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Effect of retained ownership and vertical integration within an integrated cropping system among yearling steers of differing frame score on feedlot performance, carcass measurements, and systems economics following delayed feedlot entry

S. Şentürklü*, †, D. G. Landblom*, R. J. Maddock‡, T. Petry§, and S. I. Paisley#

*Dickinson Research Extension Center, North Dakota State University, Dickinson, ND 58601; †Animal Science Department, Canakkale Onsekiz Mart Universitesi, Canakkale, Turkey 17200; ‡Animal Sciences Department, North Dakota State University, Fargo, ND 58108; §Extension Agribusiness and Applied Economics Department, North Dakota State University, Fargo, ND 58108; #Animal Science Department, University of Wyoming, Laramie, WY 82071

ABSTRACT: In a 3-year study, 288 yearling steers (n = 96 year^{-1}) of differing frame score (small frame **SF**: average 3.80; large frame **LF**: average 5.58) were used to evaluate retained ownership, vertical integration, extended grazing, and delayed feedlot entry. Steers were managed as a common group and backgrounded for modest gain (0.60 kg·day^{-1}) grazing unharvested corn supplemented with mixed hay and 0.37 kg·steer^{-1}·day^{-1} of a 32% CP supplement. The first week of May, the steers were assigned randomly to either feedlot control (FLOT) or grazing (GRAZ) treatments and then within treatment, the steers were stratified into SF and LF groups. The FLOT steers were delivered directly to the University of Wyoming, Sustainable Agriculture Research Extension Center (SAREC), Lingle, Wyoming, for growing and finishing and the GRAZ steers grazed native range (NR, 108 d), field pea-barley (32 d), and unharvested corn (71 d). Total FLOT days on feed (DOF) was 218 d whereas the GRAZ steers grazed perennial and annual forages for 211 d before transfer to the feedlot (82DOF). Small frame steers grew slower during grazing (P = 0.03) and feedlot finishing (P < 0.001) compared to the LF steers. Grazing cost and cost/kg of gain was less for the SF steers ($250.27 vs. $300.27/steer; $0.2525 vs. $0.2757/kg of gain). In the feedlot, LF steer starting BW (P < 0.001), end BW (P = 0.003), gain (P < 0.001), and ADG (P < 0.001) were greater. GRAZ steer compensatory gain in the feedlot, for the LF and SF steers, was 26.8 and 24.0% greater, respectively, compared to the LF and SF FLOT steers. Delaying feedlot entry reduced finishing cost of gain for the GRAZ system by an average 34.0% (P = 0.001). GRAZ steer HCW for LF and SF was greater than FLOT LF and SF steers (P = 0.01). Dressing percent (P < 0.001) and marbling score (P = 0.02) were greater for SF steers. LF steer REA (P = 0.001) was greater for both FLOT and GRAZ treatments. Percent Choice or better quality grade ranged from 91.7 to 97.2% across treatments, but did not differ (P = 0.11). Meat tenderness (P = 0.48) and cooking loss (P = 0.43) did not differ. SF steers were more profitable than LF steers at the end of grazing and both SF and LF GRAZ steers were more profitable than FLOT steers. Long-term extended grazing and reduced feedlot residency supported comparable meat quality and consistent profitability.

Key words: delayed feedlot entry, extended grazing, integrated crops and livestock, retained ownership, yearling steers

INTRODUCTION

In the beef cattle business, profitability is impacted by a multitude of factors that are out of the producer's control. Therefore, producers are challenged with creating greater net value by retaining ownership using a vertically integrated system with the potential to increase beef value marketed. Harvested feeds increase slaughter breakeven cost (Anderson et al., 2005) compared to cattle managed extensively grazing for longer periods followed by an abbreviated concentrate feeding period (Lunt and Orme, 1987). Alternatively, in lieu of marketing calves directly after weaning, retaining ownership coupled with extended summer grazing allows producers to capitalize on compensatory growth (Lewis et al., 1990), reduced slaughter closeout cost (Shain et al., 2005), and greater integrated system net profit (Sindt et al., 1991). Yearling systems that utilize perennial pasture and grazing within a diverse, multi-crop, 5-year rotation enhance economically important muscle and marbling traits, when compared to a traditional feedlot growing and finishing program, and delaying feedlot entry has the greatest potential for system profitability (Senturklu, et al., 2014). Considering the results of Senturklu et al. (2014), the objective of this study was to evaluate small- and large frame yearling steers and compare a traditional feedlot system to a long-term extensive grazing system, with reduced feedlot residency, and document grazing and feedlot performance, carcass measurements, meat tenderness and cooking losses, and systems economics.

MATERIALS AND METHODS

The North Dakota State University institutional animal care and use committee (IACUC) approved all animal procedures.

