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A Systems Approach to Production From Weaning to Harvest

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A SYSTEMS APPROACH TO PRODUCTION FROM WEANING TO HARVEST

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INTRODUCTION

Although some summer and fall calving occurs, the majority of calves in the Northern States are born in the spring. Therefore, to have a consistent supply of feeders entering feedlots, a variety of stocker programs are used. About 30% of calves produced in the U. S. enter the feedlot as calf-feds. Some of these calf-feds are weaned and enter the feedlot 30 to 40 days later. It is also common for calves to be backgrounded two to six months before entering the feedlot.

Many calves enter yearling programs. These cattle are nutritionally restricted to varying degrees and for various times. They make compensatory gain on grass and then make additional compensatory gain when they enter the feedlot (Klopfenstein et al., 1999). Because of the great variety of cattle production systems, cattle enter the feedlot at varying weights, ages and nutritional backgrounds. Ranchers have an opportunity to add value to their calves by backgrounding them. Ranches have forage resources. It may be possible, in some cases at least, to optimize the use of those forage resources by backgrounding calves produced on the ranch. We have conducted research on backgrounding programs over the past 15 to 20 years. We also feed 600 or more calf-feds each year. We want to share those observations and the appropriate economics with you.

Compensatory Gain on Grass. In the mid 1980's we conducted a two year study on compensatory gain (Lewis et al., 1990). We had three levels of winter gain on crop residues and measured summer gain. The cattle made 88% compensation. More restricted cattle in the winter made up 88% of the gain they did not make relative to the higher gaining winter calves. Five years of data were summarized from our Scottsbluff Research Center (Hayden et al., 1997). Calves were fed for two rates of winter gain. Slow gaining calves grazed cornstalks and fast gaining calves were limit-fed a high energy diet. They then grazed (summer) for two or four months. The calves that grazed season long (four months) made 57.6% compensation. Those that grazed only two months made 38.2% compensation. During the last two years of the study, British breed steers were compared to Continental cross steers. Compensation was the same (54.3 and 52.5%) suggesting that frame size does not affect degree of compensation.

We have completed four more experiments using wet corn gluten feed as the supplement on cornstalks to increase winter gain. This supplement is of interest because of cost and nutrients contained. Gains on grass varied over the four years and were not related to degree of compensation. The degree of compensation averaged 30.5% and ranged from 17 to 48%. Based on these data, we would draw the following generalizations:

1) Compensatory gain on grass is variable and difficult to predict.
2) Longer restriction may reduce compensatory gain.
3) Full season grazing gives 40 to 45% compensation on average.
4) Compensation can be explained by intake of NE_g above maintenance.
5) Partial season grazing reduces percentage of compensation.

All of these cattle were finished and following are some generalizations about compensatory gain in the feedlot.

1) Feedlot compensatory gain is variable and very difficult to predict.
2) Even relatively short restrictions produce compensatory gain. This is reflected in increased intake and gains but not increased efficiency.
3) Yearlings gain more, eat more and are less efficient than calf-feds.
4) As a very broad generalization, the heavier cattle are entering the feedlot, the lower their feed efficiency will be.
5) Rapid gain on grass prior to entering the feedlot does not necessarily reduce feed efficiency and often increases it.

Growing-finishing Systems. We are all well aware that the beef industry is segmented and that it is common for one segment to make a profit at the expense of another segment. Often that advantage is in the compensatory gain obtained with the cattle. This emphasizes the importance of looking at the complete production system. In each of five years, British-breed calves were purchased in the fall and allowed a 28 day receiving and acclimation period. Calves were then assigned to a low-input wintering period consisting of grazing cornstalk residue or feeding harvested forages. All calves were fed a protein supplement during the stalk grazing and harvested forage feeding periods. Following the winter and spring feeding periods, calves were assigned to grazing treatments. Cattle continuously or rotationally grazed from the first week of May to the first week of September. Following grazing, cattle were finished on a high-concentrate corn-based finishing diet. Breakeven cost was used as the measure of success of each system and included all input costs.

Grazing systems (continuous brome and brome/warm-season grass) were analyzed across five years. Cattle grazing brome and warm-season grasses had greater ($P<.05$) daily gains during the summer grazing period compared with cattle grazing only brome (Table 1). During the finishing period, cattle in the continuous brome system consumed more feed ($P<.05$), gained similarly, and had lower feed efficiencies ($P<.05$) compared with cattle in the brome, warm-season grass system. No difference in carcass measurements were observed between treatments. Cattle grazing brome and warm-season grasses had more desirable slaughter breakeven costs compared to cattle continuously grazing brome (Table 1). Cattle from the brome and warm-season grass system entered the finishing period with heavier weights and were able to maintain this weight advantage throughout the finishing period.

