Factors Affecting Dystocia in Brahman-Cross Heifers in Subtropical Southeastern United States[1]

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ABSTRACT: This study was conducted to determine relative relationships among factors affecting dystocia in Brahman-cross heifers. Body and pelvic measurements were obtained in mid-June (when heifers were approximately 17 mo old), 45 d after a 60-d breeding season. Heifers studied were 207 Red Brangus, 209 Simbrah, and 250 Braford bred to Black Angus bulls; calving began on December 1. Heifers grazed stockpiled bahia and hemarthria grass or ryegrass supplemented with 0.9 kg of 32% protein cottonseed meal and 1.8 kg of mill-run black strap molasses daily during calving. Calvings were scored (1 = no difficulty to 4 = major difficulty). A random sample of birth weights were obtained on 131 and 210 calves in 1992 and 1993. Data were analyzed within year by SAS procedures. Breed differences in dam size and pelvic measurements were highly significant. Residual correlations between body weight and pelvic area were .20 and .35 (both $P < .01$) for 1991 and 1992. Dystocia incidence was 6.9% in 1992 and 10.5% in 1993, with higher incidence in males than in females (1992, 10.6 vs 3.1%, $P = .08$; 1993, 15.6 vs 4.2%, $P < .01$, male vs female, respectively). Male birth weight exceeded ($P < .01$) that of females (26.7 vs 24.3 kg, 1992; 28.1 vs 26.1 kg, 1993). Correlations among dam size and calf birth weight were not significant. Birth weight was significantly correlated with dystocia score (.19 and .49, 1992 and 1993). Path analyses of influences on dystocia found birth weight, dam heart girth, and body weight significant in 1992, but only birth weight significant in 1993. Regression of calving score on birth weight was curvilinear and significant in both years, with the birth weight inflection point at 22 kg. We conclude that dam body size data obtained following the breeding season were of minor value in determining dystocia, but birth weight was consistently important.

Key Words: Dystocia, Pelvic Area, Body Size, Birth Weight, Heifers

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Introduction

Neonatal calf losses from dystocia have a major negative impact on production efficiency in beef cattle (Bellows and Short, 1994). Bellows et al. (1990) calculated the relative numerical ranking of four major factors affecting dystocia and found the following: calf sex = 1.00; dam precalving weight = 1.10; dam precalving pelvic area = 1.16; birth weight = 3.05. A genotype × environment interaction study involving cattle exchanged between Brooksville, FL, and Miles City, MT, found major effects of environment on calf birth weight (Burns et al., 1979). Burfening et al. (1987) reported calf birth weights and dystocia scores were lower in the southeastern United States than in other geographical regions of the nation. The present study was conducted to determine whether the relative relationships of factors affecting dystocia were similar to those reported by Bellows et al. (1971) in a geographical region where birth weights were low and parturient females were of *Bos taurus* × *Bos indicus* breeding.

Materials and Methods

This research was conducted at the Deseret Cattle and Citrus Ranches, St. Cloud, FL, over a 3-yr period from 1991 to 1993. Animals, location, and management were similar to those described by Olson et al. (1992). The study involved a total of 666

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individually identified, primiparous heifers of which 207 were Brangus, 209 were Simbrah, and 250 were Braford (Table 1).

All heifers were bred on pasture by natural service in multiple sire herds (1 bull to 50 heifers) to Black Angus bulls selected for light birth weights and calving ease. The 60-d breeding season began on March 1 of each year. In mid-June, approximately 45 d after the end of the breeding season, heifers were palpated for pregnancy and data for the study were obtained from a random sample of the pregnant heifers. Data included body weight, measured hip height, and heart girth plus pelvic height and width. Pelvic measurements were obtained with a Rice pelvimeter as described by Bellows et al. (1971). A visual condition score was assigned (1 = thinnest and 9 = fattest). Pelvic area and frame score values were calculated. All measurements and calculations followed the guidelines of the Beef Improvement Federation (1990).

Heifers grazed stockpiled bahia and hemarthria grass or ryegrass during gestation. During the calving season, grazing was supplemented with 0.9 kg of 32% protein pelleted cottonseed meal and 1.8 kg of mill-run black strap molasses daily. Molasses was fed in tanks that were filled twice weekly with the appropriate amount of molasses to supply 1.8 kg average intake per day.

