Consequence of two grazing systems before feedlot entry on yearling steer grazing and feedlot performance, carcass traits, meat acceptance, and net return

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Abstract

One hundred forty-four yearling steers, previously wintered for modest gain of less than 1.0 lb/day, were randomly assigned in early-May based on birth date and weight to one of three production systems: 1) control (feedlot direct) (**FLT**), 2) Perennial grass pasture (crested wheatgrass (CWG) > native range (NAT) (**PST**), 3) Perennial grass pasture followed by annual forage (crested wheatgrass > native range > field pea-barley (PBLY) > unharvested corn (CN)) (**ANN**). During the grazing period, gains were slower for the PST than the ANN system. At feedlot entry, ANN system steers were heavier and needed less days on feed (DOF) to reach final harvest weight. Grazing annual forages after perennial grasses promoted improved growth and economically important ribeye area (REA), fat depth (FD), and percent intramuscular fat (%IMF). Compared to the conventional feedlot control days on feed (DOF) of 142 days, grazing system DOF to final harvest were 66 and 91 days for the ANN and PST systems, respectively. In the feedlot, grazing system steers grew faster, were more efficient, and feed cost per unit of gain was lower than the FLT control steers. Hot carcass weight was heavier for grazing steers than the FLT control, however, there was no difference between systems for either marbling score or percent Choice or better quality grade. Strip loin steaks (approx. 1.0 inch thick) were harvested from each carcass half for tenderness and sensory panel evaluation. There were no production systems differences measured for shear force or percent cooking yield and there was no systems sensory panel differences identified for tenderness, juiciness, or flavor. Net return to the production systems, without using risk management, was profitable for the ANN system ($9.09 per steer), a small loss for the PST (-$30.10 per steer), and a large loss for the control FLT system (-$298.00). These data suggest that retaining ownership through finishing preceded by a long-term sequence of perennial and annual forages supports consist growth and improves economically important muscle and fat traits; and the ANN system has the greatest potential to be profitable.

Introduction

Various factors, but most notably extended periods of drought and high grain prices, have contributed to excess feedlot capacity in the cattle feeding industry. As of July 2013, there had been 16 continuous months in which the cattle feeding industry experienced cash to cash losses when risk management was not measured (CattleFax, 2013). High grain prices supported by corn ethanol production and greater profitability in the stocker cattle business will lead to fewer calves and a greater number of yearlings being placed on feed in the future. Yearling and long-yearling cattle make up 45-55% of total feedlot placements (Brink, 2011). And rate of gain is faster among yearling cattle, but feed efficiency has been shown to be better for calf-feds (Anderson et al., 2005; Griffin et al., 2007). Previous research at the Dickinson Research Extension Center has shown that early-weaned calves backgrounded grazing fields of unharvested corn have a competitive economic advantage (Landblom et al., 2010), because moving early-weaned calves to higher quality forage improved gain and backgrounding with grazing reduces labor and mechanical harvesting costs.

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

Materials and Methods

This systems research is supported in part by the North Central Region Sustainable Agriculture Research and Education program (LNC11-335) and was conducted at the Dickinson Research Extension Center ranch located southwest of Manning, ND. The procedures used in this investigation have been approved by the North Dakota State University Institutional Animal Care and Use Committee.

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 < 1.0 lb/day grazing corn aftermath plus medium quality hay. In early May of each year, the steers were randomly assigned to one of three treatments based on frame score and weight. The treatment groups were as follows: 1) Feedlot Direct (**FLT**), 2) Perennial grass pasture (crested wheatgrass (CWG) > native range (NAT) (**PST**), 3) Perennial grass pasture followed by annual forage (crested wheatgrass > native range > field pea-barley (PBLY) > unharvested corn (CN)) (**ANN**). The FLT steers were shipped directly to the University of Wyoming, Sustainable Agriculture Research Extension Center, Lingle, WY, and fed to final harvest weight. Steers assigned to the PST and ANN forage grazing treatments were also fed to final harvest at the University of Wyoming feedlot after the long-term extended grazing period was completed.

During the grazing season, PST steers were moved from spring crested wheatgrass to native range pastures in early June and, for the ANN treatment, the steers were moved from crested wheatgrass to native range mid-June, and from native range to PBLY the 3rd week of August each year, for an average grazing period of 27 days. After PBLY grazing was completed the steers were moved to standing unharvested corn for an average 52 days. Forage crude protein change was determined with bi-monthly sampling from 3 locations in the PST and ANN treatments. The design was to graze each forage type until forage crude protein content declined to a range between 9-10.0% CP or the pasture or field was sufficiently grazed. Grazing season cost/steer for the perennial (CWG and NAT) pastures was determined using a constant cost/pound of body weight of $0.0009 multiplied times 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/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 $30/acre cash rent for western North Dakota.

