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Consequence of perennial and annual forage grazing systems before feedlot entry on yearling steer grazing and feedlot performance, carcass measurements, meat evaluation, and system net return

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ABSTRACT: In a 2-year study, yearling steers (n=141), previously wintered for modest gain of <0.454 kg·hd^{-1}·d^{-1}, were randomly assigned in early May each year based on birth date and weight to one of three retained ownership rearing systems: 1) feedlot control (**FLT**), 2) perennial grass pasture (crested wheatgrass (CWG) > native range (NAT) (**PST**) or 3) perennial grass pasture followed by annual forage (CWG > NAT > field pea-barley (PBLY) > unharvested corn (CN)) (**ANN**). During the extended grazing period, grazing annual forages after perennial grasses promoted increased growth (*P* = <0.0001), rib-eye area (REA, *P* = <0.0001), fat depth (FD, *P* = <0.0001) and percent of intramuscular fat (%IMF, *P* = 0.0003). At feedlot entry, ANN steers were heavier (*P* = <0.0001) and required less finishing days on feed (DOF). Compared with the FLT control steers (142 DOF), the number of DOF for the grazing system's steers was 66 and 91 days for the ANN and PST systems, respectively. For feedlot performance, grazing system steer ADG was greater (*P* = 0.006), feed efficiency (FE) better (*P* = 0.018) and feed cost per unit of gain was lower (*P* = 0.0005) than for the FLT control steers. Hot carcass weight was heavier for grazing steers (*P* = <0.0001) than the FLT control; however, no difference was identified for marbling score or percent USDA Choice quality grade. Strip loin steaks (2.54 cm thick) were removed from each carcass half for tenderness, cooking yield, and sensory evaluation. There were no treatment differences for shear force, cooking yield, tenderness, juiciness or flavor. Systems net return was determined without accounting for risk management procedures. The ANN system net return was the most profitable system, returning $9.09/steer; however, the PST system steers lost -$30.10/steer, and the FLT control system lost -$298/steer. These data suggest that retaining ownership through finishing preceded by a long-term sequence of perennial and annual forages improves economically important muscle and fat traits, and the ANN system has the greatest system profit potential.

Key words: feedlot, grazing, meat evaluation, net return, perennial and annual forage, yearling steers

INTRODUCTION

Integrating crop and beef cattle systems may provide a systematic approach to offset normal perennial season forage quality decline (Greenquist et al., 2009) by providing an alternative to declining forage digestibility. Supplementation of yearling heifers grazing northern Great Plains rangeland with distiller's dried grains with solubles for 70 d improved ADG with no adverse effect on feedlot performance or carcass characteristics (Larson et al., 2012). Since yearling and long-yearling cattle make up 45 to 55 percent of total feed lot placements (Brink, 2011), employing a sequence of perennial and annual forages that are systematically grazed in an extended grazing season from May to October (180 d) in western North Dakota may be advantageous for both beef production and cropping systems. Forage quality maintenance, due to sequencing, has potential as a value added enterprise through retained ownership to reduce the number of feedlot days on feed (DOF), while maintaining meat quality, sensory acceptance, and improving net return.

The primary objective of this research was to compare two long-term yearling steer extended grazing systems, prior to feedlot entry, with conventional feedlot growing-finishing to determine the impact on animal performance, days on feed, carcass trait measurements, meat tenderness, sensory panel evaluation and systems net return.

MATERIALS AND METHODS

This research was conducted in western North Dakota at the Dickinson Research Extension Center Ranch Headquarters (14º11' 40"N 102º50'23"W) located 35 km north of Dickinson, North Dakota, USA, in accordance with guidelines approved by the NDSU Institutional Animal Care and Use Committee.

Animals and Experimental Design. After weaning in November of each year (2011 and 2012), medium- to large-frame steers (5-7 frame score; n = 141) were wintered for modest gain of <0.454 kg·hd^{-1}·d^{-1} grazing corn aftermath plus medium-quality alfalfa-bromegrass hay (*Medicago sativa and Bromus inermis*). In early May, the steers were assigned randomly to one of three triple-replicated treatments based on birth date and weight: 1) Feedlot direct control (**FLT**), 2) Perennial grass pasture (**PST**), or 3) Perennial grass pasture and seeded annual forage fields (1.74 ha) (**ANN**). The FLT control steers were shipped directly to the University of Wyoming, Sustainable Agriculture Research Extension Center, Lingle, Wyoming, and fed to final harvest weight. The PST treatment steers grazed crested wheatgrass (*Agropryon desertorum* (CWG)) followed by native range comprised of the following major plant species: blue gramma (*Bouteloua gracilis*), western wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nassella viridula*), needle and thread (*Stipa comate*), little bluestem (*Schizachyrium scoparium*), and prairie sandreed (*Calamovilfa longifolia*) (NAT). The ANN treatment consisted of a forage sequence of CWG followed by NAT, as previously described, plus 1.74 ha fields of field pea-barley intercrop (*Pisum sativum, var. Arvika* and *Hordeum vulgare, var. Stockford (PBLY)*) and unharvested corn (*Zea mays (CN)*), (e.g. CWG > NAT > PBLY > CN).

