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Effect of a stair-stepped growth regimen on subsequent breeding performance of beef heifer calves

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The objective of these studies was to determine the effect on growth performance and lactational potential of beef heifers reared on a stair-stepped nutritional program imposed during the pubertal phase. This report evaluates the effect of a stair-stepped nutritional program on subsequent breeding performance. Heifers calves managed for a stair-stepped growth pattern during the winter prior to breeding had higher cumulative conception rates compared to heifers managed for a constant rate of gain.

Summary

The effect of nutritional management for either constant or stair-stepped rates of gain on breeding performance of beef heifers was assessed in three experiments. In each experiment, heifers were assigned one of two winter management strategies. Strategies included either management of heifers for a constant rate of gain (CO) or for a low rate of gain followed by a period of rapid growth rate (SS). Estrus was synchronized in each experiment and heifers were either bred artificially (AI) on subsequent expression of heat or allowed an opportunity for natural service. Heifers that were artificially inseminated following synchronization were subsequently exposed to fertile bulls. Ultrasonographic estimates of fetal presence and age (if present) were used to subsequently classify heifers as having conceived early (to AI), within one of three 21-d breeding cycles or open. Pooled across experiments, BW and BCS at breeding were 381 and 389 kg and 6.3 and 6.8 for CO and SS, respectively. Cumulative conception rate was improved by SS ($P<.05$). Difference in cumulative conception rate between SS and CO increased through the second breeding cycle (-5.4, 9.8, 14.2 and 14.0 for heifers conceiving to AI or by 21, 42 or 63 d, respectively). Heifers calves managed for a stair-stepped growth pattern during the winter prior to breeding had higher cumulative

conception rates compared to heifers managed for a constant rate of gain.

Introduction

Rapid prepubertal growth due to a high plane of nutrition has been shown to reduce subsequent milk production in beef and dairy heifers. Thus, beef producers are annually faced with the dilemma of pushing replacement heifers to achieve optimal body weights prior to the breeding season so that they will calve early in their first calving season while not potentially reducing subsequent lactational performance. Several researchers have shown that nutritional regimens which impose a period of growth restriction followed by a period of growth compensation have minimal to no delay in the onset of puberty and as much or more milk produced during thier first lactation compared to heifers maintained at a continuous rate of gain prior to breeding. Dr. Chung Park at NDSU has demonstrated that milk production potential could be enhanced in beef heifers developed under such a stair-stepped growth regimen. Studies were initiated to refine the stair-step approach in beef heifer production systems. The objective of these studies was to determine the effect on growth performance and lactational potential of beef heifers reared on a stair-stepped nutritional program imposed during the pubertal phase. This report evaluates the effect of a stair-stepped nutritional program on subsequent breeding performance.

Procedures

Experiment 1. Seventy-two heifer calves were randomly assigned to one of 12 feedlot pens (6 heifers/pen). Pens were then assigned one of three dietary regimes. In the first dietary regime (CONTROL), heifers were managed for one of two constant rates of gain so that they would be at approximately 70% of their expected mature body weight prior to the initiation of the breeding season (June 19). Heifers were ad libitum fed a diet balanced for .68 kg/d gain from December 5 until April 1 and then fed for .45 kg/d gain from April 1 through the breeding season. The other two dietary regimes nutritionally managed heifers for either low gains (diets balanced for 0.23 and 0 kg/d before and after April 1, respectively, with intakes of crude protein and dry matter set at 100 and 60% of CONTROL) or high gains (diets balanced for 1.14 and .68 kg/d before and after April 1, respectively, with diets fed ad libitum). One of these two groups (STAIRa) started with a 6-wk period of high gain and then alternated between 6-wk periods of low gain followed by 6-wk periods of rapid gain. The other group (STAIRb) was similar to STAIRa, except that it began with a 3-wk high gain period. The intent of STAIRa and STAIRb was to test whether switching from a high growth phase to a low growth phase immediately after estrous synchronization and artificial insemination would affect breeding performance. This phase of the experiment was not implemented.

Diets were mixed and fed daily. Bunks were cleaned weekly and weight of feed refusals recorded. Body weight and body condition score (BCS) in morning before feeding was record every 21 d.

Estrus was synchronized, expression of heat monitored and heifers artificially inseminated (AI) 12 hr following standing heat for 5 d. Heifers were then exposed to bulls for a 57-d breeding season. Ultrasonographic estimates of fetal presence and age (if present) were used to subsequently classify heifers as having conceived early (to AI), within one of three 21-d breeding cycles or open.

