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January 1997

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Colburn, Dave; Deutscher, Gene H.; Adams, Don C.; Nielsen, Merlyn K.; and Olson, Pete, "Effects of Sire EPD, Dam Traits and Calf Traits on Calving Difficulty and Subsequent Reproduction of Two-Year-Old Heifers" (1997). *Nebraska Beef Cattle Reports*. 429.
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Effects of Sire EPD, Dam Traits and Calf Traits on Calving Difficulty and Subsequent Reproduction of Two-Year-Old Heifers

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Calving difficulty can be reduced by selecting low birth weight EPD sires, culling yearling heifers with large birth weights and small pelvic sizes, and producing calves with moderate bone size and birth weights.

Summary

A three-year study evaluated effects of sire birth weight EPD, heifer and calf traits on calving difficulty and subsequent rebreeding of two-year-old cows. MARC II yearling heifers (n=550) were assigned for breeding to one of four Angus sires with birth weight EPD of -2.1, -1.8, +6.3 and +5.9 lb. Of all heifer weights, only dam birth weight affected calving difficulty score. Heifers requiring caesareans had smallest pelvic areas. Calving difficulty increased as calf birth weight and external measurements increased. Low EPD sires produced calves with smaller head and foot circumferences and less dystocia. Degree of calving difficulty did not affect subsequent pregnancy rates, but did delay rebreeding conception date.

Introduction

Calving difficulty (dystocia) is one of the most important production problems of the beef industry. It has been recognized as a major cause of early calf mortality, reduced calf crop at weaning and decreased reproductive performance. The national annual loss from dystocia is estimated at $750 million.

Many factors are known to contribute to dystocia and are interrelated. The major cause reported in two-year-old heifers is a disproportion between calf birth weight and dam's pelvic area. Other factors involved are: calf sire, sex of calf, shape of calf, heifer weight and body condition, heifer nutrition and geographic location.

Therefore, a study was designed to evaluate the effects of a combination of factors: sire birth weight EPD, calf birth weight and shape, various heifer measurements and climatic conditions on dystocia and subsequent rebreeding of two-year-old heifers. Two methods of measuring dystocia: 1) pounds of delivery pressure and 2) the standard five-point subjective scoring system were evaluated. Also, the effects of dystocia on calf growth from birth to slaughter were investigated.

Procedure

This study was conducted at the University of Nebraska, West Central Research and Extension Center (WCREC), North Platte over three years using 550 MARC II heifers (1/4 Angus x 1/4 Hereford x 1/4 Simmental x 1/4 Gelbveih). Heifer calves were born in March and April at the Gudmundsen Sandhills Laboratory (GSL), Whitman, NE.

Using a standardized procedure each year, yearling heifers were assigned to 50-lb weight blocks, ranked on pelvic area from smallest to largest within weight blocks and then randomly allotted to one of four Angus sires (ABS Global, Inc., DeForest, WI). Two low and two high birth weight EPD Angus sires were used (-2.1, -1.8, +6.3, and +5.9 lb, respectively). All sires had accuracies greater than .95 for birth weight EPD.

Growth traits measured at 12, 18 and 22 months of age were heifer weight, body condition score, hip height, and internal pelvic width, height, and area. Internal pelvic measurements of width and height were obtained using a Krautman Bovine Pelvic Meter and the pelvic area was calculated by multiplying width and height. Body condition scores were given on a visual scale of 1 to 9, where 1=emaciated; 5=moderate; and 9=extremely fat.

The breeding season began May 10 each year and lasted for 42 days. Approximately 12 hours after standing estrus, heifers were artificially inseminated with semen from their assigned sire. The same four sires were used each year.

During the calving season, which began in early February, heifers were checked every two hours for signs of parturition. When heifers needed assistance, a pressure gauge was attached to the calf puller to determine the maximum pounds of pressure required to deliver the calf. Heifers were scored on a calving difficulty scale (CDS) of 1 to 5 for degree of dystocia, with 1=no assistance, 2=easy pull, 3=mechanical pull, 4=hard mechanical pull, 5=caesarean. The range of pressures for each CDS were: 73-123 lb, 124-618 lb, 619-800 lb, and 850 lb, for CDS 2, 3, 4, and 5, respectively. Since calves experiencing a caesarean birth could not be delivered with a puller, a maximum pressure was assigned (850).

Calving traits recorded immediately after parturition included: calf sex, calving date, calving difficulty score, and delivery pressure. Calf vigor scores were recorded on a scale of 1 to 5, with 1=nursed unassisted within 30 min; 2=nursed unassisted within 30 to 60 min; 3=nursed unassisted within 60 to 75 min; 4= didn't nurse within 75 min and was assisted; and 5=dead at birth. Calf traits recorded within 12 hours of birth included: birth weight, head and foot circumference, width of shoulders and hips, and depth of chest. Pelvic measurements of the heifer were also obtained at 12 hours postpartum.