At the end of an average 182 d extended grazing period, the PST and ANN forage grazing treatments were transferred to the University of Wyoming feedlot and fed to final harvest.

During the grazing season, PST steers were moved from spring crested wheatgrass to native range pastures in mid-June and, for the ANN treatment, the steers were moved from crested wheatgrass to native range in mid-June and from native range to PBLY the third week of August each year. After PBLY grazing was completed, the steers were moved to standing unharvested corn. Forage crude protein change was determined with bi-monthly sampling from three locations in the PST and ANN treatments.

The design was to graze each forage type until forage crude protein (CP) content declined to a range of 8.0 to 10.0 percent CP or the pasture or field was sufficiently grazed. Grazing season cost per steer for the perennial (CWG and NAT) pastures was determined using a constant cost per kg of body weight of $0.00198 multiplied by the start weigh and end weight to arrive at a daily grazing cost. Then, using one-half the total number of days grazed, the first half and second half grazing charges were summed to arrive at the total grazing charge per steer. For the ANN treatment, the grazing cost was based on the sum of the custom grazing charge for the CWG and NAT pastures, plus the actual farming input costs for crop establishment and $12.15 per ha cash rent for western North Dakota non-irrigated cropland.

The number of feedlot DOF was determined using ultrasound measurements for rib-eye muscle area (longissimus dorsi), external fat depth and percent of intramuscular fat. At the packing plant, carcass data was collected on chilled carcasses after a 48-hour chill. After grading, strip loin steaks were removed from each carcass half between the 12th and 13th ribs and frozen for shear force and sensory panel evaluation (AMSA, 1995) at the NDSU Meats Laboratory.

Statistical analysis. The animal performance data was analyzed using MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) with treatment and year as fixed effects and performance and carcass measurements as dependent variables. Hot carcass weight was used as a covariate to adjust carcass values. Sensory panel and shear force data were analyzed using the GLM procedure of SAS. Pen (pasture) served as the experimental unit. MIXED and GLM least-square means were separated using the predicted difference option of SAS and differences were considered significant at $P \leq 0.05$.

RESULTS AND DISCUSSION

Grazing and feedlot performance data have been summarized in Tables 1 and 2. Steer growth rate for the PST and ANN steers was 0.77 and 1.0 $kg \cdot hd^{-1} \cdot d^{-1}$, respectively, for the average 182-d grazing season, resulting in a total grazing season gain of 140 and 183 $kg \cdot hd^{-1}$ for the PST and ANN extended grazing system treatments, respectively. The total grazing cost per kg of gain was higher for the ANN treatment ($1.12 vs. $1.30 for PST and ANN, respectively).

Grazing annual forages (PBLY > CN) after native range improved economically important muscle and fat measurements prior to feedlot entry. When measured with ultrasound at the end of the grazing season, REA (P = <0.0001), FD (P = <0.0001) and the %IMF (P = 0.0003) were significantly greater for the ANN than the PST systems, which may have contributed to a numerically greater number of ANN steers having carcasses grading Choice or better after the finishing period.

Feedlot performance for either of the extended grazing systems (PST and ANN) was superior to the FLT control steers. The FLT control steers averaged 1.73 $kg \cdot hd^{-1} \cdot d^{-1}$ and reached slaughter weight earlier than steers in the PST and ANN forage grazing systems; however, once the grazing system steers entered the feedlot, their compensating ADG was significantly greater (P = 0.006) than the FLT control.

FLT control steers were 18.1 months of age at slaughter, compared with 21.4 and 22.1 months of age for the ANN and PST systems, respectively. Although grazing increased the number of days from birth to slaughter, grazing (PST and ANN) dramatically reduced the number of DOF in the feedlot. Compared with the FLT control that averaged 142 DOF, the ANN steers reached final slaughter weight after a short 66 DOF and the PST steers required 91 DOF. This difference in the number of DOF to reach final slaughter weight is a direct result of combining perennial and annual forages in a sequence in which the ANN steers grazed higher-quality forage throughout the extended grazing season.

