Effect of rotation crop, cover crop, and bale grazing on steer performance, carcass measurements, and carcass value

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Abstract

Forty-eight yearling steers of similar frame score were randomly assigned to an extended grazing study to compare grazing NR or a sequence of annual forages (field pea-barley, corn, cover crop) and evaluate the effect of bale grazing cover crop bales as a procedure for extending the grazing season for forage-finished beef. Multiple blizzards, deep snow, and drifting created an impossible situation and compromised the study. With only two options, i.e. sell the steers, or finish in the feedlot. The steers were finished at the University of Wyoming, Sustainable Agriculture Research and Extension Center (SAREC), Lingle, Wyoming, and slaughtered at the Cargill Meat Solutions plant, Ft. Morgan, Colorado.

Forage finishing beef is time consuming, because forage-based animal growth rate is approximately one-half that of similar animals fed grain-based finishing diets. Therefore, desirable procedures will insure consistent growth greater than 2.0 lb/day and economically important muscle and fat measurements will increase during the grazing season. Although weather interfered with the forage finishing component of this investigation, bale grazing cover crop bales extended the grazing season from 180 days to 221 days. Grazing data is summarized in Table 2. Forage sequence grazing combined with cover crop bale grazing supported ADG of 2.14 lb/day compared to 1.64 lb/day for NR steers (*P* = 0.01), and ANN steers were 110.0 lbs. heavier. Native range steer muscling at the end of grazing was greater (REA: CWT; *P* = 0.04) than ANN steers; however, ANN steer ultrasound percent intramuscular fat (IMF) was greater (*P* = 0.01), ANN system marbling score did not differ.

Finishing performance for NR and ANN steers paralleled one another (Table 3). Except for numerical differences, none of the criteria measured differed statistically.

For carcass measurements, ANN steer HCW averaged 85.0 lbs. heavier than NR steers, but the difference did not differ significantly (*P* = 0.18). Native range steers were higher yielding (*P* = 0.01) and the muscling relationship expressed as the ratio of REA: HCW was also greater (*P* = 0.04) than the ANN steers. Gross carcass value for ANN steers exceeded NR steers by $112.89, which is reflective of the weight margin established between NR and ANN steers during the grazing season.

Introduction

A long-term (10-Year) integrated crop and beef cattle investigation focuses on the interrelations of crop production, soil health, and beef cattle production. The crop rotation sequence consists of spring wheat, cover crop, corn, field pea-barley, and sunflower. After completing the first five years of the study, marked improvements in soil health reduced and eliminated commercial fertilizer application, while maintaining production levels and in many circumstances production increased, especially for spring wheat grown in the crop rotation. For livestock integration, yearling steers provide the animal basis for vertical integration from birth to slaughter. One objective of the study was to decrease mechanical harvest and replace with animal harvesting as much as possible. In a previous study, Senturklu et al. (2016) summarized a three-year extended grazing investigation in which yearling steers of two different frame scores (3.8 vs. 5.6) grazed an average 211 days prior to feedlot entry and were compared to similar, non-grazing, steers sent directly to the feedlot and fed for 218 days before slaughter. Extended grazing steers spent 82 days in the feedlot. Additionally, the study evaluated two marketing dates, i.e. at the end of the 211-day grazing period, or as finished cattle sold on the grid. Efficiency of the smaller framed steers had greater net return at the end of grazing, whereas large framed steers had greater net return at the end of finishing. Others have also documented yearling systems results from weaning to slaughter and reported lower breakeven cost and greater net profit (Lewis et al., 1990; Shain et al., 2005).

For the current investigation, corn, field pea-barley and 13-species cover crop grown in the crop rotation preceded bale grazing of a 5-species cover crop hay (baled in July) as a method for extending the grazing season for forage finishing. Evaluation consisted of steer grazing and finishing performance, and carcass measurement and value.

Materials and Methods

The North Dakota State University Institutional Animal Care and Use Committee approved animal research procedures used in this study.

