Cover crop bale grazing after annual forage grazing on yearling steer grazing and feedlot performance, muscling, carcass measurements and carcass value

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Abstract

One hundred forty-four yearling steers of similar frame score (5.1) 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 extending the grazing season feeding cover crop bales (bale grazing) before feedlot entry on steer performance and economics. Compared to previous research, bale-grazing cover crop bales extended the grazing season 41.5 days (180 to 221.5 days). Forage sequence grazing combined with cover crop bale grazing (Table 2) supported ADG of 2.10 lb/day for steers that grazed a combination of NR and ANN forages compared to 1.70 lb/day for steers that grazed NR for the entire period ($P = 0.01$). The ANN steers were 94.9 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 (REA) measured between the 12th and 13th ribs. The steers that grazed either NR or ANN did not differ (REA:CWT = NR 1.05; ANN 1.05, $P = 0.53$); however, ANN steer REA (P=0.002) and percent intramuscular fat (IMF) were greater ($P = 0.05$). There was a tendency for ANN steer marbling score to be greater (489.0 vs. 470.0), but the difference was not significant.

In the feedlot (Table 3), the steers were on feed 95.7 days. The ANN steers entered the feedlot heavier (P=0.04) and were 74.0 pounds heavier at the end of finishing, but did not differ (1582 vs. 1508; P=0.19).

For carcass measurements (Table 4), ANN steer HCW was 56.6 lbs. heavier (P=0.03). The NR steer dressing percent was greater and muscling, which is expressed as the ratio between REA and HCW (REA:HCW) was greater for the NR steers ($P = 0.007$) resulting in improved USDA yield grade (P=0.01). The Three-year carcass quality grade was 98.6% Choice or better.

Grazing a sequence of ANN forages for 177.9 days and cover crop baled hays for an additional 43.66 days resulted in a weight margin entering the feedlot that followed through to the end of finishing. Gross carcass value for the ANN forage steers was \$92.26 greater (P=0.031) than the NR steers (\$1,921.67 vs. 2,013.93). Thus, the 72 ANN steers grossed \$6,642.72 more than the NR steers.

Over the three-year period of this investigation, weight margins between the NR and ANN groups entering the feedlot do not change appreciably by the end of the finishing period and gross carcass value based on HCW has routinely been greater and more profitable for steers grazing ANN forages and cover crop baled hay before feedlot entry compared to NR steers.

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).

Crossbred yearling steers (n=144) with average frame score of 5.12 grazed either western North Dakota native range (NR), or a forage sequence of native range and annual forages (ANN: field-pea barley mix, corn, and a 13-specie cover crop mix).

Initially, the steers grazed NR together as a common group and were separated July 16. The NR treatment continued to graze NR and the ANN forage group started grazing field pea-barley and subsequently unharvested corn, and cover crop. When grazing was completed on November 1, the steers bale grazed a five-specie (pea, barley, sorghum-sudan, crimson clover, and berseem clover) cover crop hay. The cover crop hay was 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).

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), 56 days (Yr. 2), and 34 days (Yr. 3) for an average of 43.66 days of bale grazing 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.

Pasture and pen treatments were replicated three times. 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 177.9-day grazing period. Over the three-year period of the study, hail, wind, exceptional drought, and early deep December snow combined had a negative impact on growing and grazing conditions. Steers that grazed ANN forages before bale grazing were 94.9 lbs. heavier ($P = 0.001$; Table 2) than NR at the end of bale grazing.

The NR steer gain declined in August and September as the native range forage community matured with advancing season (ADG: NR - 0.67 lbs./day vs Corn grazing – 1.95 lbs./day); however, fall rain stimulated range regrowth and steer gain recovered during Late-September and October. Grazing ANN forage sequence crops maintained ADG at approximately 1.85 lb/day throughout the average 177.9-day grazing season, which is due to annual forage nutrient quality that was consistently greater than NR forage (Table 1).

Cover crop bale grazing gain was greater for ANN steers compared to NR steers ($P = 0.008$). Gain among ANN compared to NR was 3.04 and 1.77 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 221.5-day grazing and bale-grazing period prior to feedlot entry, steer gain and ADG was 376.52 and 1.70; and 463.72 lb and 2.10 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). Ending ribeye muscle area for ANN steers was greater (P=0.001) than the NR steers (12.05 inch vs. 10.99 inch). The muscle relationship between REA and steer ending live weight (REA: CWT) did not differ ($P = 0.37$). The percent IMF was greater for ANN steers (P = 0.05); however, marbling score was greater for the ANN steers (489 vs 470) but did not differ ($P = 0.13$).

Feedlot performance between the NR and ANN grazing treatments paralleled one another (Table 3). ANN steers entered the feedlot weighing 1255.06 lb and the NR steers weighed 1168.75 lb ($P = 0.04$), a margin of 86.31 lb, and ending weight was 1582.04 and 1508.0 lb for the NR and ANN steers, respectively. A difference of 74.0 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 ($0.60 vs. $0.59; $P = 0.71$). 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).

Hot carcass weight (P=0.03) and fat depth (P=0.04) were greater for the ANN steers. 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. Carcasses from the NR steers had greater dressing percent ($P = 0.01$), USDA YG ($P = 0.01$), and REA:HCW ratio ($P = 0.007$) (Table 4). The muscling relationship identified for the NR steers at the end of grazing remained unchanged by the end of finishing.

Gross carcass value for ANN steers was greater ($2013.93 vs. $1921.67; $P = 0.031$). Weight margins between the NR and ANN forage groups entering the feedlot do not change appreciably by the end of the finishing period and gross carcass value based on HCW has routinely been greater and more profitable for steers grazing ANN forages and cover crop baled hay before feedlot entry compared to NR steers.