Two hundred eighty-eight May-June born steer calves were weaned in November each year (n = 96/year; 2012, 2013, and 2014). Following a 7 d drylot weaning recovery period, the steers grazed unharvested corn, corn residue, and supplemental medium quality alfalfa-bromegrass (*Medicago sativa and Bromus inermis*) mixed hay plus 0.37 kg·steer^{-1}·day^{-1} of a 32% CP distiller's dried grain based supplement. The backgrounding gain goal was a modest 0.60 kg·steer^{-1}·day^{-1}.

The first week of May, the steers that averaged 12.0 months of age were randomly assigned based on weight, age, and frame score to either feedlot control (FLOT) or extended grazing (GRAZ) treatments and then stratified into SF and LF groups within treatment based on November hip height calculation (BIF, 2010). Mean frame score values for FLOT were LF: 5.63 and SF: 3.82, and for GRAZ, the mean values were LF: 5.53 and SF 3.77. Each treatment consisted of three pen/pasture replicates of eight steers/replicate (n = 24). The FLOT steers were transferred directly to the University of Wyoming, Sustainable Agriculture Research Extension Center (SAREC), Lingle, Wyoming, for growing and finishing. The GRAZ steers grazed perennial native range (NR) pasture from the first week of May to mid-August (108 d). After NR grazing, the steers moved to annual forages grown in a 5-year, multi-crop, rotation consisting of spring wheat, 7-species cover crop, corn, field pea-barley, and sunflower. Crop use designation for the field pea-barley intercrop mix (*Pisum sativum, var. Arvika* and *Hordeum vulgare, var. Stockford*) and unharvested corn (*Zea mays*) was for grazing. Field pea-barley was grazed an average 32 d and unharvested corn 71 d. Annual forage grazing was considered complete when the higher quality corn aerial plant parts disappeared. After 211 d, GRAZ treatment steers were transferred to the University of Wyoming SAREC feedlot. In the feedlot, FLOT steer dietary starch concentration (corn) increased stepwise over 135 d, at which time the final finishing diet composition consisting of 5% alfalfa hay, 15% haylage, 80% corn, and a feedlot vitamin/mineral supplement was fed to the end of the study. By design, standing corn was the last crop grazed in the grazing sequence. This aided GRAZ steer stepwise transition to the same final finishing diet over an abbreviated period of 58 d. Based on ultrasound scan (Aloka SSD-500V; 3.5 MHz-17cm transducer and standoff) and order buyer confirmation, Cargill Meat Solutions, Ft. Morgan, Colorado, purchased the steers (Angus America grid).

Native range grazing cost determination was based on a constant cost per unit of body weight ($0.002579) and starting BW, end BW, and one-half of the total days grazed to arrive at an annual grazing cost, i.e. (0.002579 x start BW x (total days grazed/2) + (0.002579 x end BW x (total days grazed/2). Annual forage farming enterprise budgets were prepared using actual expenses for seed, fertilizer, chemical, inoculation, and crop insurance. These expenses were integrated with all other expenses was from the ND Farm and Ranch Business Management Education Program crop enterprise budgets (Region 4: 2013, 2014, and 2015).

Data was analyzed using Proc MIXED in SAS (SAS Institute Inc., Cary, NC. System treatment and year were fixed effects and pasture or pen was the experimental unit and random effect. Least-square means were utilized to identify levels of the effects and to control family-wise error adjusted with Tukey. Means were determined to be statistically significant using an alpha level of 0.05.

RESULTS AND DISCUSSION

The research objective utilizing NR and annual forage grazing as a component within a diverse multi-year, multi-crop rotation system was designed to increase calf value and system net return using a retained ownership vertically integrated business model through the growth spectrum from weaning to slaughter. Cropping systems designed with soil health improvement and resultant increased soil nutrient cycling as input reduction objectives, make crop diversity a priority, and animal waste from cattle grazing in the cropping system provides an added level of diversity.

Comparing LF and SF yearling steers during the 211 d grazing period (Table 1), SF steer growth rate was less (P = 0.03) during both grazing and feedlot finishing compared to the LF steers (P < 0.001). Frame score had a positive effect on grazing cost and grazing cost per unit of gain, which was less for the SF steers ($250.27 vs. $300.27/steer; $1.34 vs. $1.23/kg gain).

Delaying feedlot entry until after 211 d of grazing was associated with compensating steer ADG, reduced DOF (82 d), and finishing cost. In the feedlot following grazing (Table 2), LF steers had greater starting BW (P < 0.001), ending BW (P = 0.003), gain (P < 0.001), and ADG (P < 0.001). GRAZ steer compensatory gain, for the LF and SF steers, was 26.8 and 24.0% greater, respectively, compared to the LF and SF FLOT treatment steers. Feedlot gain to feed efficiency was numerically improved for GRAZ system steers compared to FLOT; however, the difference was not significant (P = 0.72). Comparing the average FLOT and GRAZ systems DM feed cost/kg of gain, finishing feed cost/kg gain for the GRAZ system averaged 34.0% less (P = 0.001).

