Effect of Yearling Steer Frame Score, Grazing Sequence, and Delayed Feedlot Entry on Grazing and Feedlot Performance, Carcass Trait Measurements, and Systems Economics

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Abstract

Two hundred eighty-eight yearling steers were used in a 3-year study (*n* = 96/year) to evaluate retained-ownership vertical integration, extended grazing, delayed feedlot entry, and system's net return. After weaning, the steers were backgrounded as a common group gaining 1.33 lb/day. The steers were assigned, in a triple replicated complete randomized design, to small-frame (**SF**: average 3.80) and large-frame (**LF**: average 5.58) score treatment groups as follows: 1) feedlot growing-finishing (**FLOT**) and 2) perennial and annual forage extended grazing before feedlot finishing (**GRAZ**). The first week of May, FLOT treatment steers were shipped to the University of Wyoming, Sustainable Agriculture Research Extension Center (SAREC), Lingle, Wyoming, for growing and finishing. Average 3-year number of days on feed (DOF) for the LF and SF FLOT control steers was 218 days. The GRAZ steers grazed native range (NR) until mid-August, (108 days), then field pea-barley intercrop (32 days) followed by grazing unharvested corn (71 days). The total grazing period was 211 days. At the end of corn grazing, GRAZ steers were shipped to the SAREC feedlot for an average delayed feedlot-finishing period of 82 days. The FLOT steers were slaughtered in mid-December each year and the delayed feedlot entry GRAZ steers were slaughtered during a Feb-Mar timeframe. The SF 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 compared to the LF steers ($238.11 vs. $285.16/steer; $0.5296 vs. $0.5772/lb of gain). In the feedlot, LF steer starting BW ($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$). Net return per steer for SF and LF steers, at the end of grazing, was $684.60 and $529.78; and on a net return per acre basis, SF and LF steers were $90.68 and $64.29, respectively. Finishing net return per steer for FLOT SF and LF steers was $597.59 and $620.59, and for GRAZ SF and LF steers, net return was $866.61 and $911.58, respectively. Meat tenderness ($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 at the end of finishing. Long-term extended grazing and reduced feedlot residency supported comparable meat quality and consistent profitability.

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 (Şentürklü, et al., 2014). Considering the results of Şentürklü et al. (2014), our research team hypothesized that small-frame steers would have lower input cost, greater grazing net return, but lower finishing net return per steer. Therefore, the objectives of this study were to evaluate small- and large-frame yearling steers and compare a traditional feedlot system to a long-term extensive grazing system and 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 approved animal procedures.

Two hundred eighty-eight November weaned steer calves (May-June) were backgrounded, after a 7-day drylot weaning recovery period, grazing unharvested corn, corn residue, and supplemental medium quality alfalfa-bromegrass mixed hay plus 2.0 lb/steer/day of a 32% CP distiller's dried grain based supplement.

The steers that averaged 12.0 months of age were randomly assigned based on weight, age, and frame score to feedlot control (FLOT), or extended grazing (GRAZ) treatments. The main treatment frame score groups were then stratified into small frame (SF) and large frame (LF) groups based on November age, weaning weight, and hip height measurements (Beef Improvement Federation, 2010). Within treatment, frame score averages for FLOT were SF: 3.82 and LF: 5.63, and for GRAZ, average values were SF: 3.77 and LF: 5.53. 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 and ending BW, and one-half of the total days grazed to arrive at an annual grazing cost (Table 1). Annual forage farming enterprise budgets were prepared using actual expenses for seed, fertilizer, chemical, inoculation, and crop insurance (Table 2). These expenses were integrated with all other expenses 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

Steer frame score grazing performance, cost/steer, and cost/lb of gain are shown in Table 3. Feedlot finishing performance, feed intake and efficiency, and finishing economics for the LF and SF treatment groups within the GRAZ and FLOT systems are shown in Table 4. Carcass traits, tenderness and cooking loss, and total carcass value are shown in Table 5. All expenses and returns associated with this alternative growing and finishing systems study were recorded. The effect of System (GRAZ vs FLOT) and steer frame score within each system on net return/steer and net return/acre is shown in Table 6.

Over the 3-year period, SF steers grew significantly slower during grazing (P = 0.03) and during feedlot finishing compared to the LF steers (P = <0.001). Under grazing conditions, grazing cost and cost/lb of gain was less for the SF steers ($238.11 vs. $285.16/steer; $0.5296 vs. $0.5772/lb of gain). In the feedlot, LF steers had greater starting weight (P = <0.001), ending weight (P = 0.003), gain (P = <0.001), and ADG (P = <0.001. 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 treatment steers.

