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

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Project Brief

Over a 3-year period, 288 yearling steers (96 steers/year) originating from two beef cattle herds maintained at the Dickinson Research Extension Center (DREC) were used to evaluate a retained-ownership vertically integrated production system. The steers were divided into two frame score groups identified as small frame (**SF**: average 3.80) and large frame (**LF**: average 5.58). After weaning each fall (2012, 2013, and 2014), the steers were managed as a single group and backgrounded grazing unharvested corn that was supplemented with mixed hay (alfalfa-bromegrass-crested wheatgrass) and 2 lb/steer/day of a 32% CP supplement until the end of April each year. During the multi-year backgrounding period, the steers grew at a modest ADG of 1.33 lb/day. The first week of May each year, the steers were randomly assigned to either feedlot (FLOT) or grazing (GRAZ) treatments. Within these two main treatments, two FLOT frame score groups (LF: n=24, 5.63 and SF n=24, 3.82) and two GRAZ frame score groups (LF: n=24, 5.53 and SF n=24, 3.77) were established. The first week of May each year, FLOT treatment steers were shipped directly to the University of Wyoming, Sustainable Agriculture Research Extension Center (SAREC), Lingle, Wyoming, for growing and finishing. The 3-year average number of days on feed (DOF) for the LF and SF FLOT control steers was 218 days. The GRAZ steers grazed native range from the first week of May to mid-August, a period of 108 days before being moved to graze annual forage fields of 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, the GRAZ steers were shipped to the SAREC, Lingle, Wyoming, for a delayed feedlot entry finishing period of 82 days. When each of the systems treatment groups were finished, the groups were delivered by commercial truck to the Cargill Meat Solutions packing plant, Ft. Morgan, Colorado. Due to the system's differences, the FLOT control groups were slaughtered in mid-December each year and the delayed feedlot entry GRAZ treatment steers were slaughtered within a Feb-Mar timeframe.

Native range grazing costs were assessed using the custom grazing rate determination shown in Table 1 and farming expenses for the annual forages in the GRAZ system are shown in Table 2. Annual forage enterprise budgets were prepared using actual expenses for seed, fertilizer, chemical, inoculation, and crop insurance. All other expenses were adopted from the ND Farm and Ranch Business Management Education Program (Region 4) crop enterprise budgets (2013, 2014, 2015

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 measurements, 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 is shown in Table 6.

Results of this systems investigation show that over the 3-year period the SF steers grew significantly slower under 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 lower for the SF steers ($250.27 vs. $300.27/steer; $0.5567 vs. $0.6078/lb of gain). In the feedlot, LF steers had greater starting weight ($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 also 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 collected at Cargill Meat Solutions, Ft. Morgan, Colorado, 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 has been summarized in Table 6 Economic analysis of the vertical integration suggested that greater net return would be realized after delayed feedlot finishing compared to selling the steers at the end of the 211day grazing period. Net return for selling at the end of grazing was calculated to be $514.02 and $642.90/steer for the GRAZ LF and SF, respectively. The SF steer margin at the end of grazing was $128.88 more than the LF steers. Small frame steer profit advantage 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 $619.94, $565.06, $895.82 and $821.81 for the FLOT LF and SF, and GRAZ LF and SF, respectively. Regardless of frame score, grazing growing 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 $275.88 and $256.75 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 consisting of a combination of native range, annual forages, and a reduced feedlot residency results in comparable meat quality and consistent profitability.

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	14.88
Fertilizer/ac, $	-	37.60
Fuel & Oil/ac	4.81	13.76
Repairs/ac	6.33	16.34
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	196.35
Interest, 5.0%	5.37	9.82
Total Crop Input Cost/ac, $	117.18	206.17
Cost/Steer, $ (Cost/ac x 4.3 Ac Fields)/8 Steers	62.98	110.81

1 3-Year average crop expenses.
2 Seed, fertilizer, chemical, inoculant, and crop insurance are actual 3-year average costs/ac. 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[4], 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]	62.98	50.32				
Unharvested Corn (71 Days), $[5]	110.81	88.53				
32% CP Suppl[4]. (0.81 lb/d), $	11.18	11.18				
Grazing Cost/Head, $	300.27	250.27				
Grazing Cost/Lb of Gain, $	0.6078	0.5567				

a-b Means with unlike superscripts differ significantly P≤0.05.
13-Year average.
2GRAZ 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, **Trt;** Treatment, **Yr;** Year, **Trt x Yr;** Treatment x Year, **ADG;** Average Daily Gain, **CP Suppl;** Crude Protein Supplement
5Grazing cost for SF steers was 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, ($P \leq 0.05$)
[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 intercrop, and unharvested corn before transfer to the feedlot at the University of Wyoming.
[3] **SF;** Small Frame, **LF;** Large Frame.
[4] **SEM;** Pooled Standard Error of the Mean, **Trt;** Treatment, **Yr;** Year, **Trt x Yr;** Treatment x Year, **ADG;** Average Daily Gain, **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, ($P \leq 0.05$)
[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 intercrop, and unharvested corn before transfer to the feedlot at the University of Wyoming.
[3] **SF;** Small Frame, **LF;** Large Frame.
[4] **SEM;** Pooled 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]	602.84	537.68	602.84	537.68				
Winter Backgrounding Cost, $[6]	153.32	122.50	153.32	122.50				
Total Cost, $	756.16	660.18	756.16	660.18				
Grazing Cost:								
Grazing Cost/ Steer, $[7]			300.27	250.27				
Total Expense, $			1056.43	910.45				
End Grazing Steer Value, $			1570.45	1553.35	7.37	0.01	<0.001	0.31
Net Return, $			514.02	642.90				
Feedlot Closeout								
Expenses:								
Steer Cost, $	756.16	660.18	1056.43	910.45				
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	22.25	23.86	23.86				
Total System Expense/Steer, $	1453.23	1255.27	1327.85	1152.36				
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, $	619.94	565.06	895.82	821.81				

[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 intercrop, and unharvested corn before transfer to the feedlot at the University of Wyoming.

[3] **SF;** Small Frame, **LF;** Large Frame.

[4] **SEM;** Pooled 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