The length of time on feed was determined using ultrasound measurements for ribeye muscle area (longissimus dorsi), external fat depth and percent intramuscular fat. At the packing plant and after a 48 hour chill, strip loin steaks were taken from each carcass half between the 12th and 13th ribs and frozen for shear force and sensory panel evaluation at the NDSU Meats Laboratory.

Warner-Bratzler shear force

Steaks were thawed for 24 h at 4°C, weighed, and then cooked on clamshell-style grills, (model GRP99B, Salton Inc., Lake Forest, IL) at 177°C until steaks reached an internal temperature of 70°C. Temperatures were monitored internally in the geometric center of each steak with a copper, constantan, Neoflon PFA insulated wire and temperatures were recorded using an Omega handheld digital thermometer model HH801B (Omega Engineering Inc, Stamford, CT). A minimum of six 1.27-cm diameter cores were obtained from each steak parallel to the muscle fibers (AMSA, 1995). Each core was sheared once using a 250 mm/min crosshead speed. The mean of the 6 cores was used in the statistical analysis.

Sensory analysis

Prior to this study, the sensory analysis protocol was approved by the North Dakota State University Institutional Review Board. An experience quality attribute panel evaluated the samples. Panelists had been previously screened and trained to rate tenderness, juiciness, and flavor attributes of cooked meat samples (AMSA, 1995). Thawing and cooking procedures were the same as those used for shear force measurement. Steaks were selected randomly for each daily taste panel, with six samples served each day representing each different treatment. Each day a warm-up sample was evaluated by the panel as the first sample to ensure proper ratings of treatment samples. After cooking, steaks were allowed to set at room temperature for five minutes to equilibrate. Steaks were cut into 1.27 × 2.54 cm pieces, and all external fat and connective tissue was removed. Samples were placed in a covered container and served to each panelist.

Panelists were given two cups, the first was filled with distilled water and the other was empty for sample expectoration. Each panelist was also given unsalted saltine crackers, toothpicks, and a ballot (AMSA, 1995). The same sample was given to each panelist at the same time. Panelists were first asked to take a bite of cracker and a sip of water to cleanse their palate before starting and between each sample. Tenderness, juiciness, and flavor intensity were on a rated scale of one to eight, with one being extremely tough, dry, and flavorless, and eight being extremely tender, juicy, and flavorful.

The animal data was analyzed using MIXED procedures of SAS with treatment and year as fixed effects and performance and carcass measurements as dependent variables. Pen (pasture) served as the experimental unit and treatment, year, and the treatment x year interactions were determined. Hot carcass weight was used as a covariate to adjust carcass values. Sensory panel and shear force data were analyzed across panelist or pen and then pen means were analyzed using the GLM procedure of SAS with pen (pasture) serving 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

The results of this yearling steer alternative production systems evaluation have been summarized in Tables 1-6 and forage crude protein decline, during each forage grazing period, is depicted in Figures 1-4.

Steer growth rate for the PST and ANN steers was 1.71 and 2.21 lb/ day, respectively ($P = <0.0001$) for the 182 day grazing season; resulting in a total grazing season gain of 309 and 405 lb/steer ($P = <0.0001$) for the PST and ANN extended grazing system treatments, respectively. Total grazing cost for the ANN treatment was higher; however, the grazing cost/lb of gain for the PST and ANN systems was similar ($0.5571 vs. $0.5924 for PST and ANN, respectively; $P = 0.14$).

Grazing annual forages (PBLY > CN) after native range improved economically important carcass measurements prior to feedlot entry. When measured with ultrasound at the end of the grazing season, ribeye area (P = <0.0001), fat depth (P = <0.0001), and the percent of intramuscular fat (P = 0.0003) were significantly greater for the ANN than the PST systems (Table 2), which contributed to a numerically greater number of ANN steers having carcasses grading Choice or better.

Steer system feedlot performance is summarized in Table 3. Overall, steer feedlot performance for either of the extended grazing systems (PST and ANN), was superior to the FLT control steers. The FLT control steers averaged 3.81 lb/day and reach slaughter weight earlier than the PST and ANN forage grazing systems, however, once the grazing system steers entered the feedlot their ADGs were significantly faster than the FLT control. FLT control steers were 18.1 months of age at slaughter compared to 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 to 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 (Fig 1-4). Compared to the ANN treatment that grazed PBLY and CN beginning in mid-August of each year, forage quality decline in the native range pastures significantly reduced ribeye area, fat depth, and percent intramuscular fat among the PST system steers (Table 2), which required the PST system steers to be on feed in the feedlot for an additional 25 days before reaching final harvest end point.