Circumference of the head was measured by placing the measuring tape over the calf's poll and under the jaw bone giving the largest circumference. The foot circumference was determined by placing the measuring tape around the coronary band of the left front foot. With the calf standing, width of shoulders was measured at the widest point. The width of hips was measured at the widest dimension over the femur joints. The depth of chest was the distance between the crops and the chest floor (sternum).

Reproductive traits of the young cows obtained after calving included: cycling before the breeding season, pregnancy during breeding, and day of conception. Cycling was determined by palpation of the ovaries for corpora lutea; and blood samples were obtained and assayed for progesterone level. Cows were exposed to MARC II bulls in multiple-sire groups for a 75-day breeding season beginning May 19 at GSL each year. Breeding dates were recorded with the aid of chin-ball markers on bulls. Two pregnancy exams were performed via rectal palpation at 30-day intervals for fetal aging. Day of conception was determined using breeding dates, palpation data, and subsequent calving dates.

Table 1. Means for heifer growth traits and calf measurements by calving difficulty score[a]

	Calving Difficulty Scores[b]				
Traits	1	2	3	4	5
Heifer					
No. of heifers	197	25	104	33	30
Weights,lb					
Birth	88[e]	90[efg]	90[ef]	93[fg]	95[g]
12 mo	651[e]	669[ef]	653[ef]	673[f]	664[ef]
22 mo	957[e]	999[f]	968[ef]	992[f]	979[ef]
Pelvic Area,cm^2					
12 mo	172[e]	175[e]	170[e]	174[e]	165[f]
22 mo	245[e]	247[e]	244[e]	245[e]	235[f]
25 mo	269[e]	269[ef]	267[ef]	266[ef]	261[f]
Calf Traits					
No. of calves	197	25	104	33	30
Delivery pressure,lb	——	103[e]	457[f]	671[g]	850[h]
Birth weight,lb	72[e]	76[f]	79[g]	83[h]	88[i]
Head circumference[c].,cm	45.7[ef]	45.4[e]	45.5[ef]	45.6[ef]	46.0[f]
Foot circumference[c].,cm	17.1[e]	17.2[fg]	17.1[eg]	17.0[eg]	17.3[f]
Width of shoulders[c],cm	20.4[e]	20.6[ef]	20.6[ef]	20.6[ef]	20.9[f]
Width of hips[c],cm	22.4	22.1	22.1	22.1	22.2
Depth of chest[c],cm	29.1[ef]	29.6[e]	29.1[fg]	29.2[eg]	29.2[eg]
Vigor score[d]	2.8[e]	3.2[fg]	3.1[f]	3.6[g]	2.9[ef]

[a]Values pooled over three years, with year and sire effects removed.
[b]Scoring system 1 to 5, 1=hand pull, 3=mechanical pull, 5=Caesarean.
[c]Calf values had sex of calf and birth weight removed.
[d]Scoring system 1 to 5, 1=nursed unassisted within 30 min, 3=nursed unassisted within 75 min, 5=dead at birth.
[efghi]Means within rows with unlike superscripts differ (P<.05).

Traits measured at weaning in early September included: cow weight and body condition score and calf weaning weights. After weaning, calves were placed in a feedlot and fed growing and finishing rations until ready for slaughter the following May. Calf gain was obtained from weaning to slaughter.

Data were analyzed by analysis of variance for a randomized complete-block design with main effects of year and sire. Calf birth weight and sex were included in the model as covariables for calf shape measurement analyses. Percentage data were analyzed by Chi-square procedures. Significant year effects were found and removed statistically to determine causes of dystocia pooled over years. No year x sire interactions were found so they were deleted from the model. For presentation purposes, variables were fitted to a model with CDS to derive means by CDS classes.

Results and Discussion

The effects of climatic conditions during the three years of this study on calf birth weight and dystocia were summarized and reported in the 1996 Nebraska Beef Cattle Report, MP 66-A pp. 23-25.

The pressure system detected only slightly larger amounts (2% to 3%) of variation affecting dystocia than the standard five-point scoring system. The standard CDS system appears adequate in describing the degree of dystocia; and measuring delivery pressure is not necessary. Therefore, the data in this study are presented only by CDS classes.

Heifer Traits

Heifer weights and measurements at various ages and calf measurements by CDS are reported in Table 1. Differences were found between CDS 1 and 5

(Continued on next page)

for dam birth weight (88 vs 95 lb, respectively). This indicates heifers that were heavier at birth experienced more calving difficulty as two-yr-olds. They had heavier birth weight calves, which was probably due to genetics. In general, heifer weights at 12 and 22 months of age did not significantly affect degree of calving difficulty, indicating selecting the heaviest heifers as yearlings may not reduce the degree of dystocia at calving.