Forty-eight yearling crossbred steers (n = 24/treatment/3 reps of 8 steers; Frame Score: 4.75 to 4.85) grazed either western North Dakota native range (NR), or a forage sequence of the same type of native range and annual forages (ANN: field-pea barley, MasterGraze corn, and a 13-species cover crop). For forage finishing, a 5-species cover crop hay was baled in early July (12.9% CP) for feeding after grazing (bale grazing). For NR grazing, steers grazed NR as a common group from spring turnout the first week of May until the third week of July, at which time, the NR treatment continued to graze NR until November 2. The ANN grazing treatment grazed the sequence of crops until November 2. On November 2, NR and ANN steers moved to replicated fields and grazed cover crop hay bales.

Triplicate quarter-meter forage sample collections occurred at the start and end of each forage grazing period. Forage analysis included crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), invitro dry matter disappearance (IVDMD), invitro organic matter disappearance (IVOMD), calcium (Ca), phosphorus (Phos), and total digestible nutrients (TDN).

Multiple blizzards, deep snow, and drifting made feeding cover crop bales to the steers impossible. Forage-finish bale grazing discontinued after 41-days. Considering the impossible weather conditions, only two options existed: sell, or finish the steers. The steers were finished at the University of Wyoming, Sustainable Agricultural Research Extension Center, Lingle, WY.

Monitoring of steer growth occurred with each forge type change, and in the feedlot, end-point target was based on ultrasound backfat depth between 0.35 and 0.45 inch. Live animal ultrasound measurements occurred at the end of bale grazing before shipment to the Wyoming feedlot to determine the effect of grazing method on economically important muscle and fat traits. Steers were slaughtered at the Cargill Meat Solutions Plant, Ft. Morgan, Colorado, and grid carcass measurements included hot carcass weight (HCW), fat depth (FD), ribeye area (REA), marbling score (MS), USDA yield grade (YG), quality grade (QG), and muscle to carcass weight ratio (REA: HCW), and gross carcass value were calculated.

Mean separation determined using the MIXED procedure of SAS. Means with $P \leq 0.05$ differ significantly.

Results and Discussion

Steer growth for NR steers, during the 180-day period from the first week of May to November 2, fluctuated more than the steers grazing ANN forages, and at the end of bale grazing the ANN steers weighed 110 lb more ($P = 0.01$; Table 2). The NR steers were sensitive to range forage changes related to precipitation. As the NR matured with advancing season, gain declined; however, fall rain stimulated range regrowth and steer gain rebounded during September and October. Grazing ANN forage sequence crops maintained ADG at ±2.0 lb/day throughout the 180-day grazing season, because forage maturity among crops selected for the long-term crop rotation are staggered. For example, as field pea-barley grazing was completed, corn matured sufficiently and was ready for grazing. Since cover crop planting occurs after triticale-hairy vetch hay is baled, cover crop is ready to graze at or near the end of corn grazing. Forage finishing requires more time for animal growth then the northern Great Plains' growing season allows. Feeding of cover crop hay prepared in early-July occurred after termination of cover crop grazing. Cover crop bale grazing gain was greater for ANN steers compared to NR steers ($P = 0.002$), which was unexpected. Gain among ANN compared to NR was 3.27 and 2.0 lb/day, respectively. Given the restricted growth nature commonly associated with NR, a compensating gain response, such as the responses reported by Senturklu et al. (2016) and Choat et al. (2003), was expected. Overall, for the entire 221-day grazing and bale-grazing period prior to feedlot entry, steer gain and ADG was 362.9 and 1.64; and 472.9 lb and 2.14 lb/day, for the NR and ANN steers, respectively.

Economically important muscle and fat tissues measured with ultrasound consisted of ribeye muscle area (REA), percent intramuscular fat (IMF), and ending marbling score (MS) (Table 2). Ribeye muscle area muscle increased during the 221-day grazing period, but did not differ ($P = 0.10$); however, the muscle relationship between REA and weight (REA: CWT) was greater among the NR steers.

Feedlot performance between the NR and ANN grazing treatments paralleled one another (Table 3). ANN steers entered the feedlot weighing 1246.7 lb and the NR steers weighed 1123.8 lb, a margin of 122.9 lb.