Delaying feedlot entry until after 211 days of grazing reduced the finishing period to 82 days on feed (DOF) and associated finishing costs were reduced. Comparing the average FLOT and GRAZ systems DM feed cost/lb of gain, finishing feed cost/lb of gain for the GRAZ system averaged 34.0% less (P = 0.001).

Carcass trait measurements identified economically important differences and similarities. Hot carcass weight (HCW) was greater for LF steers in both systems. 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% across treatments, but the observed difference was not significant. Although the SF steers had higher marbling scores and a numerical tendency for higher quality grade, the gross return/carcass tended to be numerically greater for the LF steers.

Meat tenderness measured using the Warner-Bratzler shear force test identified numerical differences between FLOT and GRAZ treatments for LF and SF steers; however, there was no statistical difference between treatments (P = 0.48). Meat cooking losses were also measured for FLOT and GRAZ treatments. There were no treatment differences measured between FLOT and GRAZ systems treatments or between steer frame score types (P = 0.43).

Systems net return summarized in Table 6 for vertical integration economic analysis suggests greater net return would be realized after delayed feedlot finishing compared to selling the steers at the end of the 211-day grazing period. Net return for selling at the end of grazing was $154.82 more for the SF steers than the LF steers (LF: $529.78 vs. SF: $684.60). When calculated on a net return per acre grazed, GRAZ LF and SF steer net return per acre was $23.38 more per SF steer (LF: $64.29 vs. SF $90.68). Profit advantage for SF steers was realized from 20% lower direct annual cow cost and 20% greater carrying capacity, and lower backgrounding and grazing cost. At the end of finishing, the 3-year average systems net return/steer was $620.59, $597.59, $911.58 and $866.61 for the FLOT LF and SF, and GRAZ LF and SF, respectively. Regardless of frame score, grazing steers for 211 days before feedlot entry was more profitable than traditional feedlot growing and finishing. In the feedlot, the net return for GRAZ LF and SF system steers was $290.99 and $246.02 greater than control FLOT steers. Profitability from the GRAZ system steers was realized from a combination of reduced grazing and feedlot expenses, feedlot compensatory growth, and greater HCW resulting in a greater and more profitable net return for the GRAZ system.

The results of this 3-year study suggest that a yearling steer long-term extended grazing system from birth to slaughter consisting of a combination of native range, annual forages, and a reduced feedlot residency results in comparable meat quality and consistent profitability.

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Table 1. Native range pasture custom grazing rate calculation[1]

GRAZ SF[2]	Grazing Cost/Lb	Weight	Cost/day	Days	Period Total	Grazing Cost/ Steer/Day
Date In		**In Weight**				
May 1	0.00117	678	$0.79	54	$42.84	
Date Out		**Out Weight**				
Aug 17	0.00117	909	$1.06	54	$57.43	
Pasture Cost/Steer				108	$100.27	$0.93
GRAZ LF[2]						
Date In		**In Weight**				
May 1	0.00117	778	$0.91	54	$49.15	
Date Out		**Out Weight**				
Aug 17	0.00117	1047	$1.22	54	$66.15	
Pasture Cost/Steer				108	$115.30	$1.07

[1] 3-Year Average on a per steer per day basis
[2] **SF;** Small Frame, **LF;** Large Frame

Table 2. Farming input cost per acre for annual forage grazing.[1, 2]

	Pea-Barley	Unharvested Corn
Seed Cost/ac, $		
Corn (Pioneer P9690R)	-	58.29
Pea-Barley (Perfection pea, Haybet barley)	45.73	-
Machine Depreciation/ac, $	6.29	5.99
Fertilizer/ac, $	-	37.60
Fuel & Oil/ac	4.81	5.50
Repairs/ac	6.33	6.53
Innoculant/ac, $	4.33	-
Chemical – Pea-Barley (Glyphosate, AMS, Helfire, Rifle D)/ac	12.50	-
Chemical – Corn (Glyphosate, AMS, Helfire)/ac	-	8.60
Crop Insurance/ac, $	3.22	11.14
Land Rent/ac, $	28.60	35.74
Subtotal	111.81	169.35
Interest, 5.0%	5.59	8.47
Total Crop Input Cost/ac, $	117.40	177.82
Cost/Steer, $ (Cost/ac x 4.3 Ac Fields)/8 Steers	63.10	95.58

[1] 3-Year average crop expenses.
[2] Seed, fertilizer, chemical, inoculant, and crop insurance are actual 3-year average costs/ac. Adjustments to machine depreciation, fuel and oil, and repairs reflect harvesting by grazing. All other expenses are the 3-year average expenses adopted from crop enterprise budgets (Region 4, North Dakota Farm and Ranch Business Management Education Program, 2013, 2014, 2015).