Hot carcass weight (HCW, Table 3) was greater for LF steers in both systems Comparing systems LF steers, GRAZ LF steer HCW was greater than FLOT LF steers (P = 0.01). HCW for GRAZ SF steers was greater than FLOT SF steers (P = 0.01). Dressing percent was greater for SF steers in both FLOT and GRAZ treatments (P < 0.001) and SF steers had greater marbling score compared to the LF steers (P = 0.02). Ribeye area was greater for LF steers in both of the FLOT and GRAZ treatments (P = 0.001). Percent Choice or better quality grade ranged from 91.7 to 97.2%, but did not differ. Although the SF steers had greater marbling scores (P = 0.02) quality grade did not differ.

Meat tenderness measured using Warner-Bratzler shear force comparing FLOT and GRAZ treatments for LF and SF steers did not differ (P = 0.48). Meat cooking loss measured for FLOT and GRAZ treatments showed no treatment difference between FLOT and GRAZ (P = 0.43).

Economic analysis suggested that greater net return is realized, when ownership is retained through delayed feedlot finishing compared to selling the steers at the end of the 211d grazing period. Net return for selling at the end of grazing was $514.02 and $642.90/steer for the GRAZ LF and SF steers, respectively. The SF steer margin at the end of grazing was $128.88 more than the LF steers. The SF steer profit advantage is attributed to the combined effect of 20% reduced annual cow cost, 20% greater carrying capacity, and reduced grazing and backgrounding costs. Overall, the three-year average systems net return/steer at the end of the feedlot phase was $619.94, $565.06, $895.82 and $821.81 for the FLOT LF and SF, and GRAZ LF and SF steers, respectively (Table 3). Net return for GRAZ LF and SF system steers was $275.88 and $256.75 greater than FLOT LF and SF steers. Regardless of frame score, grazing growing steers 211d before feedlot entry was more profitable than traditional feedlot growing and finishing. Profitability from the GRAZ system steers was due to a combination of reduced grazing and feedlot expenses, greater feedlot entry BW, compensatory growth and gain to feed efficiency, and increased HCW and value resulting in a system that was consistently more profitable.

IMPLICATIONS

The results of this 3-year study suggest that a long-term, yearling steer extended grazing system consisting of a combination of native range and annual forages increases feedlot entry BW and reduces the number of DOF without sacrificing carcass quality or meat tenderness, and is associated with consistently greater profitability.

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Table 1. Effect of frame score on extended grazing performance and cost[1]

	GRAZ[2]	GRAZ[2]		P-Value		
	LF[3]	SF[3]	SEM[4]	Trt[5]	Yr[5]	Trt x Yr[5]
Number of Steers	72.0	72.0				
Frame Score	5.52[a]	3.77[b]	0.21	0.001	0.01	0.56
Winter Corn Backgrounding:						
Backgrounding Days	163.00	163.00	0.59	0.18	<0.001	0.01
Start Weight, kg	257.10[a]	205.30[b]	12.68	0.01	0.001	0.92
End Weight, kg	353.90	305.80	17.73	0.38	0.02	0.86
Gain, kg	96.80	100.50	7.55	0.75	0.11	0.83
ADG, kg	0.59	0.62	0.04	0.80	0.05	0.95
Overall Total Performance:						
Grazed Days	211.00	211.00				
Start Weight, kg	353.90	305.80	17.73	0.38	0.019	0.86
End Weight, kg	578.20[a]	509.80[b]	19.32	0.01	0.002	0.50
Gain, kg	224.30[a]	203.90[b]	4.97	0.04	0.07	0.27
ADG, kg	1.06[a]	0.97[b]	0.02	0.03	0.40	0.25
Grazing Cost:						
Perennial Pasture (108 Days), $[6]	115.30	100.24				
Field Pea-Barley (32 Days), $[6]	62.98	50.32				
Unharvested Corn (71 Days), $[6]	110.81	88.53				
32% CP Suppl. (0.37 kg/d), $	11.18	11.18				
Grazing Cost/Steer, $	300.27	250.27				
Grazing Cost/kg Gain, $	1.34	1.23				

[a-b] Within a row, means without a common superscript differ ($P < 0.05$).
[1]Three-Year average.
[2]GRAZ steers grazed a forage sequence of native range, field pea-barley intercrop, and unharvested corn.
[3] SF; Small Frame, LF; Large Frame.
[4] SEM; Pooled Standard Error of the Mean
[5] Trt - Treatment, Yr - Year, Trt x Yr - Treatment x Year
[6] Grazing cost for SF steers adjusted by 20.1% based on the results of Senturklu et al. (2015).