Experiment 2. Ninety-six heifer calves were blocked into three weight groups and randomly assigned to twelve feedlot pens within group (8 heifers/pen; 6 pens/group). Pens within group were then assigned one of two dietary regimens (2 pens/treatment/group). Dietary regimens represented heifers nutritionally managed for a continuous rate of gain (.68 kg/d) for 20 wk (CONTROL) or for a minimal rate of gain for 10 wk followed by a rapid rate of gain for 10 wk (STAIR). The minimal rate of gain was imposed by energy restriction. Metabolizable energy concentration (ME) of the restricted diet was similar to diet used in CONTROL, however dry matter intake (DMI) was restricted to 60% of DMI of CONTROL heifers. Protein concentration (CP) was increased in the restricted diet to allow for similar daily intakes between dietary regimens. Following the restricted gain phase, STAIR heifers were given ad libitum access to a high energy diet (130% ME and 100% CP of CONTROL diet) for 10 wk. Subsequently, all heifers were managed similarly through breeding.

Diets were mixed and fed daily. Intake of STAIR heifers during the restricted phase was paired to CONTROL heifers daily within weight group. "Minimal feed refusal" bunk management was employed in CONTROL heifers to accommodate calculation of intake restriction. Body weight and BCS was recorded every 14 d.

Experiment 3. Forty-eight heifer calves were blocked into three weight groups and randomly assigned to 6 feedlot pens with group (8 heifers/pen; 2 pens/group). Pens within group were then assigned one of two dietary regimens (1 pen/treatment/group). Dietary regimens represented heifers nutritionally managed for a continuous rate of gain (.68 kg/d) for 20 wk (CONTROL) or for a minimal rate of gain for 10 wk followed by a rapid rate of gain for 10 wk (STAIR). Dietary treatments were formulated as in Exp. 2 with the exception that DMI of Stair during the restricted phase was set at 70% of DMI of CONTROL within weight group. Following the 20-wk study, all heifers were managed similarly through breeding.

Diets were mixed and fed as described in Exp. 2. Body weight and BCS was recorded every 14 d.

In both Exp. 2 and 3, estrus was synchronized prior to the breeding season. Subsequent estrus monitoring and AI procedures were similar to those used in Exp. 1. Following the estrus monitoring period, heifers were exposed to bulls for a 75-d breeding season. Ultrasonographic estimates of fetal presence and age were performed similarly to Exp. 1.

Statistical analysis. Body weight, BCS and gain data were analyzed as a completely random design in Exp. 1 and as a randomized complete block design in Exp. 2 and 3. Reproductive data (heifers bred by AI and heifer conception by category or open) were analyzed within and across years as count data using chi-square analysis and reported as percentages of total heifers.

Results and Discussion

Growth performance and feed efficiency of heifers in these experiments has been previously reported. A summary of BW, BCS and average daily gain (ADG) is reported in Table 1. Intake restriction in STAIR reduced BW and ADG in Exp. 2 and 3 and BCS in Exp. 2. BCS in Exp. 3 followed this same trend. Following the intake restriction phase, STAIR increased ADG in Exp. 2 and 3 and BCS in Exp. 2. BCS (P=.17) in Exp. 3 also followed this same trend. Over the entire experimental period, STAIR increased final BW and ADG in Exp. 1 and 3. Differences in final BW and ADG in Exp. 2 followed this same trend. At breeding, BW in Exp. 1 and BCS in Exp. 2 were also increased by STAIR.

Nutritional manipulation to achieve a stair-stepped pattern of weight gains in replacement heifers was achieved in these studies. Similar growth responses as a result of nutritional manipulation have been reported in other studies. Current management practices suggest targeting beef heifers to reach 60 to 65% of their estimated mature weight by the start of the breeding season. Since the average of all the heifers in each treatment and experiment exceeded 65% of their estimated mature weight at the beginning of the breeding season (Table 1), this breeding target should have been satisfied.

Breeding performance results are reported in Table 2. STAIR did not increase the percentage of heifers that expressed estrus following an estrous synchronization protocol. In fact, estrous expression following synchronization was increased with CONTROL in Exp. 3 and when data from all experiments were combined (COMB). Furthermore, STAIR did not increase the percentage of heifers conceiving to AI (in all instances). The cumulative percentage of heifers conceiving by d 21 of the breeding period was increased by STAIR in Exp 1 and COMB. The cumulative percentage of heifers conceiving by d 42 of the breeding period was increased by STAIR in Exp 1 and 2 and COMB. Percentage of heifers not conceiving by d 63 of the breeding season was reduced by STAIR in Exp. 1, 2 and 3 and COMB.