Unlike feedlot performance with no variance between treatments, carcass measurements for FD ($P = 0.02$), YG ($P = 0.01$), and REA: HCW ratio ($P = 0.04$) differed significantly (Table 5). The ANN treatment steers consistently grazed higher quality forage and growth from cover crop hay increased the potential for fatter carcasses and more discounts for overweight carcasses. Native range steers had numerically greater MS and greater REA: HCW muscling ($P = 0.04$). The muscling relationship identified for the NR steers at the end of grazing remained consistent to the end of finishing.

Gross carcass value for ANN steers was numerically greater ($1944.37 vs. $2056.45), but did not differ (P = 0.22). Although there was no statistical difference identified, results reported by Senturklu et al. (2014; 2016) show weight margins among groups entering the feedlot do not change appreciably by the end of the finishing period and gross carcass value is routinely greater.

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1. Nutrient analysis of grazed forages and cover crop bales.

	CP, %	NDF, %	ADF, %	IVOMD, %	IVDMD, %	Ca/Phos, %	TDN, %
Native Range							
Start	9.7	64.7	35.4	57.5	58.7	0.27/0.13	55.5
End	6.9	38.8	38.9	47.4	48.6	0.31/0.11	52.6
Pea-Barley							
Start	11.0	55.0	30.2	69.6	68.5	0.50/0.23	59.7
End	8.2	67.0	37.9	54.8	54.1	0.37/0.25	53.5
Corn							
Start	7.7	56.6	29.5	78.0	77.6	0.32/0.24	60.1
End	4.6	69.2	38.2	64.7	63.6	0.17/0.20	53.2
Cover Crop							
Start	11.8	50.5	31.5	73.0	69.3	0.72/0.34	58.7
End	12.3	52.8	34.5	64.3	61.9	0.83/0.31	56.4
Cover Crop Bale	12.8	54.4	31.4	72.5	72.3	0.48/0.22	59.0

Table 2. Effect of grazing system on yearling steer grazing performance

Item	NR[1, 2]	ANN[1, 2]	SE	*P*-Value[5] Trt[4]
Number steers	24.00	24.00		
Steer Frame Score	4.75	4.85	0.36	0.43
Native Range 75 d				
Start Wt., lb	813.71	837.79	22.84	0.26
End Wt., lb.	940.46	958.71	30.27	0.66
Gain, lb	126.75	120.92	10.65	0.72
ADG, lb	1.69	1.62	0.14	0.72
Field Pea-Barley, 27 d				
Start Wt., lb	943.42	962.38	32.49	0.65
End Wt., lb.	1037.88	1024.75	37.40	0.35
Gain, lb	94.46	62.38	16.83	0.25
ADG, lb	3.50	2.31	0.62	0.25
Unharvested Corn, 50 d				
Start Wt., lb	1037.88	1024.75	37.40	0.35
End Wt., lb.	1044.00	1129.50	38.25	0.14
Gain, lb	6.12	104.75	14.57	0.009
ADG, lb	0.13	2.10	0.29	0.009
Cover Crop (13 Spec.), 28 d				
Start Wt., lb	1044.00	1129.50	38.25	0.14
End Wt., lb.	1097.58	1180.46	41.55	0.19
Gain, lb	53.59	50.96	4.31	0.69
ADG, lb	1.91	1.82	0.15	0.70
Bale Grazing, 41 d [3]				
Start Wt., lb	1097.58	1180.46	41.55	0.19
End Wt., lb.	1179.55	1314.38	40.17	0.084
Gain, lb	81.96	133.92	3.62	0.002
ADG, lb	2.00	3.27	0.09	0.002
Combined Grazing Periods:				
ANN Grazing, 105 d				
Gain, lb	154.17	218.09	10.95	0.03
ADG, lb	1.47	2.08	0.10	0.04
NR + ANN Grazing, 180 d				
Gain, lb	280.92	339.00	18.79	0.09
ADG, lb	1.56	1.83	0.10	0.10
NR + ANN + Bale Grazing, 221 d				
Gain, lb	362.88	472.92	17.67	0.01
ADG, lb	1.64	2.14	0.08	0.01
Grazing Ultrasound Evaluation				
Start REA, sq. in.	8.2	8.0	0.01	0.18
Start REA: CWT, sq. in.	1.01	0.96	0.023	0.20
End REA, sq in.	10.66	11.51	0.29	0.10
End REA: CWT, sq. in.	0.91	0.88	0.007	0.04
End Percent Intramuscular Fat	3.66	4.25	0.094	0.01
End Marbling Score[6]	472.0	504.0	11.0	0.10

