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

Progress Report

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Abstract

Ninety-six 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 an average 218.5 days. Forage sequence grazing combined with cover crop bale grazing supported ADG of 2.13 lb/day for steers that grazed a combination of NR and ANN forage compared to 1.74 lb/day for steers that grazed NR for the entire period (*P* = 0.01). The ANN steers were 87.2 lbs. heavier at the end of grazing (*P* = 0.001).

For comparison, animal muscling is expressed as the ratio of hot carcass weight (HCW) per 100 pounds to square inches of ribeye area measured between the 12th and 13th ribs. Steers that grazed NR had greater ribeye area per 100 pounds of carcass weight than ANN (REA:CWT = NR 0.91; ANN 0.88, *P* = 0.04); however, ANN steer percent intramuscular fat (IMF) was greater (*P* = 0.01), but ANN system marbling score did not differ.

One of the research questions addressed in this investigation was to determine the effect of extended NR and ANN for grazing on subsequent steer finishing performance (Table 2) and carcass measurements (Table 4). Steers that grazed the sequence of NR and ANN forage grew at a faster rate of gain and ended the grazing season heavier (*P* = 0.01) than the NR steers. Entering the feedlot heavier, the ANN steer growth was numerically slower than the NR steers (P = 0.30); however, the ANN steer shrunk ending weight was 63 pounds heavier at the end of the finishing period.

For carcass measurements (Table 4), ANN steer HCW averaged 49.0 lbs. heavier than NR steers, but did not differ (*P* = 0.11). Carcass yield expressed as dressing percent (*P* = 0.01) and USDA Yield Grade (P = 0.01) were greater for the ANN steers. Nonetheless, the REA:HCW ratio was greater for the NR steers (*P* = 0.02). The two-year carcass quality grade was 97.9% Choice or better.

Gross carcass value for the NR and ANN steers was nearly the same after two years ($1,959.88 vs. 2,019.86). By the end of the finishing period, ending weight margins did not change appreciably from starting weight margins resulting in gross carcass returns that were.

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 compared to NR.

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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).

Ninety-six yearling crossbred steers (n = 96 steers/treatment/3 reps of 8 steers; Frame Score: 5.03) 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 mix, 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 were separated. The NR steers continued to graze NR and the ANN treatment steers started grazing annual forages beginning with the field pea-barley mix, followed by unharvested corn, and then the 13-specie cover crop. On November 2 (Yr. 1) and October 23 (Yr. 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 the first year of the study and the extreme drought of 2017 reduced the number of cover crop grazing days. Therefore, cover crop hay was fed 41-days (Yr. 1) and 56 days (Yr. 2) 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 and ANN steers, fluctuated during the 170-day grazing period due largely because of drought and at the end of bale grazing the ANN steers weighed 90 lb more ($P = 0.03$; Table 2). Although steer gain declined as NR matured with advancing season, fall rain stimulated range regrowth and steer gain recovered during September and October. Grazing ANN forage sequence crops maintained ADG at approximately 1.90 lb/day throughout the average 170-day grazing season, which is 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 (Yr .1) and October 23 (Yr. 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 3.13 and 1.78 lb/day, respectively. Given the restricted growth nature commonly associated with extended grazing (NR and ANN), a compensating gain response, such as the responses reported by Senturklu et al. (2017, 2018) and Choat et al. (2003), was expected. Overall, for the entire 218.5-day grazing and bale-grazing period prior to feedlot entry, steer gain and ADG was 389.81 and 1.78; and 477.0 lb and 2.18 lb/day, for the NR and ANN steers, respectively.

Economically important muscle and fat tissues (ribeye muscle area (REA), percent intramuscular fat (IMF), and ending marbling score (MS)) were measured at the end of grazing with ultrasound (Table 2). Ribeye muscle area for ANN steers was increased during the 218.5-day grazing period, but did not differ (*P* = 0.10). The muscle relationship between REA and steer ending weight (REA: CWT) was greater for NR steers (*P* = 0.04). The percent IMF was greater for ANN steers (P = 0.01); however, MS did not differ (P = 0.10).

Feedlot performance between the NR and ANN grazing treatments paralleled one another (Table 3). ANN steers entered the feedlot weighing 1265.97 lb and the NR steers weighed 1179.67 lb (*P* = 0.04), a margin of 86.3 lb, and ending weight was 1532.8 and 1595.1 lb for the NR and ANN steers, respectively. A difference of 62.3 lb (P = 0.19). For other finishing performance criteria, there were numerical differences; however, none differed significantly. Differences between steer grazing treatments for feedlot gain to feed (G:F) and feed cost/lb of gain were nearly identical (P = 0.96). 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 dressing percent (*P* = 0.01), USDA YG (*P* = 0.01), and REA:HCW ratio (*P* = 0.02) differed significantly (Table 4). 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 ($1959.88 vs. $2019.86), but did not differ (*P* = 0.23). Although carcass value margin was not great enough to identify a statistical difference, results previously 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 compared to NR.