In evaluating correlation coefficients among years, final finishing weight was negatively correlated ($P<.01$) with slaughter breakeven cost in all years, indicating that a greater final weight lowers breakeven cost. Finishing period daily gain influenced ($P<.01$) slaughter breakeven cost in only two years, while the amount of summer gain or total grazing gain influenced ($P<.10$) breakeven cost in four of the five years. Grazing forages that maximized grazing gain, while cost of gain is fixed, reduced overall breakeven cost of production.

Carcass Palatability and Tenderness. Klopfenstein et al. (2000) reported that backgrounding system did not affect carcass quality grade. One of the major concerns facing the industry is the issue of tenderness and variation of tenderness. The marketplace will reflect differences in tenderness when we have an inexpensive and rapid measure of tenderness that can be applied to carcasses. We have conducted one study to investigate the influence of backgrounding and production system on carcass palatability and tenderness. Ninety cattle were used in three production systems. Thirty cattle were calf-feds slaughtered at 14 months of age. The other 60 cattle were in two yearling systems. The yearlings grazed crop residues during the winter months and were placed on grass May 1. Thirty cattle were placed on feed September 2 and the other 30 on November 19. The two groups averaged 19 and 21 months of age at slaughter. Heifers were used for the yearling systems because they are smaller-framed (Fox et al., 1992) and have carcass characteristics similar to those of steers when slaughtered at the same fatness end point (Adams and Arthaud, 1963; Suess et al., 1966; Zinn et al., 1970; Prost et al., 1975). The calf-feds were Continental × British steers from five different Nebraska ranches. The yearling heifers were British breeding, mostly crossbreds from four ranches. None of the cattle had any Brahman influence. Cattle were serially slaughtered (at one of two times). Yield and quality grades were obtained in a commercial packing plant and the whole ribs from the right side were cut into steaks and cooked at 70° C for determination of shear force and evaluation of palatability using a consumer taste panel.

Fat depth was .7 to .8 cm for the first slaughter group and 1.1 to 1.2 cm for the second slaughter group. When data were statistically adjusted to equal marbling scores, no differences were observed for flavor or juiciness of steaks from cattle produced in the three systems. However, the yearling cattle were significantly less tender than the calf-feds. Although the cattle were genetically different, the lower tenderness scores of the yearlings is likely due to the greater age (Cross et al., 1984). The two-month difference in age between cattle in the two yearling systems had no effect on tenderness. In order to better understand the importance of the differences between the calf-feds and the yearlings, the uniformity of quality attributes was compared within systems and the risk of having an acceptable steak was estimated. The probability for an animal to belong in one of the different groups of acceptability and shear force rating was based on variation in this study. The estimated probability of being in the "undesirable" or "tough" category for a calf-fed was .08 and .004%, respectively (Table 2). The probability of "very tender" loin steaks was 99.2% for the calf-feds and 90.3 to 93.2% for the yearlings. The probability of a "tough" yearling steak was only .10 to .18%. Clearly, age reduces tenderness, but that does not mean yearlings are tough. The ribs in this study were aged 14 days and the steaks were not overcooked. In fact, a subsequent study with these steaks shows that the tenderness differences disappeared when steaks were cooked to 75° C rather than 65 or 70° C (Calkins et al., 1995). Even though some would argue that calf-feds ensure tenderness, subsequent aging and cooking can mitigate the differences. We conclude that backgrounding systems has little, if any, effect on tenderness and has little risk of producing "tough" steaks if they are handled appropriately.

Yearlings versus Calf-feds. Data from calf-finishing (CALF) and yearling grow/finish systems at the University of Nebraska from 1995 to 1998 were used. For the yearling systems, two winter systems were evaluated. In one system, steers were grown over the winter at 0.42 lb/day average over four years (SLOW). In the second system, steers were grown at 1.54 lb-lb/day over four years (FAST). The SLOW system represented 160 steers fed in 14 pens, while the FAST system represented 212 steers fed in 18 pens. Calf-finishing trials began in the fall (October and November). The CALF treatment represented 1257 head of steers fed in 128 pens.

