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Stair-stepped growth patterns in heifer development programs

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Research Summary

The stair-stepped growth regimen increased overall trial gains, improved growth efficiencies and reduced total dry matter consumed in both heifer calves and bred heifers. Subsequent calving performance and milk production data on heifers in this study will be monitored for assessment of carryover effects of heifer developmental regimen.

Introduction

Research has demonstrated in a number of species increases in subsequent milk production when females are exposed to a stair-stepped growth regimen during development. Stair-stepped growth is accomplished by nutritionally alternating phases of low and rapid growth rates. These studies are part of a series of ongoing experiments designed to determine the effect of a stair-stepped growth regimen on growth performance and subsequent lactational potential of beef heifers. The first study imposed the growth regimen in heifer calves from weaning to breeding. The second study focused on bred heifers prior to first calving. Only growth and calving performance are presented in this report.

Materials and Methods

Experiment 1. 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 (1.5 lb/d) for 20 wk (CO1) or for a minimal rate of gain for 10 wk followed by a rapid rate of gain for 10 wk (SS1). The minimal rate of gain was imposed by dietary energy restriction. Metabolizable energy concentration (ME) of the restricted phase diet was similar to diet used in first 10-wk phase of CO1, however dry matter intake (DMI) was restricted to 70% of DMI of CO1 heifers. Protein concentrations (CP) was increased in the restricted diet to allow for similar daily intakes between the dietary regimens in the first phase. Following the restricted gain phase, SS1 heifers were given ad libitum access to a high energy diet (130% ME and 100% CP of CO2 diet) for 10 wk. Differences in diets between phases for CO1 were primarily in ME to account for expected environmental changes. Following the 20-wk study, all heifers were managed similarly through breeding. Diets used in the restricted and rapid growth phases are shown in Table 1.

Diets were mixed and fed daily. Intake of CO1 heifers during the restricted phase of growth was paired to CO1 heifers daily within weight group. "Minimal feed refusal" bunk management was employed in CO1 heifers to accommodate calculation of intake restriction. Body weight (BW) and body condition score (BCS) was recorded every 14 d. Estrus was synchronized and heifers were artificially inseminated 12 hr following standing heat. Heifers were then exposed to intact bulls for the remainder of the breeding season.

Data were analyzed as a randomized complete block design using standard analysis of variance procedures and pen as the experimental unit.

Experiment 2. Twenty bred heifers were randomly assigned to four feedlot pens. Pens were then assigned to one of two dietary regimens (2 pens/regimen). The structure of the experiment was similar to Experiment 1, with the following exceptions. The experimental period consisted of two 9-wk phases (18 wk total). Control (constant gain; CO2) heifers were nutritionally managed for 1.0 lb/d. Diets used in the restricted and rapid growth phases are shown in Table 2. Experimental regimens (CO2 and stair-stepped [SS2]) ended when the first heifer calved and all heifers were subsequently managed similarly through weaning.

Data were analyzed as a completely random design using standard analysis of variance procedures and pen representing the experimental unit.

Results and Discussion

Experiment 1. In heifer calves, initial BW (P=.35) and BCS (P=.42) did not differ between dietary regimen (Table 3). During the restricted phase (first 10 wk), BW (P<.01), BCS (P=.06), average daily gain (ADG; P<.01) DMI (P<.01) and growth efficiency (GE; P<.01) were all depressed by SS1. Intakes were reduced 75% during the restricted phase. During the rapid growth phase (final 10 wk), BW (P=.01), ADG (P<.01), DMI (P=.05) and GE (P<.01) were all improved by SS1. Final BCS (P=.17) did not differ between growth regimens. Over the entire period (20 wk), ADG (P=.02) and GE (P<.01) were improved by SS1, while DMI (P<.01) was reduced.

Experiment 2. In bred heifers, initial BW (P=.09) was greater for CO2 heifers. Initial BCS (P=.35) did not differ between dietary regimens (Table 4). During the restricted phase (first 9 wk), BW (P=.08), ADG (P=.10) and DMI (P<.01) were depressed by SS2. At the end of the restricted phase, BCS (P=.15) and GE (P=.18) were not statistically effected by dietary regimen. Intakes were reduced 76% during the restricted phase. Gain data was terminated at wk 17 (heifers began calving 4 days prior to end of wk 18), intake data continued through wk 18. During the rapid growth phase, BW (P<.01), BCS (P=.06), ADG (P<.01), DMI (P=.05) and GE (P<.01) were improved by SS2. Over the entire 18 wk period, ADG (P<.01) and GE (P<.01) were improved, while DMI (P<.01) was depressed, by SS2. Calving date (P=.07) was reduced 4.8 d by SS2. Calf birth weight (P=.33) were not influenced by growth regimen.