Calving was under field pasture conditions, and diagnosis of calving difficulty and determination of need for obstetrical assistance was at the discretion of individual herdsmen. Calvings were observed and given a numerical score (1 = no difficulty or assistance to 4 = major difficulty and assistance involved in the delivery). One heifer produced twins, and another experienced an abnormally presented calf at birth. Both heifers were removed from the data set, leaving 666 animals in the analyses. Calves were ear-tagged at birth for identification, and calf birth weights were obtained on a representative random sample of 131 calves in 1992 and 210 calves in 1993 (Table 1). Minimum calf-weighing goals were to obtain birth weights throughout the calving season on every third calf born in 1992 and two of every three calves born in 1993. These calvings were used for the analyses of dystocia and related factors; data on heifers for which calf birth weight was not obtained was included only in analyses of the body size data obtained in June.

Because this was a field study, all data were analyzed within year by the GLM procedure of SAS (1989). The within-year approach was used to determine consistency of results over years and to eliminate interactions with year and regression heterogeneity resulting from changes in breeding plans, matings, personnel, and any other year confounding. Analyses of data collected in June were tested for differences due to dam breed. Calving data were tested for differences due to dam breed, calf sex, and the two-way interaction. Residual correlations (adjusted for dam breed and calf sex where appropriate) were calculated and used to determine standard partial regression (b′) coefficients. The b′ values were tested for significance by the method of Wright (1958). Linear and quadratic regressions were also calculated and tested for significance by SAS (1989) procedures.

Results and Discussion

Body measurement data summarized by breed of dam within year are shown in Table 2. In 1991, pelvic height did not differ among the three dam breeds, but differences in pelvic width and area were highly significant. Breed differences in hip height, heart girth, body condition score, body weight, and frame score were all highly significant. Similar breed differences were noted in 1992, with the breed difference in pelvic height approaching significance (P = .07). Breed differences in all other traits were significant or highly significant.

Calving data summarized by dam breed and calf sex within year are shown in Table 3. Data represent the 131 and 210 random sampling of calvings in 1992 and 1993, respectively, in which calf birth weights were obtained. Breed of dam effects on birth weight and dystocia score or incidence were nonsignificant in both years. Birth weight averages ranging from 23 to 28 kg are low and resulted from intentional selection of sires that produced low birth weights and the geographical effect on birth weights (Burns et al., 1979; Burfening et al., 1987). Calf sex effects on birth weight were highly significant in both years. Sex

Table 1. Breed and number of heifers studied

	Year of measurement		Year of calving[a]	
Breed	1991	1992	1992	1993
Brangus	107	100	45	67
Simbrah	109	100	34	75
Braford	150	100	52	68
Totals	366	300	131	210

[a]Dams that had been measured and whose calves were weighed at birth. See text for sampling method.

Table 2. Least squares means of body measurement data obtained in June 1991 or June 1992

Year	Dam breed	No. animals	Pelvic height (cm)	Pelvic width (cm)	Pelvic area (cm^2)	Hip height (cm)	Heart girth (cm)	Body condition score	Body wt (kg)	Frame score
1991	Brangus	107	16.0 ± .10	14.5 ± .10	233.2 ± 2.3	122.2 ± .43	160.0 ± .51	5.6 ± .06	304.2 ± 2.6	3.3 ± .09
	Simbrah	109	16.1 ± .10	13.9 ± .10	223.5 ± 2.3	124.0 ± .43	164.6 ± .51	5.9 ± .06	329.6 ± 2.5	3.6 ± .08
	Braford	150	15.8 ± .08	12.5 ± .08	198.9 ± 2.0	123.2 ± .36	166.1 ± .43	6.1 ± .05	343.5 ± 2.2	3.4 ± .07
	Significance		$P > .10$	$P < .01$	$P < .01$	$P < .01$	$P < .01$	$P < .01$	$P < .01$	$P < .01$
1992	Brangus	100	14.8 ± .21	12.7 ± .14	188.2 ± 4.2	127.2 ± .51	168.1 ± .71	5.9 ± .06	335.7 ± 3.6	4.0 ± .10
	Simbrah	100	15.3 ± .20	13.0 ± .13	199.0 ± 4.0	125.7 ± .43	168.1 ± .66	5.9 ± .08	337.8 ± 3.4	3.8 ± .10
	Braford	100	15.1 ± .21	12.5 ± .14	189.7 ± 4.1	123.4 ± .45	165.6 ± .76	5.6 ± .07	317.4 ± 3.5	3.3 ± .10
	Significance		$P = .07$	$P < .05$	$P < .05$	$P < .01$	$P < .01$	$P < .01$	$P < .01$	$P < .01$

differences in dystocia score approached significance in both years, and the effect on dystocia incidence approached significance in 1992 and was highly significant in 1993. The breed × sex interaction did not affect dystocia score in 1992 but approached significance in 1993. This interaction seemed to be caused by the magnitude of the difference between sexes within the breeds of dam (Brangus, 1.33 vs 1.00; Simbrah, 1.17 vs 1.12; Braford, 1.08 vs 1.09; male vs female, respectively).

