Effect of bale grazing following annual forage sequence grazing on steer grazing and feedlot performance, muscling ratio, carcass measurements, and carcass value

Progress Report

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Abstract

Forty-eight yearling steers of similar frame score were randomly assigned to an extended grazing study to compare grazing native range (**NR**) or a sequence of NR and annual forages (**ANN**: field pea-barley, corn, cover crop) to evaluate the effect of further extending the grazing season feeding cover crop bales (bale grazing) on steer performance and economics. At the end of bale grazing, 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. Compared to previous research, bale-grazing cover crop bales extended the grazing season from 180 days to 221 days. 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 at the end of grazing. Steer muscling at the end of grazing was greater for NR steers than ANN steers (REA:CWT; $P = 0.04$); however, ANN steer percent intramuscular fat (IMF) was greater ($P = 0.01$), but ANN system marbling score did not differ.

Annual forage steer feedlot starting and ending body weights (BW) were 123 and 117 lb. heavier than the NR steers, but did not differ. Finishing performance for NR and ANN steers was similar for all criteria measured.

For carcass measurements, ANN steer HCW averaged 85.0 lbs. heavier than NR steers, but did not differ ($P = 0.18$). Native range steers were higher yielding ($P = 0.01$) and the muscling relationship expressed as the ratio of REA: HCW was also greater ($P = 0.04$) for NR than the ANN steers. Heavier ANN steer BW entering the feedlot carried through to slaughter resulting in a gross carcass value for ANN steers exceeded NR steers by $112.89.

Introduction

A long-term (10-Year) integrated crop and beef cattle investigation at the Dickinson Research Extension Center 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 replacing mechanical harvest with animal harvesting. Senturklu et al. (2018) evaluated long-term grazing of either native range or annual forages prior to feedlot entry and compared performance and economics of delayed feedlot entry to steers grown and finished in the feedlot. A 10-year (2003 to 2012) economic sensitivity analysis comparing delayed feedlot entry with traditional feedlot growing and finishing, which favored extended grazing and delayed feedlot entry. Seventy percent of the time (7 out of 10 years) extended grazing net return outperformed feedlot growing and finishing. In a subsequent follow-up study, Senturklu et al. (2017) 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 economics for two marketing dates, 1) at the end of the 211-day grazing period, and 2) retained ownership through finishing and slaughter. Small-framed steer efficiency resulted in greater net return at the end of grazing. Large-framed steers had greater net return at the end of finishing. Others have also documented the merits of improved forage quality and compensatory gain in yearling systems from weaning to slaughter and reported lower breakeven cost and greater net profit (Lewis et al., 1990; Shain et al., 2005).

For the current study, corn, field pea-barley and a 13-specie cover crop grown in the crop rotation preceded bale grazing of a 5-specie cover crop hay (12

to 13% CP) as a method for extending the grazing season after completion of NR and ANN forage grazing. The objective of this study is to determine the value of grazing season ending cover crop bale grazing as a technique to extend the regular grazing season on steer grazing performance before feedlot entry and subsequently on finishing performance, carcass measurements, and economics.

Materials and Methods

The North Dakota State University Institutional Animal Care and Use Committee approved animal research procedures used in this study (A16015).

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, corn, and a 13-specie cover crop mix). For bale grazing, a 5-species cover crop hay is grown and baled in early July to obtain cover crop hay with crude protein value ranging between 12.0 and 13.0% CP (Table 1). 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 and GRAZ treatments separated. The NR steers continued to graze NR and the ANN treatment steers started grazing annual forages beginning with field pea-barley, followed by unharvested corn, and then the 13-specie cover crop. On November 2, NR and ANN steer grazing ended and the steers began grazing cover crop hay bales in three replicated fields per treatment.

Forage samples were collected using a 0.25 sq. m frame at the start and end of each forage grazing period. Forage samples were analyzed by the NDSU Nutrition Laboratory for 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 = 81.38 + (CP % * 0.36) - (ADF % * 0.77).

Multiple blizzards, deep snow, and drifting made feeding cover crop bales difficult; therefore, bale grazing only lasted 41-days before the steers were shipped to the University of Wyoming, SAREC feedlot, Lingle, WY, for finishing.

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 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 grazing period from the first week of May to November 2, fluctuated more than for 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 recovered during September and October. Grazing ANN forage sequence crops maintained ADG at approximately 2.0 lb/day throughout the 180-day grazing season, due to annual forage nutrient quality that was consistently greater than NR forage (Table 1). The northern Great Plains (NGP) growing season ends with the first killing frost in September (Average Date: September 25); however, cover crop grazing continued until November 2, when the NR and ANN forage grazing season ended. Cover crop bale grazing gain was greater for ANN steers compared to NR steers ($P = 0.002$). Gain among ANN compared to NR was 3.27 and 2.0 lb/day, respectively. Given the restricted growth nature commonly associated with both NR and ANN grazing, 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, and ending weight was 1500.8 and 1618.4 lb for the NR and ANN steers, respectively. A difference of 117.6 lb. In research reported by others, delaying feedlot arrival grazing NR and/or improved tame grass pastures resulted in greater feedlot starting BW and

ending slaughter weight compared to steers that did not graze before entering the feedlot (Winterholler et al., 2008; Reuter and Beck, 2013; Lancaster et al., 2014).

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 overweight carcass discounts. 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 unchanged at 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 carcass value margin was not great enough to be different statistically, results reported by Senturklu et al. (2017; 2018) 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 and more profitable for steers grazing ANN forages before feedlot entry.

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Table 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]	SEM	*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]	SEM	*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]	SEM	*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.