The desired level of intake restriction was not achieved in either experiment. Restriction averaged 75.5% across both experiments as opposed to the desired level of 70%. Future studies will need to address the restriction protocol with respect to feed deliveries.

Dry matter intakes in Experiment 2 were lower than expected for both experimental treatments. Although SS2 heifers were able to experience a compensatory growth response despite this intake reduction, CO2 heifers reflected the lower intake with corresponding lower growth. Nonetheless, in both experiments, the experimental stair-stepped growth response was achieved. Overall performance in both experiments was consistent with previous studies conducted at the Center. The stair-stepped growth regimen increased overall trial gains, improved growth efficiencies and reduced total dry matter consumed. Subsequent calving performance and milk production data on heifers in this study will be monitored for assessment of carryover effects of heifer developmental regimen.

Table 1. Diet composition (as fed basis) in Experiment 1 (heifer calves).		
Restricted phase	**CO1**	**SS1**
Hay	13.41	46.03
Corn silage	79.18	35.62
Grain-based meal[a]	7.41	18.35
Compensation phase[b]	**CO1**	**SS1**
Hay	11.60	10.21
Corn silage	80.41	28.55
Grain-based meal[a]	7.72	60.80

Total	**CO1**	**SS1**
Hay	11.67	24.94
Corn silage	79.80	31.46
Grain-based meals	7.57	43.35

[a] Grain-based meals were formulated and mixed to specifications by Land O'Lakes/Harvest States, Inc. (Dr. Jeff Heldt, Billings, MT).

[b] 216 lb of an MGA containing supplement was fed to both groups during the compensating phase as part of a estrous synchronization protocol.

Table 2. Diet composition (as fed basis) in Experiment 2 (bred heifers).

Restricted phase	**CO2**	**SS2**
Hay	72.45	73.73
Grain-based meal[a]	27.55	26.27
Compensation phase	**CO2**	**SS2**
Hay	71.67	18.40
Grain-based meal[a]	28.33	81.60

Total	CO2	SS2
Hay	72.11	44.27
Grain-based meals	27.89	55.73

[a] Grain-based meals were formulated and mixed to specifications by Land O’Lakes/Harvest States, Inc. (Dr. Jeff Heldt, Billings, MT).

Table 3. Animal performance in Experiment 1 (heifer calves).

Initial conditions	CO1	SS1	P-value
Body weight, lb	662.8	664.9	.35
Body condition score	6.2	6.1	.42
Restricted phase (10 wk)	**CO1**	**SS1**	**P-value**
Body weight, lb	811.8	719.6	<.01
Body condition score	6.7	5.5	.06
Average daily gain, lb/d	2.13	.78	<.01
Dry matter intake, lb/d	19.7	14.7	<.01
Growth efficiency (gain/intake)	.108	.053	<.01

Compensating phase (10 wk)	CO1	SS1	P-value
Body weight, lb	942.8	966.7	.01
Body condition score	7.3	7.6	.17
Average daily gain, lb/d	1.87	3.53	<.01
Dry matter intake, lb/d	20.5	20.9	.05
Growth efficiency (gain/intake)	.091	.169	<.01
Overall performance (20 wk)	**CO1**	**SS1**	**P-value**
Average daily gain, lb/d	2.00	2.16	.02
Dry matter intake, lb/d	20.1	17.8	<.01
Growth efficiency (gain/intake)	.100	.121	<.01

Table 4. Animal performance in Experiment 2 (bred heifers).

Initial conditions	CO2	SS2	P-value
Body weight, lb	1032.0	1012.4	.09
Body condition score	6.9	6.4	.35

Restricted phase (9 wk)	CO2	SS2	P-value
Body weight, lb	1102.4	1036.5	.08
Body condition score	6.5	6.0	.15
Average daily gain, lb/d	1.12	.38	.10
Dry matter intake, lb/d	23.7	18.0	<.01
Growth efficiency (gain/intake)	.047	.021	.18
Compensating phase (8 wk)	**CO2**	**SS2**	**P-value**
Body weight, lb	1085.6	1203.9	<.01
Body condition score	6.2	7.0	.06
Average daily gain, lb/d	-.03	2.99	<.01
Dry matter intake, lb/d	17.7	19.4	.05
Growth efficiency (gain/intake)	-.017	.154	<.01
Overall performance (18 wk)	**CO2**	**SS2**	**P-value**
Average daily gain[a], lb/d	.45	1.61	<.01
Dry matter intake, lb/d	20.6	18.6	<.01
Growth efficiency[a] (gain/intake)	.022	.086	<.01

Calving date	Mar 1	Feb 25	.07
Birth weight, lb	85.2	83.5	.33
[a] Average daily gain calculated over 17 wk and intakes over 18 wk.			

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