For yearling trials, calves of British breeding weighing 520 lb were received and given a 28 day acclimation period. They were then placed on cornstalks from late November to mid-February and then drylotted until about May. The FAST calves received 5 lb (dry matter) of wet corn gluten feed as an energy, protein, and phosphorus supplement. The SLOW calves received 1.8 lb (dry matter) of a protein supplement. The same supplements were fed during the drylot phase when the forage was ammoniated wheat straw. The cattle grazed both cool- and warm-season grasses until mid-September when they were placed in the feedlot. They were stepped-up and fed a 40% (dry basis) corn gluten feed diet. Calves for calf-fed trials averaged 612 lb initial weight and were primarily black, exotic cross steers. They were given a 25 to 35 acclimation period and then started on various feeding experiments. They were fed 160 to 180 days and marketed in May and June. They were fed finishing diets comparable to the yearlings, most containing wet corn gluten feed.

For initial yearling steer cost, average weight of a pen was multiplied by the 7-year average October calf price ($82.57/cwt.) for 500 to 550 lb feeders (USDA Agricultural Marketing Service). Simple interest was charged on the total sum of initial animal cost for the entire ownership period. All interest charges discussed herein were based on a simple 9.8% rate. Twenty-five dollars/head was charged for health, processing, and implanting. Interest was charged against health cost over the entire ownership period. Both winter groups were charged a stalk charge of $0.12/head/day. Interest was charged for half of the stalk grazing period plus the remainder of ownership. During stalk grazing calves in the FAST group were supplemented with wet corn gluten feed (5 lb/head/day; DM basis) at a cost of $102.99/ton (DM basis), which is equal to a corn price of $2.48/bu (as is), and a mineral supplement ($36.40/ton; DM basis). Interest was charged on wet corn gluten feed and mineral supplement for half of stalk period and for the remainder of ownership. Interest was charged on the cost of both corn and protein supplement for half of the stalk grazing period plus the remainder of ownership. Steers in the SLOW group received 1.8 lb/day of a protein supplement at $216.60/ton. Interest was handled in a similar way as described above.

During the dry lot period, both groups were fed ammoniated wheat straw ad libitum. Intake of the groups was monitored for cost calculations (12.3 and 15.3 lb/head/day [as is] for FAST and SLOW, respectively). Ammoniated wheat straw was priced at $40/ton (as is) and interest was charged on straw for half of the period plus the remainder of ownership. Costs and feeding rate for wet corn gluten feed were the same as in stalk grazing. Steers in the SLOW group were fed a mineral supplement at the rate of 0.278 lb/head/day (DM basis). Interest was charged on all feed ingredients for all groups for half of the dry lot period plus the remainder of ownership. Stalk and drylot yardage was charged at the same rate ($0.12 and 0.10/head/day for FAST and SLOW, respectively). Yardage charge differences were the result of increased feeding costs associated with wet corn gluten feed compared to the SLOW group. In addition to the drylot yardage charge, a day charge of $0.12/head was applied to animals in all groups. Interest was charged on yardage and drylot costs for half of the respective period plus the remainder of ownership. For summer costs, grazing was charged at the rate of $0.50/head/day, and interest was charged for half of the grazing period plus the remainder of ownership.

Finishing costs include both feed and yardage. For feed, DM intakes for a pen were determined and a diet cost of $114.20/ton (DM basis) was applied. Feedlot yardage was applied at $0.30/head/day. Interest was charged on feed and yardage costs for half of the feeding period. Total steer cost was the sum of steer, winter, summer, and finishing costs plus 2% death loss. To calculate slaughter breakeven, total cost was divided by final weight. Wet corn gluten feed, whole corn, dry-rolled corn, and high-moisture corn were charged on an equal dry basis, and price was determined using 10-year average corn price for Nebraska ($2.48/bu; as-is). A 10% shrink, processing, and handling fee was applied to corn and wet corn gluten feed. Alfalfa in the finishing diet was priced based on 10-year average price in Nebraska ($60.72/ton; as-is) along with a 10% markup.