Despite reaching slaughter end point sooner, feedlot performance for the conventional FLT control system was inferior in most of the economically important categories measured. Compared to the FLT control, extended grazing systems that delaying feedlot entry resulted in better ADG (P = 0.006), feed efficiency (P = 0.018), feed cost/steer (P = <0.0001), and feed cost/lb of gain (P = 0.005).

Carcass closeout measurements are summarized in Table 4. Hot carcass weight for the FLT system was 78 lb lighter (P = <0.0001) than the average of the two pasture systems, which no doubt contributed to the numerically fewer number of FLT steer carcasses grading Choice or better. Although there was a numerically small number of carcasses grading Choice or better, there was no statistical difference between the systems treatments for quality grade. Steer carcasses from the PST and ANN forage systems tended to have greater ribeye area (P = 0.078), as well as greater fat depth (P = 0.033). The FLT control steers were leaner resulting in lower yield grade values (P = 0.042) compared to the PST and ANN system carcasses; however, marbling score (P = 0.58) and quality grade (P = 0.31) did not differ.

Meat tenderness and sensory panel evaluations of strip loin steaks showed that there was no difference between systems treatments for Warner-Bratzler shear force (P = 0.109) and cooking yield (P = 0.062); and the sensory panel evaluation of steaks showed that there was no difference between steaks for perceived tenderness (P = 0.3998), juiciness (P = 0.2601), and flavor (P = 0.2451).

The systems 2-year average income, expense, and net return are shown in Table 6. The ANN extended grazing system was the only system with a positive net return of $9.09, whereas, the PST system lost $30.10; a difference of $39.19 between PST and ANN. The PST system net loss is attributed to slower ADG resulting from maturing native range forage quality decline associated with the advancing late summer and fall season. The control feedlot system lost -$298.05.

The results of this NCR-SARE 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 was a profitable system without using risk management tools, which was an underlying objective in the study.

The decision for cattlemen with access to both pasture and crop land will be determined by several factors such as the implications of crop insurance, adequate fencing, and reliable water source. Water can be hauled to locations where permanent water is not developed, but the logistics may be prohibitive. A decision for whether to graze or not to graze crop land will also depend on the predicted value of a harvested crop for cash sale compared to selling beef from a an integrated crop-livestock system.

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Fig. 1 Crested Wheatgrass CP change