Matrices of residual correlations showing the relationships among the body measurements are summarized within year in Table 4. Pelvic dimensions and area were correlated with other body size measurements in both years. This agrees with previous studies that have shown pelvic dimensions are an indirect measure of body size (Basarab et al., 1993; Bellows and Staigmiller, 1994) and include the correlations with hip height, heart girth, body weight, and frame score in the present study. The greatest difference noted between years was that the relationships between body condition score and pelvic dimensions were nonsignificant in 1991 but were highly significant in 1992. This change may be due to year genetic differences among the heifers or having different individuals assign the visual condition scores in the two study years. The result identifies a problem inherent with collection of field data and further validates our decision to conduct analyses on a within-year basis. Other relationships were consistent between years.

Residual correlation matrices showing the relationships among dam body measurements and subsequent calf birth weight and dystocia score in the random sample of dams in which calving data was obtained are summarized in Table 5. The similarity of the r values in Tables 4 and 5 indicates the sample was representative of the population studied. The correlation between birth weight and dystocia score was significant in 1991 to 1992 and highly significant in 1992 to 1993. Birth weight was not significantly correlated with any of the body size traits in either year, with the correlation between birth weight and dam body weight approaching significance only in 1992 to 1993. Pelvic area was correlated with body size traits in both years ($P < .10$ to $P < .01$) but was not correlated ($P > .10$) with dystocia score, although the correlations with dystocia score were negative.

Table 3. Least squares means of calving data obtained in 1992 and 1993[a]

Dam breed	1992 Calf sex	1992 No. animals	1992 Birth wt (kg)	1992 Dystocia Score	1992 Dystocia Incidence (%)	1993 Calf sex	1993 No. animals	1993 Birth wt (kg)	1993 Dystocia Score	1993 Dystocia Incidence (%)
Brangus	Male	25	26.3 ± .8	1.17 ± .09	12.0	Male	39	28.4 ± .4	1.33 ± .08	20.5
	Female	20	24.1 ± .9	1.00 ± .00	0.0	Female	28	25.5 ± .5	1.00 ± .00	0.0
Simbrah	Male	16	26.4 ± 1.0	1.25 ± .12	12.5	Male	41	28.0 ± .4	1.17 ± .07	17.1
	Female	18	25.1 ± .9	1.06 ± .11	5.6	Female	34	26.4 ± .4	1.12 ± .08	8.8
Braford	Male	25	27.6 ± .8	1.17 ± .09	8.0	Male	35	27.9 ± .4	1.08 ± .08	8.6
	Female	27	23.8 ± .7	1.07 ± .09	3.7	Female	33	26.4 ± .4	1.09 ± .08	3.0
Significance										
Dam breed			$P > .10$	$P > .10$	$P > .10$			$P > .10$	$P > .10$	$P > .10$
Calf sex			$P < .01$	$P = .07$	$P = .08$			$P < .01$	$P = .06$	$P < .01$
Breed × sex			$P > .10$	$P > .10$	$P > .10$			$P > .10$	$P = .08$	$P > .10$

[a]Data used from dams whose calves were weighed at birth.

Table 4. Correlation matrix for body measurement data obtained in June 1991 or June 1992[a]

Year		Pelvic height	Pelvic width	Pelvic area	Hip height	Heart girth	Condition score	Body weight
1991	Pelvic width	.27**	—					
	Pelvic area	.76**	.83**	—				
	Hip height	.29**	.08	.23**	—			
	Heart girth	.22**	.18**	.25**	.33**	—		
	Condition score	−.06	.04	−.01	.04	.27**	—	
	Body weight	.21**	.11*	.20**	.40**	.66**	.33**	—
	Frame score	.29**	.07	.21**	.98**	.31**	.03	.39**
1992	Pelvic width	.50**	—					
	Pelvic area	.89**	.84**	—				
	Hip height	.01	.18**	.10†	—			
	Heart girth	.30**	.26**	.33**	.31**	—		
	Condition score	.34**	.13*	.28**	.06	.36**	—	
	Body weight	.32**	.27**	.35**	.38**	.70**	.45**	—
	Frame score	.01	.18**	.10†	.96**	.32**	.07	.38**

[a]Total animals, 366 and 300 in 1991 and 1992, respectively. †$P < .10$; *$P < .05$; **$P < .01$.