Thus, compared with the ANN treatment, declining late summer and fall native range forage quality resulted in lesser REA, FD and %IMF among the PST system steers. Declining late-season forage quality required the PST steers to be on feed for an additional 25 days to reach the final harvest end point.

Despite reaching the slaughter end point sooner, feedlot performance for the FLT control system steers was inferior in most of the economically important criteria measured. In total and compared with the FLT control, extended grazing systems that delay feedlot entry resulted in better feedlot ADG (P = 0.006), FE (P = 0.018), feed cost per steer (P = < 0.0001) and feed cost per kg of gain (P = 0.005). This does not agree with the findings of others (Larson et al., 2012; Greenquist et al., 2009).

Carcass measurements and meat evaluation criteria are summarized in Table 3. For carcass trait measurements, average HCW for the FLT control system was 78 pounds lighter than the average of the two pasture systems, which is likely due to the fact that steers in the grazing systems' treatments were an average 3.7 months older. Although a numerically smaller number of carcasses graded Choice or better, no statistical difference was found among the systems' treatments for quality grade. Steer carcasses from the PST and ANN forage systems tended to have larger REA (P = 0.078), as well as greater FD (P = 0.033). Marbling score and quality grade did not differ between FLT, PST, and ANN treatments; however, YG was lower (P= 0.042) for the FLT steers.

Meat tenderness and sensory panel evaluations of strip loin steaks (Table 3) did not differ among treatments for Warner-Bratzler shear force and cooking meat yield. Sensory panel evaluation of the steaks showed no difference for perceived tenderness, juiciness or flavor.

The system's two-year average income, expense, and net return are summarized in Table 4. Utilizing annual forage as a way to extend the grazing season 112 d longer, in this study, compared to the 70 d grazing period reported by Larson et al. (2012), reduced the number of feedlot DOF by 54%. The ANN system showed a positive net return of $9.09 per steer and the PST system lost -$30.10 per steer. The PST net loss is attributed to slower growth due to declining forage quality during the latter part of the grazing season, which is in agreement with Caton and Dhuyvetter (1997). The conventional feedlot control system lost -$298.05; a margin of $307.14 between the ANN and FLT systems.

IMPLICATIONS

The results of this study indicate that extended grazing systems can reduce the cost of production among steers held for retained ownership. The ANN extended grazing system that included grazing annual forages during the late summer and early fall seasons prior to feedlot entry is a systematic procedure whereby cow-calf producers can capitalize on their herds genetics profitably and do so without risk management intervention.

The decision for cattlemen to use an extended yearling grazing program to capture value added profits will be determined by several factors such as the implications of crop insurance, cost for adequate fencing, reliable water sources, and the estimated return from competing crops or enterprises.

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Table 1. Effect of grazing system on yearling steer grazing performance

				P-Value		
	PST	ANN	SE	Trt	Yr	Trt x Yr
No. Steers	48	47				
Grazing:						
Days Grazed	181	183				
Start Wt., kg	369	375	2.54	0.058	<0.0001	0.76
End Wt., kg	509[a]	558[b]	3.81	<0.0001	0.004	0.002
Gain, kg	140[a]	183[b]	2.47	<0.0001	<0.0001	0.0001
ADG, kg	0.77[a]	1.0[b]	0.14	<0.0001	<0.0001	0.0003
Cost/Head, $[c, d]	157.19[a]	238.36[b]	0.81	<0.0001	0.36	0.005
Cost/Lb Gain, $	0.5571	0.5924	0.015	0.14	<0.0001	0.001
Fat and Muscle:						
REA, sq cm	55.9[a]	70.1[b]	0.71	<0.0001	0.54	0.01
FD, cm	0.58	0.84	0.017	<0.0001	<0.0001	0.0006
IMF, %	3.22	4.13	0.11	0.0003	0.047	0.25

[a-b]Means within a row with different superscripts differ (P < 0.05).