Table 2. Effect of steer frame score and extended grazing on feedlot finishing performance, efficiency, and economics[1]

	FLOT[2] LF[3]	FLOT[2] SF[3]	GRAZ[2] LF[3]	GRAZ[2] SF[3]	SEM[4]	P-Value Trt[5]	Yr[5]	Trt x Yr[5]
Number of Steers	72.0	72.0	72.0	72.0				
Frame Score	5.63[a]	3.82[b]	5.53[a]	3.77[b]	0.26	<0.001	0.001	0.56
Growth Performance:								
Grazing Days	-	-	211.00	211.00				
Feedlot Days Fed	218.00	218.00	82.00	82.00	3.51	<0.001	0.04	0.01
Start Weight, kg	348.00	304.50	557.70	492.80	19.34	<0.001	<0.001	0.85
End Weight, kg	687.60	595.20	730.20	635.40	23.56	0.003	<0.001	0.51
Gain, kg	339.6[a]	290.7[b]	173.10[c]	142.80[d]	7.63	<0.001	0.01	0.09
ADG, kg	1.56[c]	1.33[d]	2.11[a]	1.74[b]	0.054	<0.001	0.94	0.46
Feed Intake and Efficiency:								
DM Feed/Steer/Day, kg	12.17	9.95	13.23	11.56	0.45	0.13	<0.01	<0.21
Gain : Feed, kg	0.128	0.134	0.159	0.151	0.002	0.72	<0.056	<0.60
Finishing Economics:								
DM Feed, Yardage, Brand, & Hospital cost/Steer, $	674.98[a]	572.84[b]	247.56[c]	218.05[d]	11.71	<0.001	0.001	<0.001
DM Feed, Yardage, Brand, & Hospital cost/kg Gain, $	1.99[a]	1.97[a]	1.43[b]	1.53[b]	0.022	<0.001	<0.001	0.02

[a-d] Within a row, means without a common superscript differ ($P < 0.05$).
[1]Three-Year average.
[2]FLOT steers transferred directly to the University of Wyoming feedlot for growing and finishing; GRAZ steers grazed a sequence of native range, field pea-barley, and unharvested corn before transfer to the feedlot.
[3] SF; Small Frame, LF; Large Frame.
[4] SEM; Pooled Standard Error of the Mean,
[5] Trt - Treatment, Yr - Year, Trt x Yr - Treatment x Year

Table 3. Effect of steer frame score and extended grazing on carcass trait measurements, value, and net return[1, 2]

	FLOT[3] LF	FLOT[3] SF	GRAZ[3] LF	GRAZ[3] SF	SEM[4]	P-Value Trt[5]	Yr[5]	Trt x Yr[5]
Carcass Traits								
Hot Carcass Weight, kg	397.20[c]	349.30[d]	422.60[a]	373.30[b]	13.44	0.01	<0.001	0.01
Dressing Percent, %	60.22[a]	61.09[b]	60.19[a]	60.84[b]	0.21	<0.001	<0.001	<0.001
Ribeye Area, cm^2	84.70[a]	77.10[b]	89.90[c]	83.90[a]	4.05	0.001	<0.001	<0.001
Marbling Score[6]	612.00[a]	640.70[b]	583.40[c]	631.40[ab]	10.21	0.02	0.01	0.21
Percent Choice, %	93.10	94.24	91.67	97.22	2.73	0.11	0.04	0.19
Meat Quality								
Warner-Bratzler Shear Force, lb	2.43	2.41	2.64	2.64	0.061	0.48	<0.001	0.29
Cooking Loss, %	17.85	17.61	17.50	15.40	1.17	0.43	<0.001	0.12
System Economics								
Carcass Value/Steer, $	2073.33	1820.33	2223.67	1974.17	77.78	0.001	0.001	0.02
Total Expenses[7]	1453.23	1255.27	1327.85	1152.36				
Net Return	619.94	565.06	895.82	821.81				

[a-d] Within a row, means without a common superscript differ ($P < 0.05$).
[1]Three-Year average.
[2]FLOT steers transferred directly to the University of Wyoming feedlot for growing and finishing; GRAZ steers grazed a sequence of native range, field pea-barley, and unharvested corn before feedlot transfer. Slaughtered at Cargill Meat Solutions, Ft. Morgan, Colorado.
[3] SF; Small Frame, LF; Large Frame.
[4] SEM; Pooled Standard Error of the Mean,
[5] Trt - Treatment, Yr - Year, Trt x Yr - Treatment x Year.
[6]400 = small, 500 = modest, 600 = moderate
[7] Includes annual cow cost, steer backgrounding and grazing cost, feedlot cost, brand and health inspection, and transportation to feedlot and packing plant.