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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. **Two-year effect of grazing system on yearling steer grazing performance**

Item	NR[1, 2]	ANN[1, 2]	SEM	*P*-Value[5] Trt[4]
Number steers	48.00	48.00		
Steer Frame Score	5.03	5.03	0.24	0.99
Native Range, (75 + 68), 71.5 d				
Start Wt., lb	838.59	841.90	17.52	0.86
End Wt., lb.	987.96	988.59	23.57	0.98
Gain, lb	149.37	146.69	12.03	0.88
ADG, lb	2.09	2.05	0.21	0.91
Field Pea-Barley, (27 + 36), 31.5 d				
Start Wt., lb	989.44	990.42	23.73	0.98
End Wt., lb.	1052.19	1030.40	22.00	0.32
Gain, lb	62.75	39.98	14.92	0.31
ADG, lb	1.99	1.26	0.59	0.37
Unharvested Corn, (50 + 43), 46.5 d				
Start Wt., lb	1052.19	1030.40	22.00	0.32
End Wt., lb.	1090.61	1159.55	27.16	0.09
Gain, lb	38.42	129.15	14.97	0.002
ADG, lb	0.83	2.78	0.37	0.004
Cover Crop (13 Spec.), (28 + 13), 20.5 d				
Start Wt., lb	1102.44	1157.36	29.68	0.18
End Wt., lb.	1141.83	1166.26	25.87	0.52
Gain, lb	39.39	8.90	9.42	0.29
ADG, lb	1.92	0.43	1.32	0.22
Bale Grazing, (41 + 56), 48.5 d [3]				
Start Wt., lb	1141.83	1166.26	25.87	0.52
End Wt., lb.	1228.32	1318.36	26.45	0.03
Gain, lb	86.49	152.10	13.71	0.007
ADG, lb	1.78	3.13	0.23	0.002
Combined Grazing Periods:				
ANN Grazing, (105 + 92), 98.5 d				
Gain, lb	152.42	175.83	20.28	0.43
ADG, lb	1.55	1.77	0.19	0.44
NR + ANN Grazing				
(71.5 + 31.5 + 46.5 + 20.5), 170 d				
Gain, lb	303.28	324.38	19.31	0.46
ADG, lb	1.78	1.90	0.11	0.47
NR + ANN + Bale Grazing				
(71.5 + 31.5 + 46.5 + 20.5 + 48.5), 218.5 d				
Gain, lb	389.81	477.00	13.25	0.001
ADG, lb	1.78	2.18	0.06	0.001
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 48.5 d.

[4] Trt – Treatment
[5] Means with *P* < 0.05 differ significantly.
[6] Marbling score: 400 = small; 500 = modest; 600 moderate

Table 3. Systems two-year 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]	48.00	48.00		
Days on feed	104.00	104.00		
Feedlot start Wt., lb	1179.67	1265.97	28.39	0.04
Feedlot end Wt., lb	1532.80	1595.06	31.83	0.19
Feedlot gain, lb	353.13	329.09	21.04	0.44
Feedlot ADG, lb	3.40	3.16	0.17	0.30
DM Intake, lb	27.68	25.52	1.14	0.21
Gain:feed, lb	0.1244	0.1245	0.005	0.98
Feed cost/steer, $	207.71	194.77	8.11	0.29
Feed cost/steer/day, $	2.04	1.89	0.10	0.31
Feed cost/lb gain, $	0.5951	0.5975	0.026	0.95
Total feedlot cost/steer, $	325.24	313.63	14.97	0.60
Total feedlot cost/lb gain, $	0.9317	0.9583	0.037	0.62

[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 48.5 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. Two-year 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	48.00	48.00		
HCW, lb	947.68	996.64	19.86	0.11
Dressing Percent, %	61.83	62.48	0.12	0.01
Fat depth, in	0.43	0.52	0.34	0.11
REA, sq. in	14.79	14.74	0.23	0.89
REA : HCW ratio, sq. in	1.57	1.49	0.022	0.02
Marbling score[6]	531.04	543.39	20.19	0.49
USDA YG	2.46	2.87	0.093	0.01
QG Choice or better, %	97.92	97.92	2.08	1.00
Grid Market Price/CWT, $	206.06	203.45	1.65	0.29
Gross carcass value, $	1959.88	2019.86	35.48	0.23

[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.