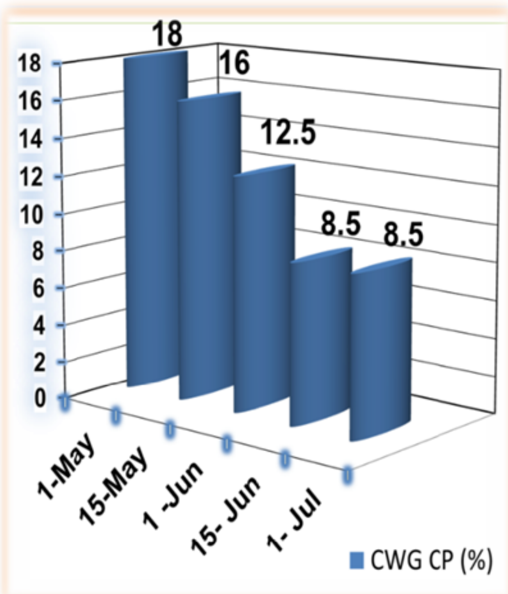

Fig. 2. Native range CP change

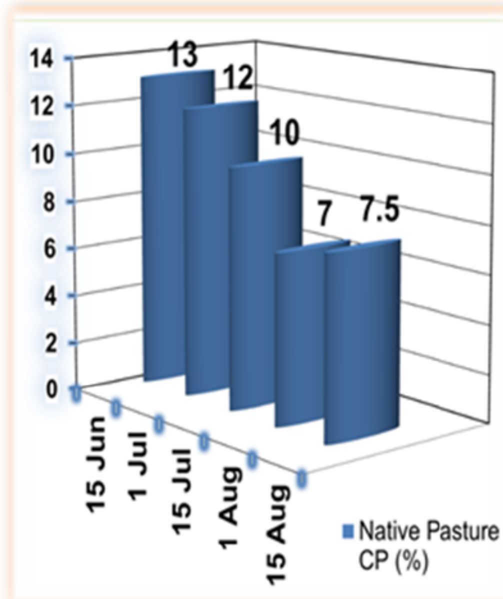

Fig. 3. Field Pea-Barley CP change

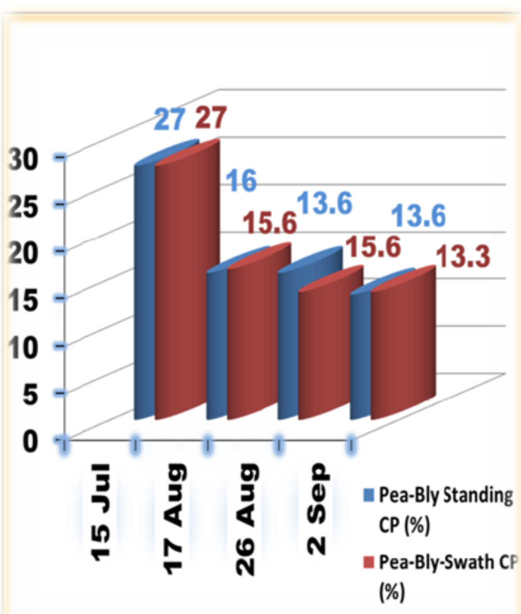

Fig. 4 Unharvested corn CP change

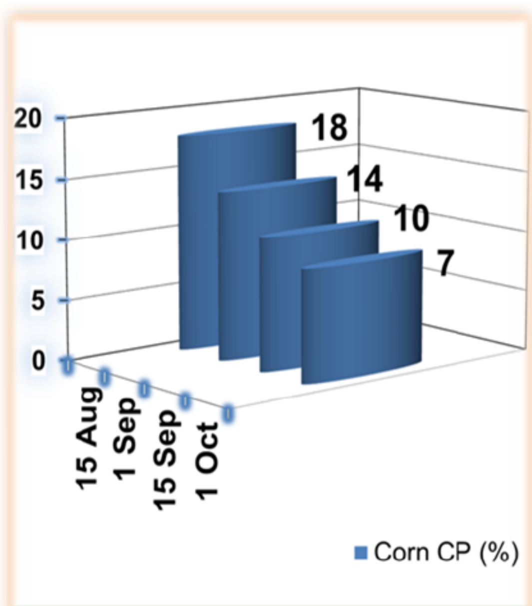

Table 1. Effect of extended grazing system on yearling steer pasture performance

	PST[e]	ANN[e]	SE	*P-Value* Trt	Yr	Trt x Yr
No. Steers	48	47				
Pasture:						
Days Grazed	181	183				
Start Wt., lb	814	826	5.59	0.058	<0.0001	0.76
End Wt., lb	1122[a]	1231[b]	8.39	<0.0001	0.004	0.002
Gain, lb	309[a]	405[b]	5.54	<0.0001	<0.0001	0.0001
ADG, lb	1.71[a]	2.21[b]	0.03	<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

[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

[e] PST – crested wheatgrass > native range > feedlot; ANN – crested wheatgrass > native range > field pea/barley > unharvested corn > feedlot

Table 2 Effect of extended grazing forage system on ribeye area, fat depth, and percent intramuscular fat

	PST[a]	ANN[a]	SE	*P-Value* Trt	Yr	Trt x Yr
Ultrasound Measurement:						
Ribeye Area, sq. in.						
Start	7.57	7.60	0.024	0.47	0.005	0.47
End	8.66[a]	10.86[b]	0.11	<0.0001	0.54	0.01
Difference	1.09	3.27	0.11	<0.0001	0.18	0.01
Pct. Difference, %	14.4	43.1	1.48	<0.0001	0.13	0.0009
Fat Depth, in.						
Start	0.16	0.16	0.0061	0.67	0.20	0.75
End	0.23	0.33	0.0076	<0.0001	<0.0001	0.0006
Difference	0.07	0.17	0.007	<0.0001	<0.0001	0.0003
Pct. Difference, %	42.8	109.2	4.66	<0.0001	<0.0001	0.0005
Pct. Intramuscular Fat, %						
Start	3.37	3.43	0.065	0.33	0.005	0.46
End	3.22	4.13	0.11	0.0003	0.047	0.25
Difference	-0.15	0.70	0.11	0.0007	0.008	0.39
Pct. Difference, %	-5.9	19.9		0.0008	0.004	0.43

[a] PST – crested wheatgrass > native range > feedlot; ANN – crested wheatgrass > native range > field pea/barley > unharvested corn > feedlot