In general, no differences were found in hip height and heifer body condition at 12 or 22 mo of age among CDS.

Heifer pelvic area significantly affected CDS only for heifers requiring caesareans (CDS 5). These heifers had smaller pelvic area measurements at 12 and 22 months of age than heifers in all other CDS groups. These results indicate yearling pelvic measurements would have been useful in detecting heifers requiring caesarean deliveries. Heifer pelvic areas at calving (25 months) showed the same significant differences between CDS as at 12 and 22 months.

Yearling pelvic area was highly correlated (.78) to precalving pelvic area, indicating that yearling pelvic area accounted for 61% of the variation in precalving pelvic area and could be used as an indicator for precalving pelvic area.

Table 2. Means for heifer and calf measurements by sire[a]

	Low Sire[b]		High Sire[b]	
Traits	1	2	3	4
No. of heifers	139	137	137	136
12-mo heifer weight, lb	653	653	656	655
12-mo heifer pelvic area, cm^2	171	170	171	171
No. of calves	106	93	94	96
Calf birth weight, lb	72^{f}	73^{f}	79^{g}	80^{g}
Head circumference[c], cm	45.2^{f}	45.6^{h}	46.0^{g}	45.7^{gh}
Foot circumference[c], cm	16.9^{f}	17.0^{h}	17.4^{g}	17.1^{h}
Width of shoulders[c], cm	20.6	20.5	20.4	20.6
Width of hips[c], cm	22.3	22.3	22.2	22.3
Depth of chest[c], cm	29.1	29.2	29.3	29.1
Delivery pressure, lb	246^{f}	230^{f}	363^{g}	298^{fg}
Calving difficulty[d]., %	41^{fh}	33^{f}	52^{g}	46^{gh}
Calving difficulty score	2.0^{fh}	1.9^{f}	2.5^{g}	2.2^{gh}
Caesarean, %	3^{f}	5^{f}	16^{g}	7^{f}
Vigor score[e]	2.7^{f}	3.0^{fh}	3.2^{gh}	3.3^{g}

[a]Values pooled over three years, with year effects removed.
[b]Sire BWT EPD: 1= -2.1, 2= -1.8, 3= +6.3, 4= +5.9 lb.
[c]Values pooled over three years, with year and calf birth weight removed.
[d]Calving difficulty scores 3 to 5.
[e]Scoring system 1 to 5, 1=nursed unassisted within 30 min, 3=nursed unassisted within 75 min, 5=dead at birth.
[fgh]Means within rows with unlike superscripts differ (P<.05).

Calf Traits

As expected, the delivery pressure increased as CDS increased (Table 1). Pounds of pressure required for each CDS were 103, 457, 671, and 850 for scores 2, 3, 4, and 5, respectively. This pressure directly measured the severity of calving difficulty.

Calf birth weight increased as CDS increased and was the most important factor determining CDS. Calf birth weight accounted for 36.5% of the variation in delivery pressure.

Differences were found for calf head and foot circumferences and width of shoulders among CDS. Calf head circumference was larger for CDS 5 than CDS 2. Score 5 had calves with larger foot circumference and width of shoulders compared to CDS 1. Depth of chest results were inconsistent across CDS, with no differences found for width of hips. The results on width of hips may be due to the procedure used in handling calves during parturition. During delivery, calves were rotated to reduce the possibility of hip lock and avoid causing further stress to the calf and heifer. Of the calf measurements, head circumference and width of shoulder measurements appear to be the most important indicators of degree of dystocia in our data set.

Calf birth weight was found to be highly correlated to foot circumference (.79) and accounted for 62% of the variation, indicating that foot circumference may be a good indicator of birth weight.

Calf vigor score increased (P<.05) as CDS increased up to CDS 4 meaning less vigorous calves with the more difficult births. Score 5 was not different from CDS 1 indicating calves born with a caesarean did not experience any more stress, and were as vigorous as calves born unassisted.

Sire Effects

Means for heifer and calf measurements by sire are reported in Table 2. There were no differences for heifer yearling weight and pelvic area among the sires due to the heifer allotment procedure. Calf birth weight was different between sire EPD groups, 73 vs 80 lb, low vs high, respectively. The difference in birth weight EPD between the two sire groups was 8 lb, indicating that sire birth weight EPD was a good predictor of average calf birth weight. However, the range of birth weights for a single sire was 60 to 100 lb. Predictability of calf birth weight for a single calf can be low, due to genetic effects from the dam and sire causing a wide range of birth weights and more dystocia than expected.