[1] NR - Native Range; ANN – Native Range, Field Pea-Barley, Unharvested Corn, Cover Crops, Cover Crop Bales.

[2] NR and ANN steers grazed NR until July 20, 2017. NR steers grazed NR and ANN steers grazed annual forage crops until November 2, 2016.

[3] NR and ANN steers were removed from the respective NR and ANN grazing treatments and fed cover crop hay for 41 d.

[4] Trt – Treatment

[5] Means with $P < 0.05$ differ significantly.

[6] Marbling score: 400 = small; 500 = modest; 600 moderate

Table 3. Systems feedlot finishing performance of steers placed into feedlot after bale grazing.

Item	NR[1, 2, 3]	ANN[1, 2, 3]	SE	*P*-Value[5] Trt[4]
Number steers[3]	24.00	24.00		
Days on feed	119.00	119.00		
Feedlot start Wt., lb	1123.75	1246.67	37.66	0.11
Feedlot end Wt., lb	1500.80	1618.40	57.47	0.22
Feedlot gain, lb	377.05	371.73	20.04	0.85
Feedlot ADG, lb	3.14	3.09	0.17	0.84
DM Intake, lb	24.83	25.24	1.49	0.86
Gain:feed, lb	0.127	0.124	0.0049	0.67
Feed cost/steer, $	210.78	213.94	11.55	0.86
Feed cost/lb gain, $	0.5597	0.5763	0.022	0.60
Total feedlot cost/steer, $	346.11	351.93	12.71	0.76
Total feedlot cost/lb gain, $	0.9233	0.9467	0.038	0.40

[1] NR - Native Range; ANN – Grazing sequence of Native Range, Field Pea-Barley, Unharvested Corn, and Cover Crops
[2] NR and ANN steers grazed NR until July 20, 2016. NR steers continued grazing NR and ANN steers grazed annual forage crops from July 20 to November 2, 2016.
[3] NR and ANN steers were removed from the respective NR and ANN grazing treatments and fed cover crop hay for 41 d before transfer to the University of Wyoming, SAREC feedlot, Lingle, Wyoming.
[4] Trt – Treatment
[5] Means with $P < 0.05$ differ significantly.

Table 4. Effect of grazing system on closeout carcass characteristics.

Item	NR[1, 2, 3]	ANN[1, 2, 3]	SE	*P*-Value[5] Trt[4]
Number steers	24.00	24.00		
HCW, lb	931.0	1016.0	35.66	0.18
Fat depth, in	0.37	0.44	2.35	0.02
REA, sq in	14.43	14.70	0.35	0.63
REA : HCW ratio, sq in	1.55	1.45	3.23	0.04
Marbling score[6]	546.7	530.4	25.58	0.44
USDA YG	2.38	2.71	0.058	0.01
QG Choice or better, %	100.00	100.00		0.31
Gross carcass value, $	1944.37	2056.44	55.46	0.22

[1] NR - Native Range; ANN – Grazing sequence of Native Range, Field Pea-Barley, Unharvested Corn, and Cover Crops
[2] NR and ANN steers grazed NR until July 20, 2016. NR steers continued grazing NR and ANN steers grazed annual forage crops from July 20 to November 2, 2016.
[3] NR and ANN steers were removed from the respective NR and ANN grazing treatments and fed cover crop hay for 41 d before transfer to the University of Wyoming, SAREC feedlot, Lingle, Wyoming.
[4] Trt – Treatment
[5] Means with $P < 0.05$ differ significantly.
[6] Marbling score: 400 = small; 500 = modest; 600 moderate.