Calf finishing (CALF) slaughter breakevens were calculated on pens of animals from each of the respective trials. Initial animal cost was based on the USDA 7-year average October feeder cattle price discussed previously for the yearling trials ($82.57), indicating $78.44/cwt. for 600-650 lb steer calves. However, data from Oklahoma suggests approximately $2.66/cwt (total = $81.10/cwt.) should be added back to the purchase price for black exotic cross steers (May 15, 2000 Feedstuffs, pp. 9). In our calf finishing trials, black exotic cross steers were purchased. Additionally, calf purchase data compiled at Nebraska over the past seven years shows that $81.65/cwt. was paid for animals weighing 600-650 lb. Therefore, an average between Oklahoma and Nebraska data was used to arrive at a purchase price of $81.38/cwt. for 600-650 lb steers used for calf finishing. Interest was applied to initial cost of the animal over ownership. Health, processing, and implanting were assessed a flat rate of $25.00/head. Feed charges for the CALF treatment were based on the same finishing diet cost charged to the yearlings ($114.20/ton; DM basis). Average DM intake for each pen was used to determine feed consumption. Yardage was charged at $0.30/head/day. Interest was charged on the finishing diet and yardage for half of the feeding period. A 2% death loss was applied to all of the calves. To calculate slaughter breakeven, total cost was divided by final weight. Profitability was determined for both CALF and yearling (FAST and SLOW) treatments. Profitability was calculated using the seven-year average May-June USDA Choice slaughter steer price ($66.21/cwt.; USDA Agricultural Marketing Service) for the CALF data. Likewise, the seven-year average December-January USDA choice slaughter steer price ($67.48/cwt.; USDA Agricultural Marketing Service) was used for yearling data.

Animal Performance. Initial weight (before the winter period) of the yearling-finishing systems were 521 and 524 lb for FAST and SLOW, respectively (Table 3). Gains over the winter period were imposed to evaluate any potential compensatory growth response in the subsequent summer grazing period. Initial summer weights were 763 and 592 lb for FAST and SLOW, respectively. Average daily gains on grass were 1.21 lb/day for FAST and 1.65 lb/day for SLOW. Steers in the SLOW system exhibited some compensatory growth during the summer period as a result of lower winter gains.

Final weights off grass and initial feedlot weights were 931 lb for FAST and 814 lb for

SLOW. Steers on the CALF treatment entered the feedlot weighing 612 lb. Significant year × treatment interactions ($P < 0.05$) were found for ADG, DM intake, and feed efficiency. For ADG, steers on the FAST system gained faster ($P < 0.05$) compared to SLOW, which gained faster ($P < 0.05$) compared to CALF in 1995. In 1996, 1997, and 1998 steers on the FAST and SLOW systems gained similarly compared to one another, but both gained faster ($P < 0.05$) compared to CALF. Steers on the FAST system consumed more feed ($P < 0.05$) compared to SLOW which consumed more ($P < 0.05$) compared to CALF in 1995 and 1996. In 1997 and 1998, DM intake for steers in the FAST and SLOW yearling systems were similar, but increased ($P < 0.05$) compared to CALF. Calves were more efficient compared to yearling systems ($P < 0.05$) in 1995, 1996, and 1998; however, no differences in efficiency were noted in 1997. It is likely that inclement weather affected feed efficiency in the analysis. In three of the four years analyzed, calves were more efficient than yearlings; however, in the winter and spring of 1997 significant mud was encountered which likely decreased performance of the calves. Yearlings were on feed in the fall and early winter, and therefore where not exposed to the mud encountered by the calf-feds in 1997. Steers on the FAST system were heavier ($P < 0.05$) at slaughter compared to both SLOW and CALF. Steers on the SLOW system were heavier ($P < 0.05$) compared to CALF. The FAST cattle had 126 lb heavier final weights than CALF even though they were 91 lb lighter at the initiation of the feeding system. Yearlings generally gained much more rapidly, ate much more feed, but were 10 to 12% less efficient than calf-feds.

Carcass Data. Steers on the FAST (858 lb) system produced heavier carcass weights ($P < 0.05$) compared to SLOW (790 lb), which were heavier ($P < 0.05$) compared to CALF (777 lb; Table 3). No differences were noted in fat depth over the 12th rib although yearlings (FAST and SLOW) had higher USDA yield grades ($P < 0.05$) compared to CALF. Marbling scores were higher for the FAST and SLOW cattle than CALF. There was a treatment by year interaction for marbling score ($P < .01$) but FAST cattle had higher scores than CALF each year. SLOW cattle had higher scores than CALF two of the four years.

Economic Analysis. For slaughter breakeven and profit/loss, year × treatment interactions ($P < 0.05$) were found. The four year averages for slaughter breakeven were $66.00, 68.10, and 69.21/cwt. for FAST, CALF, and SLOW, respectively (Table 3). However, profitability is likely a better measure, because it accounts for different marketing times. The FAST yearling system was the most profitable ($P < 0.05$) compared to CALF or SLOW, showing an average profit of $21.00/head over the four year period. Losses incurred by CALF and SLOW were -23.18 and -20.66 ($/head), respectively.