Table 3. Effect of frame score on extended grazing performance and cost[1]

	GRAZ[2] LF[3]	GRAZ[2] SF[3]	SEM[4]	P-Value Trt[4]	Yr[4]	Trt x Yr[4]
Number of Steers	72	72				
Frame Score	5.52[a]	3.77[b]	0.21	0.001	0.01	0.56
Winter Corn Backgrounding:						
Backgrounding Days	163	163	0.589	0.18	<0.001	0.01
Start Weight, lb	566.78[a]	452.67[b]	27.96	0.01	0.001	0.92
End Weight, lb	780.24	674.22	39.09	0.38	0.02	0.86
Gain, lb	213.46	221.56	16.65	0.75	0.11	0.83
ADG[4], lb	1.30	1.36	0.098	0.80	0.05	0.95
Overall Total Performance:						
Grazed Days	211	211				
Start Weight, lb	780.24	674.22	39.09	0.38	0.019	0.86
End Weight, lb	1274.66[a]	1123.82[b]	42.60	0.01	0.002	0.50
Gain, lb	494.04[a]	449.6[b]	10.96	0.04	0.07	0.27
ADG, lb	2.34[a]	2.13[b]	0.048	0.03	0.40	0.25
Grazing Cost:						
Perennial Pasture (108 Days), $	115.30	100.24				
Field Pea-Barley (32 Days), $[5]	63.10	50.42				
Unharvested Corn (71 Days), $[5]	95.58	76.37				
32% CP Suppl. (0.81 lb/d), $	11.18	11.18				
Grazing Cost/Head, $	285.16	238.11				
Grazing Cost/Lb of Gain, $	0.5772	0.5296				

[a-b] Means with unlike superscripts differ significantly $P \leq 0.05$.
[1] 3-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:** Standard Error of the Mean, **Trt:** Treatment, **Yr:** Year, **Trt x Yr:** Treatment x Year
[5] Grazing cost for SF steers reduced by an adjustment of 20.1% based on the results of Senturklu et al. (2015)

Table 4. 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[4]	Yr[4]	Trt x Yr[4]
Number of Steers	72	72	72	72				
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	211				
Feedlot Days Fed	218	218	82	82	3.51	<0.001	0.04	0.01
Start Weight, lb	767.3	671.4	1229.6	1086.4	42.63	<0.001	<0.001	0.85
End Weight, lb	1515.8	1312.1	1609.8	1400.8	51.93	0.003	<0.001	0.51
Gain, lb	748.6[a]	640.9[b]	381.6[c]	314.8[d]	16.83	<0.001	0.01	0.09
ADG[4], lb	3.44[c]	2.95[d]	4.70[a]	3.88[b]	0.118	<0.001	0.94	0.46
Feed Intake and Efficiency:								
DM[4] Feed/Steer/Day, lb	26.83	21.93	29.17	25.49	0.986	0.13	<0.01	<0.21
DM Feed/lb of Gain, lb	7.84	7.50	6.23	6.62	0.387	0.72	<0.056	<0.60
Finishing Economics:								
DM Feed Cost/lb of Gain, lb	0.807[a]	0.786[a]	0.577[b]	0.612[b]	0.0203	<0.001	<0.001	0.01
DM Feed, Yardage, Brand, & Hospital cost/Steer, $	674.98[a]	572.84[b]	247.56[c]	218.05[d]	11.705	<0.001	0.001	<0.001
DM Feed, Yardage, Brand, & Hospital cost/lb of Gain, $	0.9027[a]	0.8978[a]	0.6524[b]	0.7040[b]	0.0223	<0.001	<0.001	0.02

[a-d] Means with different superscripts within a line are significantly different, (P≤0.05)
[1]3-Year average
[2]FLOT steers moved directly to the feedlot for growing and finishing and GRAZ steers grazed a sequence of native range, field pea-barley, and unharvested corn before transfer to the feedlot at the University of Wyoming
[3] **SF:** Small Frame, **LF:** Large Frame
SEM: Standard Error of the Mean, **Trt:** Treatment, **Yr:** Year, **Trt x Yr:** Treatment x Year, **DM:** Dry Matter

Table 5. Effect of steer frame score and extended grazing on carcass trait measurements and value[1, 2]