Values in Table 5 were further analyzed to study cause-and-effect relationships by calculating the b′ values among dam body size traits and subsequent birth weight and dystocia score. The biological relationship assumed was that pelvic area, birth weight, and dystocia score were the dependent variables. Results are summarized in Table 6.

In Path analyses 1, pelvic area was the dependent variable and year differences were found. The effect of condition score was important in both years, but was negative in 1991 to 1992 and positive in 1992 to 1993. These differences may have resulted from factors confounded with year discussed earlier in this article. Results support the conclusion that larger heifers had larger pelvic areas. In Path analyses 2, birth weight was the dependent variable and hip height was the only independent variable suggesting ($P < .10$) influence, but in the 1991 to 1992 data set only. We interpret this result to indicate external measurements of heifers at the end of the breeding season had little relationship with subsequent calf birth weight and would be of little predictive value. In Path analyses 3, dystocia score was the dependent variable and year differences were again noted. Body size, as measured by pelvic area ($P < .10$) and body weight ($P < .01$), had negative effects, and birth weight ($P < .05$) and heart girth ($P < .01$) had positive effects in 1991 to 1992. Birth weight was the only important ($P < .01$) path of influence in 1992 to 1993. Year differences between the two data sets may have

Table 5. Correlation matrix for body measurements (June) and subsequent calving data for heifers whose calves were weighed at birth[a]

Year		Dystocia score	Birth weight	Pelvic height	Pelvic width	Pelvic area	Hip height	Heart girth	Condition score	Body weight
1991–1992	Birth weight	.19*	—							
	Pelvic height	−.11	−.05	—						
	Pelvic width	−.10	−.02	.30**	—					
	Pelvic area	−.14	−.05	.79**	.81**	—				
	Hip height	−.01	.14	.15†	.16†	.19*	—			
	Heart girth	.08	.07	.07	.23**	.19*	.30**	—		
	Condition score	.03	.05	−.16†	−.09	−.15†	−.01	.19*	—	
	Body weight	−.05	.05	.15†	.16†	.19*	.41**	.71**	.25**	—
	Frame score	−.01	.14	.14†	.16†	.19*	1.00**	.30**	−.01	.40**
1992–1993	Birth weight	.49**	—							
	Pelvic height	−.09	−.04	—						
	Pelvic width	−.06	.04	.49**	—					
	Pelvic area	−.09	−.01	.89**	.83**	—				
	Hip height	−.02	.10	.01	.19**	.11	—			
	Heart girth	.01	.11	.29**	.22**	.30**	.32**	—		
	Condition score	−.01	.06	.36**	.12†	.29**	.05	.33**	—	
	Body weight	.04	.13†	.31**	.24**	.33**	.44**	.69**	.41**	—
	Frame score	−.01	.12	−.01	.18**	.09	.98**	.31**	.05	.42**

[a]Total animals, 131 and 210 in 1991 to 1992 and 1992 to 1993, respectively. †$P < .10$; *$P < .05$; **$P < .01$.

resulted from factors confounded with year, but the effect of birth weight was significant in both years. We interpret these results to indicate that birth weight had a consistently important effect on dystocia score. All R^2 values were small in the 1991 to 1992 data set but were somewhat larger for Path analyses 1 and 3 for the 1992 to 1993 data set.

Our overall interpretation of these results is that body size measurements obtained on pregnant, primiparous heifers after the end of the breeding season are of minor value in explaining variation in pelvic area, calf birth weight, or dystocia score. However, the consistently important effects of birth weight on dystocia indicate that it is an important causative factor associated with dystocia in Brahman-cross heifers in this geographical region.

Data were further analyzed to determine whether the relationships between birth weight and dystocia score were nonlinear. Two models were used: the first included dam breed and birth weight, linear and quadratic. We found dam breed to be nonsignificant (breed of dam, $P = .84$ for 1991 to 1992 and $P = .54$ for 1992 to 1993). Data were then reanalyzed pooled over dam breed. Results are summarized in Figure 1. Calculations from the curvilinear regression equations gave minimum dystocia scores (point of inflection) at 20.9 kg and 23.5 kg for the 1991 to 1992 and 1992 to 1993 data sets, respectively. Additional calculations found a dystocia score of 1.5 was associated with birth weights of 30.6 kg and 32.0 kg in 1991 to 1992 and 1992 to 1993, respectively. Dystocia score tended to increase with light birth weights, but this must be interpreted with caution because the total number of calves with birth weight less than 20 kg was small (n = 11). This finding tends to agree, however, with results of Patterson et al. (1987), who found increased perinatal death loss in calves with very light birth weights.