Table 3. Feedlot performance, efficiency, and cost of gain comparison between extended grazing and feedlot direct systems

	PST[e]	ANN[e]	FLT[e]	SE	*P-Value* Trt	Yr	Trt x Yr
No. Steers[d]	48	47	46				
Feedlot Days on Feed	91	66	142				
Kill age, Months	22.1[a]	21.4[b]	18.1[c]	0.043	<0.0001	0.0001	0.003
Feedlot Start Wt., lb	1073[a]	1189[b]	808[c]	15.1	<0.0001	0.65	0.002
Feedlot End Wt., lb	1488[a]	1479[a]	1350[b]	18.1	0.0002	0.71	0.21
Feedlot Gain, lb	416[a]	290[b]	538[c]	12.1	<0.0001	0.27	0.014
Feedlot ADG, lb	4.59[a]	4.41[a]	3.81[b]	0.15	0.006	0.33	0.006
Feed/Head, lb	2605[a]	1859[b]	3701[c]	64.27	<0.0001	0.03	0.002
Feed/Head/Day, lb	28.0[a]	26.9[a]	25.3[b]	0.52	0.01	0.04	0.19
Feed:Gain, lb	6.23[a]	6.15[a]	6.91[b]	0.24	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/Lb Gain, $	0.9283[a]	0.9550[a]	1.08[b]	0.035	0.005	0.003	0.001

[a-c]Means within a row with different superscripts differ (P < 0.05).
[d]Annual Forage, one steer died of bloat after entry into unharvested corn; Feedlot Control, one steer bloated and died each year.
[e] PST – crested wheatgrass > native range > feedlot; ANN – crested wheatgrass > native range > field pea/barley > unharvested corn > feedlot; FLOT – control system; feedlot growing-finishing

Table 4. Carcass closeout and quality grade comparison between extended grazing and feedlot direct systems

	PST[e]	ANN[e]	FLT[e]	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 (Ribeye Area)	13.0[a]	12.54[b]	12.10[c]		0.078	<0.0001	0.16
SE[d]	(0.22)	(0.20)	(0.33)				
Fat Depth	0.51[a]	0.50[a]	0.37[b]		0.033	0.91	0.001
SE[d]	(0.022)	(0.021)	(0.032)				
Marbling Score	516.0	529.7	501.2		0.58	<0.0001	0.82
SE[d]	(19.2)	(18.1)	(27.5)				
Yield Grade	2.93[a]	2.82[a]	2.41[b]		0.042	<0.0001	0.0001
SE[d]	(0.083)	(0.077)	(0.123)				
Percent Choice or Better, %	82.1	86.5	65.6		0.312	0.017	0.023
SE[d]	(6.15)	(5.70)	(9.46)				

[a-c] Means within a row with different superscripts differ (P < 0.05).
[d] SE: hot carcass weight used in covariate analysis
[e] PST – crested wheatgrass > native range > feedlot; ANN – crested wheatgrass > native range > field pea/barley > unharvested corn > feedlot; FLOT – control system; feedlot growing-finishing

Table 5. Effect of yearling steer growing and finishing production system on Warner-Bratzler shear force, cooking yields, and sensory panel evaluation of beef loin

Treatment[a]	WBSF, lbs	Cooking Yield, %
Annual Forage	6.93 ± 0.266	84.2 ± 1.04
Grass	7.78 ± 0.266	81.0 ± 1.04
Feedlot Control	7.30 ± 0.266	82.5 ± 1.04
	P = 0.109[c]	*P* = 0.062[c]

Treatment[a]	Tenderness[b]	Juiciness[b]	Flavor[b]
Annual Forage	5.02 ± 0.11	5.53 ± 0.10	5.87 ± 0.09
Grass	5.10 ± 0.11	5.63 ± 0.10	5.78 ± 0.09
Feedlot Control	5.54 ± 0.11	5.78 ± 0.10	5.91 ± 0.09
	P = 0.3998[c]	*P* = 0.2601[c]	*P* = 0.2451[c]

[a] PST – crested wheatgrass > native range > feedlot; ANN – crested wheatgrass > native range > field pea/barley > unharvested corn > feedlot; FLOT – control system; feedlot growing-finishing

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

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

Table 6. Income, expense, and net return comparison between extended grazing and feedlot direct systems

	PST[a]	**ANN**[a]	**FLT**[a]
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**

[e] PST – crested wheatgrass > native range > feedlot; ANN – crested wheatgrass > native range > field pea/barley > unharvested corn > feedlot; FLOT – control system; feedlot growing-finishing