	FLOT[3] LF	FLOT[3] SF	GRAZ[3] LF	GRAZ[3] SF	SEM[4]	P-Value Trt[4]	Yr[4]	Trt x Yr[4]
Carcass Traits								
Hot Carcass Weight, lb	875.70[c]	770.06[d]	931.68[a]	822.89[b]	29.64	0.01	<0.001	0.01
Dressing Percent, %	60.22[a]	61.09[b]	60.19[a]	60.84[b]	0.211	<0.001	<0.001	<0.001
Ribeye Area, sq. in	13.13[a]	11.95[b]	13.93[c]	13.00[a]	0.247	0.001	<0.001	<0.001
Marbling Score	611.97[a]	640.68[b]	583.44[c]	631.36[ab]	10.21	0.02	0.01	0.21
Percent Choice, %	93.06	94.24	91.67	97.22	2.73	0.11	0.04	0.19
Carcass Value/Steer, $	2042.47	1753.88	2243.61	2017.51	91.81	0.79	0.04	0.90
Meat Quality								
Warner-Bratzler Shear Force, lb	5.36	5.32	5.81	5.81	0.135	0.48	<0.001	0.29
Cooking Loss, %	17.85	17.61	17.50	15.40	1.17	0.43	<0.001	0.12

[a-d] Means with different superscripts within a line are significantly different, (P≤0.05)
[1]3-Year average
[2]Steers were slaughtered at the Cargill Meat Solutions, Ft. Morgan, Colorado
[2]FLOT steers moved directly to the feedlot for growing and finishing; and GRAZ steers grazed a sequence of native range, field pea-barley, and unharvested corn before transfer to the feedlot at the University of Wyoming.
[3] **SF:** Small Frame, **LF:** Large Frame
[4] **SEM:** Standard Error of the Mean, **Trt:** Treatment, **Yr:** Year, **Trt x Yr:** Treatment x Year

Table 6. Effect of steer frame score, extended grazing and retained ownership vertical integration on system net return at the end of grazing and at feedlot closeout[1]

	FLOT[2] LF[3]	FLOT[2] SF[3]	GRAZ[2] LF[3]	GRAZ[2] SF[3]	SEM[4]	P-Value Trt[4]	Yr[4]	Trt x Yr[4]
Cow-Calf & Backgrounding Cost:								
Annual Cow Cost, $[5]	602.19	508.14	602.19	508.14				
Winter Backgrounding Cost, $[6]	153.32	122.50	153.32	122.50				
Total Cost, $	755.51	630.64	755.51	630.64				
Grazing Cost:								
Grazing Cost/ Steer, $[7]			285.16	238.11				
Total Expense, $			1040.67	868.75				
End Grazing Steer Value, $			1570.45	1553.35	7.37	0.01	<0.001	0.31
Net Return/Steer, $			529.78	684.60				
Net Return/Ac., $[9]			64.29	90.68				
Feedlot Closeout Expenses:								
Steer Cost, $	755.51	630.64	1040.67	868.75				
Feedlot Cost/Steer, $	674.98[a]	572.84[b]	247.56[c]	218.05[d]	11.71	<0.001	0.001	<0.001
Transportation to Packing Plant , $[8]	22.25	19.26	23.86	20.76				
Total System Expense/Steer, $	1452.74	1222.74	1312.09	1107.56				
Income:								
Carcass Value/ Steer, $[8]	2073.33[b]	1820.33[d]	2223.67[a]	1974.17[c]	77.78	0.001	<0.001	0.02
System Net Return/Steer, $	620.59	597.59	911.58	866.61				

[a-d] Means with different superscripts within a line are significantly different, ($P \leq 0.05$)

[1]3-Year average

[2]FLOT steers moved directly to the feedlot for growing and finishing; and GRAZ steers grazed a sequence of native range, field pea-barley, and unharvested corn before transfer to the feedlot at the University of Wyoming

[3] **SF:** Small Frame, **LF:** Large Frame

[4] **SEM:** Standard Error of the Mean, **Trt:** Treatment, **Yr:** Year, **Trt x Yr:** Treatment x Year

[5] Expenses are adopted from Beef Cow-Calf Enterprise Analysis and annual cow cost for SF steers was adjusted based on a 20% carrying capacity increase for small frame (Region 4, North Dakota Farm and Ranch Business Management Education Program, 2013, 2014, 2015)

[6] Expenses are the 3-year average expenses adopted from Beef Backgrounding Enterprise Analysis (Region 4, North Dakota Farm and Ranch Business Management Education Program, 2013, 2014, 2015)

[7]From Table 2

[8]Steers were slaughtered at the Cargill Meat Solutions, Ft. Morgan, Colorado

[9] Net return/Ac based on sum of native range and annual forage acres grazed per steer