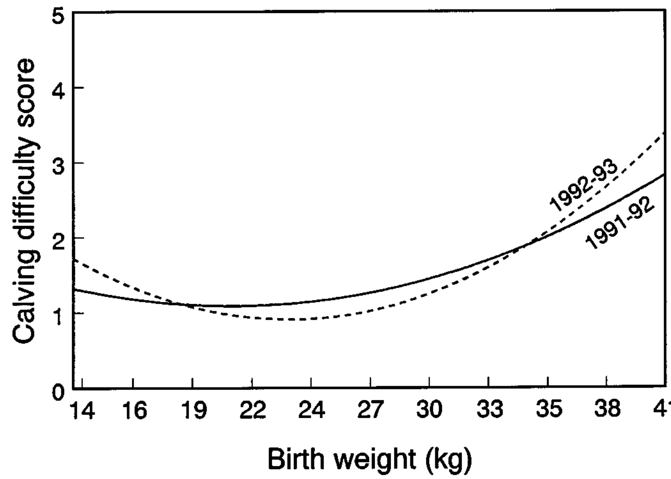

Figure 1. Least squares regression plots of dystocia score on birth weight (BW) for: 1991–1992, $\hat{Y} = 3.0034 - .1830\ BW^{\dagger} + .0044\ BW^{2}*$; 1992–1993, $\hat{Y} = 5.4860 - .3889\ BW^{**} + .0083\ BW^{2**}$. $^{\dagger}P = .08$; $*P < .05$; $**P < .001$.

Dams of *Bos indicus* breeding have been shown to produce calves with lower birth weights than do *Bos taurus* dams (Dobson and Kamonpatana, 1986). Bellows et al. (1988) reported placental differences between F_1 Brahman and F_1 *Bos taurus* dams. Ferrell (1991) found a lower blood flow to the uterus in Brahman than in Charolais dams and suggested this was responsible for reduced fetal growth and lower birth weights. Bellows et al. (1993) reported significant fetal genotype × maternal uterine environment interaction effects on fetal growth. They speculated that the "growth-depressing" effect of the Brahman uterine environment was subject to modification depending on the genetic growth potential of the fetus.

Selection for greater growth results in higher weaning and yearling weights of calves and is a common practice in the beef industry regardless of geographical region. Genetic correlations between birth weight and postweaning growth traits are positive (Gregory, 1984), indicating that continual selection for greater postweaning growth can increase birth weight and potentially dystocia. The findings of the present study showed that an average birth weight of 31 kg (which is not considered a high birth weight) was associated with a dystocia score of 1.5. We suggest that the growth potential of the fetus may eventually exceed the ability of the *Bos indicus* maternal environment to suppress fetal growth with the result being high birth weights. Thus, dystocia problems in primiparous heifers of the Brahman

Table 6. Standard partial regression coefficients (b′)[a]

Path analyses number and dependent variables	Independent variables	Year 1991–1992 b′	Year 1992–1993 b′
1 Pelvic area	Hip height	.11	–.02
	Heart girth	.11	$.13^{\dagger}$
	Condition score	–.20**	.18*
	Body weight	.12	.17*
	R^2	.09	.15
2 Birth weight	Pelvic area	–.08	–.06
	Hip height	$.16^{\dagger}$	.06
	Heart girth	.08	.06
	Condition score	.04	.02
	Body weight	–.06	.07
	R^2	.03	.02
3 Dystocia score	Birth weight	.18*	.50**
	Pelvic area	$-.13^{\dagger}$	–.09
	Hip height	.01	–.09
	Heart girth	.23**	–.06
	Condition score	.01	–.03
	Body weight	–.21**	.10
	R^2	.08	.26

[a]Values calculated using residual correlations shown in Table 5.
$^{\dagger}P < .10$; $*P < .05$; $**P < .01$.

crossbreeds in this geographical region could potentially increase if a conscious effort is not made to control birth weight.

Implications

Interest has developed in using pelvic measurements, with or without concomitant body measurements, as tools to cull heifers that have a high probability of experiencing dystocia at parturition. This study suggests that obtaining these measurements after the end of the breeding season would be of little predictive value in Brahman-cross heifers. The finding that birth weight has a consistently important causative effect on dystocia in Brahman-cross heifers in this subtropical geographical region indicates producers must be aware that high birth weights will cause dystocia. This means that breeding programs for heifers must be based on keeping birth weights under control regardless of geographical region.

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