Calf head and foot circumferences were different between the low and high EPD sires even when calf birth weight was held constant. Differences were also found between the two low birth weight EPD sires for head and foot circumferences: 45.2 vs 45.6 cm, and 16.9 vs 17.0 cm, respectively. Also, there were differences between the two high EPD sires for foot circumference. However, Sires 2 and 4 were not different for head and foot circumferences. These results suggest there were differences between sires within birth weight EPD groups. Also, there were similarities between sires of each birth weight EPD group. No differences were found for width of shoulders, width of hips or depth of chest among sires.

Calving difficulty percentage was lower for heifers bred to the low birth weight EPD sires. However, Sire 1 (birth weight EPD -2.1) was not significantly different from Sire 4 (birth weight EPD +5.9), even though they were significantly different for birth weight. A significant difference was found between the two high sires for percent caesareans: 16% for Sire 3 and 7% for Sire 4. This difference is not explained by the small difference in birth weight. The difference may be due to larger bone per unit of calf birth weight for Sire 3, thus causing more dystocia. Sire 3 had a larger foot circumference (larger bone) compared to Sire 4, (Table 2).

There were differences in calf vigor score among sires. Sire 1 was significantly different from Sire 4. These two sires are of interest because they were significantly different for calf birth weight but not CDS. This indicates that heavier calves are less vigorous and slower to nurse.

Table 3. Means for heifer reproductive traits after calving and weaning and post-weaning growth traits of calves by calving difficulty score

	Calving difficulty scores[a]				
Traits	1	2	3	4	5
No. of heifers (2-yr-old)[b]	195	25	107	29	30
Cycling,(%)	44	42	37	40	25
Conception date	June 13^{f}	June 16^{fg}	June 18^{g}	June 24^{g}	June 15^{fg}
Pregnancy 75d,%	90	84	93	90	80
No. of heifers (3-yr-old)[b]	159	20	94	20	21
Second calf birth wt.,lb	85^{f}	87^{fg}	87^{fg}	92^{g}	87^{fg}
Calving difficulty,%	6^{f}	10^{fg}	9^{f}	30^{g}	10^{fg}
Calf Growth Traits[c]					
Weaning Wt[d]., lb	480^{f}	480^{f}	480^{f}	471^{fg}	460^{g}
Slaughter Wt[e]., lb	1129^{f}	1190^{g}	1170^{g}	1177^{g}	1184^{g}
Gain[e]	702^{f}	761^{g}	739^{g}	744^{g}	761^{g}
ADG[e], lb/d	2.6^{f}	2.9^{g}	2.9^{g}	2.9^{g}	3.1^{g}

[a]Scoring system 1 to 5, 1=no assistance, 3=mechanical pull, 5=Caesarean.
[b]Values pooled over three years, with year and sire effects removed.
[c]Values pooled over three years.
[d]Year, sire, sex of calf, birth weight and birth date effects removed.
[e]Year, sire, and sex of calf effects removed. Gain was calculated from weaning to slaughter.
[fg]Means within rows with unlike superscripts differ (P<.05).

Subsequent Reproduction

Reproductive traits of the cows after calving by CDS are shown in Table 3. No differences were observed in percentage of heifers cycling before the breeding season by CDS. Significant differences were found in conception date between CDS 1 compared to 3 and 4. There was a trend, as CDS increased to 4, conception date increased from June 13 to June 24. Score 5 was not different from the other CDS, but these heifers had the second earliest conception date. These data indicate that heifers requiring caesareans experienced less stress during parturition than CDS 3 and 4 heifers. There were no significant differences for percentage of heifers pregnant among CDS.

Second calf birth weights were similar by CDS; however, the second calves were heavier than the first calves. Differences were found in calving difficulty percentage for three-year-old cows. The heifers in CDS 1 (as two-year-olds) experienced 6% calving difficulty as a three-year-old compared to 30% in the heifers in CDS 4. Heifers in CDS 5 (caesareans) experienced only 10% calving difficulty as three-year-old cows. The only cows that were culled from the study were those that lost calves as a two-year-old, and those that were not pregnant after the breeding season. These results show that heifers experiencing dystocia as two-year-olds will have considerably less difficulty as three-year-olds.

Calf Growth

Table 3 shows the growth of calves from weaning to slaughter by CDS. Calves delivered by caesarean section were significantly lighter at weaning than calves from CDS 1, 2, and 3. No obvious explanation is known as these calves were the heaviest at birth. We theorize that the caesarean surgery may have negatively affected milk production of the heifer which slowed growth of the calf. However, these calves showed compensatory gain in the feedlot and had high slaughter weights. The calves from cows with CDS 1 had slower gains in the feedlot than all other calves. These calves were the smallest at birth and may have had less genetic growth potential. Weaning and slaughter weights of calves were inconsistent across sires.

This research study shows the complexity of dystocia and the many factors influencing it, plus the effects on subsequent cow reproduction and calf growth. These results should be quite useful in helping producers change management practices to reduce calving difficulty. Dystocia and calf losses can be reduced through proper sire selection, heifer selection and calving management.

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