[c] Field Pea-Barley Crop Input Cost – Seed $25.40/ac, Seeding $15/ac, Innoculant $5.08/ac, Pre-Plant Chemical $3.18/ac, Windrowing $10/ac, Land Rent $30/ac = ($88.66/ac x 13.5 ac)/24 Steers = $49.87/Steer; Mean Days Grazed: 26 days

[d] Unharvested Corn – Seed $47.82/ac, Planting $15/ac, Fertilizer (Urea $37.85/ac, MESZ $28.69/ac, Potash $4.96/ac), Chemical $3.43/ac, Land Rent $30/ac = (167.75/ac x 13.5 ac)/24 Steers = $94.36/Steer; Mean Days Grazed: 52 days

Table 2. Systems feedlot finishing performance

	PST	ANN	FLT	SE	*P-Value* Trt	Yr	Trt x Yr
No. Steers[d]	48	47	46				
Feedlot Days on Feed	91	66	142				
Harvest age, Months	22.1[a]	21.4[b]	18.1[c]	0.043	<0.0001	0.0001	0.003
Feedlot Start Wt., kg	487[a]	539[b]	367[c]	6.8	<0.0001	0.65	0.002
Feedlot End Wt., kg	675[a]	671[a]	612[b]	8.2	0.0002	0.71	0.21
Feedlot Gain, kg	188[a]	132[b]	245[c]	5.5	<0.0001	0.27	0.014
Feedlot ADG, kg	2.07[a]	2.00[a]	1.73[b]	0.068	0.006	0.33	0.006
Feed:Gain, kg	2.83[a]	2.79[a]	3.13[b]	0.109	0.018	0.19	0.0001
Feed Cost/Head, $	381.18[a]	276.12[b]	578.30[c]	7.62	<0.0001	<0.0001	0.0002
Feed Cost/kg Gain, $	2.03[a]	2.09[a]	2.36[b]	0.077	0.005	0.003	0.001

[a-c]Means within a row with different superscripts differ (P < 0.05).

[d]ANN: one steer died of bloat after entry into unharvested corn; FLT: one steer bloated and died each year.

Table 3. Carcass closeout and quality grade comparison between extended grazing and feedlot direct systems

	PST	ANN	FLT	SE	*P-Value* Trt	Yr	Trt x Yr
No. Steers	48	47	46				
Hot Carcass Weight	854.5[a]	850.7[a]	774.8[b]	9.30	<0.0001	0.14	0.032
REA, sq cm	83.9[a]	80.9[b]	78.1[c]		0.078	<0.0001	0.16
SE[d]	(0.22)	(0.20)	(0.33)				
FD, cm	1.30[a]	1.27[a]	0.94[b]		0.083	0.91	0.001
SE[d]	(0.022)	(0.021)	(0.032)				
Marbling Score[e]	516.0	529.7	501.2		0.58	<0.0001	0.82
SE[d]	(19.2)	(18.1)	(27.5)				
YG	2.93[a]	2.82[a]	2.41[b]		0.042	<0.0001	0.0001
SE[d]	(0.083)	(0.077)	(0.123)				
QG Choice or Better, %	82.1	86.5	65.6		0.312	0.017	0.023
SE[d]	(6.15)	(5.70)	(9.46)				
Meat Evaluation:							
Warner-Bratzler Shear Force, kg	3.53	3.15	3.31	0.12	0.11		
Cooking Yield, %	81.0	84.2	82.5	1.04	0.062		
Sensory Tenderness[f]	5.10	5.02	5.54	0.11	0.40		
Sensory Juiciness[f]	5.63	5.53	5.78	0.10	0.26		
Sensory Flavor[f]	5.78	5.87	5.91	0.09	0.25		

[a-c] Means within a row with different superscripts differ (P < 0.05). [d] SE: hot carcass weight used in covariate analysis

[e] Marbling score: 400 = small marbling; 500 = modest marbling

[f]1 = extremely tough, dry, bland; 8 = extremely tender, juicy, flavorful

Table 4. Systems income, expense, and net return

	PST	ANN	FLT
No. Steers	48	47	46
Income:			
Gross Carcass Value/Head, $	**1718.41**	**1738.93**	**1497.41**
Expenses:			
Steer Cost/Head, $	1041.72	1051.56	1034.02
Wintering Cost/Head, $	60.00	60.00	60.00
Grazing Cost/Head			
Perennial Grass, $	157.19	94.13	
Field Pea/Barley, $		49.87	
Standing Unharvested Corn,$		94.36	
Feedlot Feeding Cost/Head, $	381.18	276.12	578.30
Transportation, Health & Brand, $	108.42	103.80	123.14
Total System Expense/Head, $	**1748.51**	**1729.84**	**1795.46**
Net Return/Head, $	**-30.10**	**9.09**	**-298.05**

[c] Means within a row with different superscripts differ (P < 0.05).