Effects of Sire Birth Weight on Calving Difficulty and Maternal Performance of Their Female Progeny

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ABSTRACT : Weight records from birth to calving and calving scores of 407 two-year old heifers and weights of their offspring from birth to one year of age were used to study the effects of sire birth weight on maternal traits of their female progeny. The heifers (G_1) were the progeny of 81 sires (G_0) and were classified into three classes based on their sires' birth weights (High, Medium and Low). The heifers were from three distinct breed-groups and were mated to bulls with medium birth weights within each breed-group to produce the second generation (G_2). The data were analyzed using a covariance model. The female progeny of high birth-weight sires were heavier from birth to calving than those sired by medium and low birth-weight bulls. The effect of sire birth weight on calving difficulty scores of their female progeny was not significant. Grand progeny (G_2) of low birth-weight sires were lighter at birth than those from high birth-weight sires ($p < 0.05$) but they did not differ significantly in weaning and yearling weights from the other two Grand progeny groups. The results indicated that using low birth weight sires would not result in an increase in the incidence of dystocia among their female progeny calving at two-year of age and would not have an adverse effect on weaning and yearling weights of their grand progeny.

(Key Words : Calving Difficulty, Sire Birth Weight. Growth Rate)

INTRODUCTION

Calving difficulty is associated with increased calf birth weight (Bellows et al., 1971; Meijering, 1984; Naazie et al., 1989). Selection and use of sires with high growth rates and mature weights result in correlated responses in birth weight and accordingly higher incidence of calving difficulty (Koch et al., 1982; Schaeffer and Wilton, 1977).

The use of sires with low birth weights has been shown to reduce the incidence of calving difficulty in first-calf heifers (Bar-Anan, 1979; Makarechian and Berg, 1983). However, the use of female offspring of such matings may have some downside risks both in terms of their ability to calve without assistance and lower growth performance in their progeny. Heifers from low birth weight sires, grow at a slower rate, reach lower mature weights and have a higher incidence of dystocia at first calving (Philipsson, 1976). Meijering and Postma (1985) on the other hand reported that, the use of low birth weight sires would reduce the incidence of dystocia directly (for their direct progeny) and maternally (when their daughters subsequently calved).

It is becoming common in Western Canada to use low birth weight bulls on heifers for their first calving. The question posed by this practice is what are the risks of selecting female offspring from low birth weight sires for breeding replacements.

The objectives of this study were therefore to assess both the direct effects of sire birth weight on the weights of their calves and the subsequent incidence of dystocia for their female progeny at first calving. Also the weight for age of the second generation progeny was assessed.

MATERIALS AND METHODS

Experimental procedures

Records of weights (birth, weaning and calving), pelvic diameters and calving difficulty scores of 407 two-year-old heifers accumulated over six years (1985-1991) at the University of Alberta Beef Cattle Research Ranch at Kinsella, Alberta, were used in this study. The heifers belonged to three synthetic breed-groups, Beef Synthetic#1

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(SY1), Beef Synthetic#2 (SY2) and Dairy Synthetic (SD), providing three replications. Details of the genetic compositions of the breed-groups, breeding and management of the herd have been described by Berg et al. (1990).

The heifers (G_1) were classified into three groups according to the birth weight of their sires (G_0). The sire birth weights were adjusted for the age of dam as described by Sharma et al. (1982). Adjusted birth weights above 41.0 kg were classified as high (H), from 36.5-41.0 kg as medium (M) and less than 36.5 kg low as (L). The classification of bulls was similar to the calving difficulty risk classification of bulls used in some bull test stations (Colorado State University, 1993). The numbers of sires and their averaged birth weights by breed and birth-weight class and the numbers of their female progeny that calved are presented in table 1.

Table 1. Means and standard deviations of sires' birth weights (kg) by birth weight class and breed-group and the numbers of their daughters (female progeny) that raised a calf

Generation	Sire birth weight class	Breed group					
		Beef synthetic #1		Beef synthetic #2		Dairy synthetic	
		n	Mean ± SD	n	Mean ± SD	n	Mean ± SD
Sire (G_0)	High	16	48.1 ± 6.1	8	45.0 ± 3.4	11	45.9 ± 3.6
	Medium	8	39.9 ± 1.2	11	38.8 ± 1.3	3	38.2 ± 1.3
	Low	8	33.4 ± 2.6	14	33.4 ± 1.7	2	32.0 ± 2.9

Generation	Sire birth weight class	Number of progeny that raised a calf			
		Beef synthetic #1	Beef synthetic #2	Dairy synthetic	Total
Daughters (G_1)	High	86	40	66	192
	Medium	43	63	16	122
	Low	33	53	7	93

After reaching the breeding age of approximately 14 months, the heifers were exposed to 54 bulls with medium birth weights (39.9 ± 4.7, 38.7 ± 3.0 and 39.3 ± 4.5 kg for SY1, SY2 and DS respectively). Matings were in single sire groups, within each breed-group for 45 days starting in July to produce the Grand progeny (G_2) of the original sires (G_0). The pregnant heifers from the three breed-groups were managed together following breeding.

Calving difficulty of the heifers were scored on a scale of 0 to 5 (0 = normal calving and 5 = difficult delivery requiring surgery) and were transformed to Snell scale (ranging from 0 = normal to 100 = the most difficult) as described by Tong et al. (1977) for normal approximation. Pelvic width and height of the heifers were measured with a Rice pelvimeter (Lane Manufacturing, Denver, CO) 5 to 6 months after calving to allow the pelvic inlet to involute to the normal state. Pelvic area was approximated as the product of the two pelvic measurements. The calves (G_2) were weighed within 24 hours after birth, at weaning and finally at one year of age. The herd was managed according to the guidelines of the Canadian Council on Animal Care.