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

ITEM	ANN[1, 2]	NR[1, 2]	SEM	*P*-Value[5] Trt[4]
Number steers	72.00	72.00		
Steer Frame Score	5.11	5.13	0.16	0.92
Native Range, (73.3 d)				
Start Wt., lb	856.76	849.10	12.15	0.66
End Wt., lb.	993.04	988.46	15.92	0.84
Gain, lb	136.28	139.36	9.40	0.82
ADG, lb	1.86	1.90	0.17	0.87
Field Pea-Barley, (31.9 d)				
Start Wt., lb	994.27	989.45	15.94	0.83
End Wt., lb.	1073.25	1072.02	20.85	0.97
Gain, lb	78.98	82.57	18.24	0.89
ADG, lb	2.48	2.58	0.58	0.84
Unharvested Corn, (57.33 d)				
Start Wt., lb	1073.25	1072.02	20.86	0.97
End Wt., lb.	1184.91	1110.53	21.04	0.02
Gain, lb	111.66	38.53	11.55	0.001
ADG, lb	1.95	0.67	0.33	0.001
Cover Crop (13 Spec.), (15.32 d)				
Start Wt., lb	1183.45	1118.43	21.77	0.051
End Wt., lb.	1187.92	1148.51	19.98	0.182
Gain, lb	4.47	30.08	13.30	0.192
ADG, lb	0.29	1.96	0.956	0.08
Bale Grazing, (43.66 d) [3]				
Start Wt., lb	1187.92	1148.51	19.98	0.182
End Wt., lb.	1320.49	1225.61	17.87	0.001
Gain, lb	132.57	77.10	12.94	0.008
ADG, lb	3.04	1.77	0.24	0.001
Combined Grazing Periods:				
ANN Grazing, (104.6 d)				
Gain, lb	193.65	159.08	15.11	0.13
ADG, lb	1.85	1.52	0.13	0.12
NR + ANN Grazing, (177.9 d)				
Gain, lb	331.17	299.44	13.49	0.12
ADG, lb	1.86	1.68	0.094	0.24
NR + ANN + Bale Grazing, (221.5 d)				

Gain, lb	463.72	376.52	11.02	0.001
ADG, lb	2.10	1.70	0.06	0.001
Grazing Muscle & Fat (Ultrasound)				
Start REA, sq. in.	9.01	9.21	0.38	0.72
Start REA: CWT, sq. in.	1.05	1.09	0.04	0.53
End REA, sq. in.	12.05	10.99	0.25	0.002
End REA: CWT, sq. in.	0.92	0.90	0.01	0.37
End Percent Intramuscular Fat	4.17	3.84	0.11	0.05
End Marbling Score[6]	489.0	470.0	8.00	0.13

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

[2] Average grazing start date each year: NR May - 4, Pea-Barley - July 16, Unharvested Corn – August 17, Cover Crop – October 18, Bale Grazing – November 1, End grazing and transfer to feedlot – December 15.

[3] NR and ANN steers were removed from the respective NR and ANN grazing treatments and fed baled cover crop hay for 43.66d.

[4] Trt – Treatment

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

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

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

ITEM	ANN[1, 2, 3]	NR[1, 2, 3]	SEM	*P*-Value[5] Trt[4]
Number steers[3]	72.00	72.00	-	-
Days on feed	95.67	95.67	-	-
Feedlot start Wt., lb	1255.06	1168.75	18.70	0.04
Feedlot end Wt., lb	1582.04	1508.00	23.99	0.19
Feedlot gain, lb	326.98	339.25	15.03	0.57
Feedlot ADG, lb	3.48	3.60	0.17	0.60
DM Intake, lb	27.17	27.82	1.03	0.66
Gain:feed, lb	0.13	0.13	0.004	0.72
Feed cost/steer, $	194.58	198.57	6.64	0.68
Feed cost/steer/day, $	2.08	2.12	0.10	0.78
Feed cost/lb gain, $	0.60	0.59	0.017	0.71
Total feedlot cost/steer, $	310.57	313.67	10.84	0.84
Total feedlot cost/lb gain, $	0.95	0.93	0.02	0.50

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

[2] Average grazing start date each year: NR May - 4, Pea-Barley - July 16, Unharvested Corn – August 17, Cover Crop – October 18, Bale Grazing – November 1, End grazing and transfer to feedlot – December 15.

[3] NR and ANN steers were removed from the respective NR and ANN grazing treatments and fed cover crop hay for 43.66 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. Three-year effect of grazing system on closeout carcass characteristics.

ITEM	ANN[1, 2, 3]	NR[1, 2, 3]	SEM	*P*-Value[5] Trt[4]
Number steers	72.00	72.00		
HCW, lb	980.69	924.14	16.91	0.03
Dressing Percent, %	61.83	62.48	0.12	0.01
Fat depth, in	0.53	0.46	0.024	0.04

REA, sq. in	14.64	14.34	0.33	0.33
REA : HCW ratio, sq. in	1.50	1.56	0.02	0.007
Marbling score[6]	552.96	531.11	13.25	0.49
USDA YG	2.85	2.56	0.088	0.01
QG Choice or better, %	98.61	98.61	1.39	1.00
Grid Market Price/CWT, $	205.87	207.51	1.50	0.49
Gross carcass value, $	2013.93	1921.67	27.90	0.031

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

[2] Average grazing start date each year: NR May - 4, Pea-Barley - July 16, Unharvested Corn – August 17, Cover Crop – October 18, Bale Grazing – November 1, End grazing and transfer to feedlot – December 15.

[3] NR and ANN steers were removed from the respective NR and ANN grazing treatments and fed cover crop hay for 43.66 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.