Overall breeding performance was improved by STAIR in these studies. Flushing refers to the practice of feeding thin cows and heifers supplemental energy beginning prior to and continuing throughout the breeding season. It is generally believed that this practice will cause more females to come into heat, to breed earlier in the season and to conceive at first service. Short-term feeding of supplemental energy prior to the breeding season may increase pregnancy rates even though body weight and condition score are not affected. This increase seems to be associated with an increase in the percentage of heifers cycling earlier in the breeding season. Although STAIR provided an increase in energy intake prior to the breeding season and an increase in overall pregnancy rate, there is no indication that the increase in pregnancy rate was associated with an increase in the percentage of heifers cycling earlier in the breeding season.

Table 1. Body weight (BW, kg), body condition score (BCS) and average daily gain (ADG, kg/d) of heifer calves managed for either a constant rate of gain (Control) or stair-stepped (Stair) rates of gain prior to breeding.

	Experiment 1			Experiment 2		Experiment 3	
	Control	Stair (a)	Stair (b)	Control	Stair	Control	Stair
Initial							
BW	249.6	249.2	251.6	283.5	286.3	300.6	301.6
BCS	-	-	-	6.2	6.3	6.2	6.1

Restricted phase				-------- 70 d --------		-------- 70 d ---------	
BW	-	-	-	322.9[x]	291.1[y]	368.2[x]	326.4[y]
BCS	-	-	-	6.0[x]	5.2[y]	6.7	5.5
ADG	-	-	-	.56[x]	.07[y]	.97[x]	.35[y]
Compensating phase				-------- 70 d --------		-------- 70 d --------	
BW	-	-	-	381.8	401.3	427.7[x]	438.5[y]
BCS	-	-	-	6.2[x]	6.7[y]	7.3	7.6
ADG	-	-	-	.84[x]	1.57[y]	.85[x]	1.60[y]
Overall performance	------------- 193 d -------------			------- 140 d -------		------- 140 d -------	
BW	362.2[x]	381.7[y]	382.4[y]	-	-	-	-
ADG	.58[x]	.68[y]	.68[y]	.70	.82	.91[x]	.98[y]
Breeding							
BW	353.9[x]	371.9[y]	373.9[y]	370.0	379.5	426.5	434.7
%MBW[a]	67.6	71.1	71.1	70.5	72.4	79.8	81.4
BCS	6.7	6.9	6.8	5.9[x]	6.5[y]	7.2	7.5

[a] Estimated percentage of mature body weight.

[x,y] Means within row and experiment with different superscripts differ (P<.05).

Table 2. Breeding performance of heifer calves managed for either a constant rate of gain (Control) or stair-stepped (Stair) rates of gain prior to breeding.

	Bred	**Cumulative % of heifers conceiving to AI, by day of breeding season or open**				
	AI[b]	**AI**	**21-d**	**42-d**	**63-d**	**Open**

Experiement 1^{w}						
Control	20.8	8.3	16.7^{z}	54.2^{z}	79.2^{y}	20.8^{y}
Stair-a	37.5	25.0	58.3	87.5	95.8	4.2
Stair-b	16.7	12.5	62.5	83.3	95.8	4.2
Experiment 2^{v}						
Control	41.7	25.0	52.1	70.8^{x}	75.0^{y}	25.0^{y}
Stair	29.2	14.6	47.9	83.3	89.6	10.4
Experiment 3						
Control	100.0^{x}	50.0	50.0	87.5	91.7^{x}	8.3^{x}
Stair	91.7	41.7	45.8	87.5	100.0	0.0
Combined^{w}						
Control	51.0^{x}	27.1	42.7^{x}	70.8^{z}	80.2^{z}	19.8^{z}
Stair	40.8	21.7	52.5	85.0	94.2	5.8

[a] Percentage of heifers that expressed estrus to a estrous synchronization protocol. All heifers observed in estrus following synchronization were artificially inseminated 12-hr following standing heat..

[b] Cumulative percentage of heifers conceiving to either artificial insemination (AI) or natural service in 21-d intervals or open.. Bulls were turned out 5 days after last AI date. Estimations of conception were based upon ultrasonographic determinations of fetal presence.

[v,w] Number of heifers within treatments conceiving to either AI or natural service in 21-d intervals or open differ ($P < .15$ and .05, respectively).

[x,y,z] Treatment means within a column and experiment differ ($P < .15$, .10 and .05; respectively).

[illegible] Superscripts in text indicate statistical significance (P .15. .10 and .05, respectively).