Statistical analysis

Data were analyzed by covariance analysis, using the GLM procedure of SAS (1990). Fixed linear models used for analysis included the effects of sire birth weight class, breed-group and daughter or Grand progeny's year of birth. The above-mentioned factors were considered for all the traits analyzed. Other effects such as the age of heifers (G_1) and the age and sex of the Grand progeny (G_2) were trait specific and considered for the analysis of the particular traits as covariates. Least-squares analyses of variance, means and standard errors were derived and least-square means tested, using PDIFF option.

RESULTS AND DISCUSSION

High birth weight sires produced heifers (G_1) that were heavier ($p < 0.05$) at birth, yearling, 18 months and calving (2-year), compared with the daughters of low birth weight sires (table 2). Weaning weights of the heifers in the three sire birth weight classes were not statistically different ($p > 0.05$). Overall, approximately 71% of the heifers had normal birth, while 12.5% required slight assistance at calving and over 16% experienced higher levels of dystocia.

Heifers sired by the high birth weight bulls had a

Table 2. Least-squares means and standard errors of traits of daughters (G_1) by sire birth weight class

Daughters' traits	Sire birth weight class		
	High	Medium	Low
Birth weight (kg)	39.3 ± 0.7^a	37.6 ± 0.8^b	37.2 ± 0.9^b
Weaning wt (kg)	212.4 ± 2.8^a	210.8 ± 3.3^a	207.8 ± 3.8^a
Yearling wt (kg)	276.9 ± 2.2^a	261.6 ± 3.0^b	252.9 ± 3.5^c
18 month wt (kg)	406.0 ± 2.6^a	390.4 ± 3.5^b	381.2 ± 4.0^b
2-yr weight (kg)	449.7 ± 3.0^a	428.6 ± 3.9^b	421.5 ± 4.6^b
Calving difficulty score*	18.6 ± 2.7^a	17.3 ± 3.8^a	15.3 ± 2.3^a
Pelvic width (cm)	16.3 ± 0.1^a	16.2 ± 0.1^a	16.2 ± 0.1^a
Pelvic heigh (cm)	17.5 ± 0.1^a	17.2 ± 0.1^b	17.2 ± 0.1^b
Pelvic area (cm^2)	285.0 ± 1.8^a	280.2 ± 2.3^b	279.0 ± 2.7^b
Ratio of calf birth weight on:			
dam pelvic width	2.10 ± 0.03^a	2.04 ± 0.04^a	2.06 ± 0.04^a
dam pelvic height	1.97 ± 0.02^a	1.92 ± 0.03^a	1.94 ± 0.03^a
dam pelvic area	0.12 ± 0.01^a	0.12 ± 0.01^a	0.12 ± 0.01^a

[a,b,c] least-squares means followed by different letters in the same row are significantly different ($p < 0.05$).

* Transformed scores ranging from 0 to 100.

slightly higher ($p < 0.05$) calving difficulty score compared with the heifers sired by medium and low birth-weight bulls (table 2).

The mean vertical pelvic diameter (pelvic height) of the heifers sired by high birth weight bulls was greater than those sired by medium and low birth weight bulls ($p < 0.05$). Heifers sired by high birth weight bulls had also larger pelvic area ($p < 0.05$) than those sired by low birth weight bulls (tabel 2).

The mean ratios of calf birth weight (G_2) to the dam's (G_1) pelvic width, height and area, as a measure of feto-pelvic incompatiblity, were not different ($p > 0.05$) among the three sire birth weight classes (table 2). Feto-pelvic incompatiblity is recognized as one of the most important causes of dystocia in two-year-old heifers (Meijering, 1984). The results indicated that, although the heifers sired by low birth weight bulls had lighter body weight and smaller pelvic area than those sired by high birth weight bulls, they did not have higher incidence of dystocia, because their calves were also lighter at birth. These results are in agreement with the results reported by Meijering and Postma (1985).

Grand progeny (G_2) of the high birth weight sires were heavier at birth ($p < 0.05$) compared with those from low birth weight sires (34.4 vs 32.0 kg), while the difference was not significant between the low and medium sire birth weight classes. There were no significant differences among the three sire birth weight classes for Grand progeny's (G_2) weaning weight (table 3). This was probably due to the negative genetic correlation between direct and maternal genetic effects on weaning weight (Hohenboken and Brinks, 1971; Trus and Wilton, 1988; Lee et al., 1997). Yearling weights of the Grand progeny of the three sire birth weight classes were not significantly different (tabel 3).

In conclusion, the low birth weight sires produced female progeny (G_1) which were lighter and smaller in pelvic area than those sired by high birth weight bulls at birth, yearling and two-year of age. The sire birth weight did not have a significant effect on the level of calving difficulty among the female progeny calving at two-year of age. Grand progeny (G_2) of the low birth weight sires were lighter at birth compared to those of the high birth weight sires, however, sire birth weight did not have a significant effect on weaning weight and yearling weight of the Grand progeny. Therefore, the industrial application of low birth weight bulls should be used to sire the heifers for the first calving to avoid risk of dystocia in selecting female offspring (G_1) without negative effect on yearling weight of the Grand progeny (G_2).

Table 3. Least-squares means and standard errors of weights of Grand progeny (G_2) by sire birth weight class

Trait	Sire birth weight class		
	High	Medium	Low
Birth weight (kg)	34.4 ± 0.4^a	33.2 ± 0.5^{ab}	33.0 ± 0.6^b
Weaning weight (kg)	184.9 ± 2.2^a	186.0 ± 2.9^a	186.4 ± 2.9^a
Yearling weight (kg)	399.0 ± 7.6^a	411.1 ± 9.9^a	390.4 ± 11.3^a

[a,b,c] least squares means followed by different letters in a row are significantly different ($p < 0.05$).

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