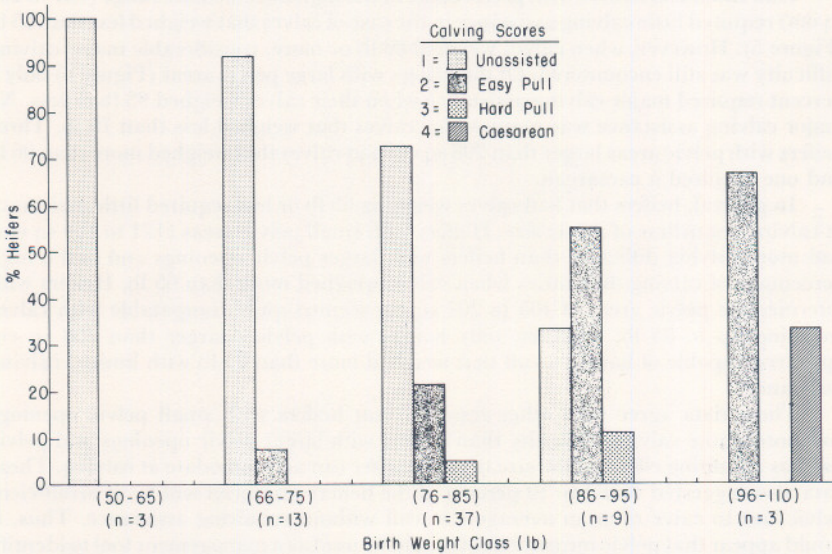


Figure 6. Percentage of calving difficulty of 1/2 Limousin heifers with large pelvic areas (208-250 sq cm) by calf birth weight.

with pelvises in the low intermediate range, 63 percent required some assistance and 26 percent required major assistance or caesarean. The percentage of heifers requiring major assistance or caesarean was further reduced to 14 percent in those heifers with pelvic areas in the high intermediate range and only 6 percent of the heifers with large pelvic areas required more than slight assistance.

Only 7.5 percent of all the heifers had pelvic areas in the small category (121 to 164 sq cm); however, 85 percent of these heifers required calving assistance. Thus, it would appear that pelvic measurements would adequately identify those heifers with the highest probability of having calving difficulty.

The same general trends were observed in the 3/4 Limousin heifers; however, the number of heifers in each pelvic area category was small and differences were not as apparent. Three-quarter Limousin heifers with large pelvic areas required less major assistance and there was a steady increase in the percent of unassisted births as pelvic area increased (Figure 2).

Heifers were also grouped by birth weight of their calves to examine the interrelationship of pelvic size, birthweight and calving difficulty (Figures 3-6).

Figure 3 represents, for each birth weight group, the percentage of 1/2 Limousin heifers with a pelvic area of 121-164 sq cm that had a calving score of 1, 2, 3 or 4. Heifers with small pelvic areas had some calving difficulty even when calves were small (less than 65 lb). As birthweight increased, the percent of heifers of this pelvic size requiring assistance also increased to the point that no heifer having a calf larger than 85 lb calved unassisted.

Figure 4 represents 1/2 Limousin heifers with pelvic areas in the low intermediate range (165 to 186 sq cm). Heifers that had calves weighing 75 lb or less required little major assistance while a high percentage of heifers that had calves weighing more than 85 lb required major assistance or caesarean. Heifers having calves that weighed from 76 to 85 lb were intermediate in amount of calving difficulty.

Half Limousin heifers with pelvic areas in the high intermediate range (187 to 207 sq cm) required little calving assistance in the case of calves that weighed less than 85 lb (Figure 5). However, when calves weighed 86 lb or more, considerable major calving difficulty was still encountered. Of the heifers with large pelvic areas (Figure 6) only 5 percent required major calving assistance when their calves weighed 95 lb or less. No major calving assistance was required for calves that weighed less than 75 lb. Three heifers with pelvic areas larger than 208 sq cm had calves that weighed more than 96 lb and one required a caesarean.

In general, heifers that had calves weighing 65 lb or less required little assistance at calving regardless of pelvic size. Heifers with small pelvic areas (121 to 164 sq cm) had more calving difficulty than heifers with larger pelvic openings and had a high percentage of calving difficulties when calves weighed more than 65 lb. Heifers with intermediate pelvic areas of 165 to 207 sq cm seemed quite compatible with calves weighing up to 85 lb; however, only heifers with pelvises larger than 208 sq cm appeared capable of having a calf that weighed more than 85 lb with limited calving assistance.

These data agree with other research that heifers with small pelvic openings encounter more calving difficulty than heifers with larger pelvic openings and pelvic size has a limiting effect on the size of calf a heifer can accommodate at calving. These data also suggested that 5 to 10 percent of the heifers produced will be of insufficient pelvic size to calve even an average size calf without requiring assistance. Thus, it would appear that pelvic measurements could be used as a management tool to identify those heifers with a high risk of having calving difficulty. These heifers could be culled from the breeding herd. However, if it was desired to keep them in spite of their expected calving problem, they could be mated to bulls known to sire smaller calves in order to minimize calving problems.