Previous Nebraska work indicated similar results for slaughter breakeven when cattle were finished as calves compared to a yearling-finishing program (1989 Nebraska Beef Cattle Report, pp. 29-31). Cost of gain and slaughter breakeven were lower for yearling-finishing systems, except when the price of corn was very low in relation to other inputs. Data from Kansas showed large deviations in the price spread for calves with changes in the price of corn (2000 Kansas State Cattleman's Day pp. 88-91). For example, the price differential between 500 and 800 lb steers with below average corn price ($1.68/bushel) is approximately $20.00/cwt.; however, when corn price rises to $3.56/bushel, the price differential can diminish to $7.00/cwt. for the same steers. Price differential paid for calves for calf-finishing compared to calves which will be grown in a yearling program can greatly impact breakeven and profitability.

Another variable which could have an impact on the relative slaughter breakevens and profit/loss between CALF and yearling treatments is the price of summer forage. In the present analysis, $0.50/head/day was charged for summer forage. Increasing the charge to $0.70/head/day would result in similar slaughter breakevens between FAST and CALF treatments. A further increase to $0.75-0.80/head/day would be required to result in similar values for profitability. Several factors may interact with slaughter breakeven and profitability such as purchase price, the cost of forage, the price of corn, and slaughter cattle price. In the absence of high levels of compensatory growth, yearlings produced with increased rates of winter gain result in the sale of more carcass weight and have reduced slaughter breakevens compared to yearlings grown over the winter with minimal inputs. In the present analysis, slaughter weight was the largest determining factor in terms of both slaughter breakeven and profit/loss, explaining 21 and 30% of the variation, respectively, based on regression analysis. Steers on the FAST system had more slaughter and carcass weight ($P < 0.05$) compared to both SLOW and CALF treatments, resulting in reduced slaughter breakeven and increased profitability.

These backgrounding programs fit nicely in a farming area where cornstalks and wet corn gluten feed are readily available. How well does it fit on ranches where neither are available? The basic concepts are the same. The forage resources on ranches are winter range and hay. These are not greatly different than cornstalks and ammoniated wheat straw. It is probably not feasible to feed wet corn gluten feed on most ranches. However, dry corn gluten feed and dried distillers grains are available as commodities. Both supply protein, energy and phosphorus. The feeding level will be dictated by gains desired and digestibility of the forage. Dried corn gluten feed and distillers grains will be more expensive than wet corn gluten feed. However, handling and feeding costs may be less. Numerous fuel alcohol plants are being built and it is expected that supplies of the byproducts will be plentiful. That plentiful supply should keep prices at moderate levels.

Clearly cattle type (mature weight) is important to yearling production versus calf feeding. Large framed steers certainly should be fed as calves. Smaller framed steers and heifers are good candidates for yearling systems. If calves are to be retained in yearling programs, weaning weight is much less important and smaller cows with lower maintenance requirements may increase profitability compared to larger cows producing calf-feds. On many ranches, it may be appropriate to "sort" calves at various times after weaning to produce calf-feds, short yearlings and long yearlings. This takes advantage of different frame scores of calves within the herd and spreads market risk.

Finally, the yearling systems described herein were economical primarily because of the heavy weights of the cattle entering the feedlot. There may be resistance by feeders to buy large (1000 lb) feeders. In order for ranchers to earn the benefits from a yearling system, it may be necessary to retain ownership in the feedlot.

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Note: 1996 and later Nebraska Beef Cattle Reports may be viewed at www.ianr.unl.edu/pubs/beef/beefrpt.htm

Table 1. Performance data pooled across years (five) for cattle grazing continuous brome or brome and warm-season grass (Shain et al., 1998).

Item Treatment:	Continuous brome	Brome, warm-season
Weight, lb		
Initial	453	448
Initial summer	583	577
End summer	771[a]	796[b]
Final	1154	1175
Daily gain, lb		
Winter	.68	.68
Summer	1.59[a]	1.81[b]
Finishing performance		
DMI, lb/day	26.76[a]	25.76[b]
Daily gain, lb	3.59	3.58
Feed/gain	7.46[a]	7.25[b]
Carcass data		
Fat depth, in	.42	.42
Quality grade[c]	18.7	18.7
Yield grade	2.39	2.34
Steer cost, $[d]	361.88	358.40
Interest[e]	46.10	45.90
Health[f]	25.00	25.00
Winter costs, $		
Feed[g]	78.95	78.95
Supplement[h]	19.42	19.42
Summer costs, $		
Grazing[i]	40.98	41.94
Finishing costs, $		
Yardage[j]	31.92	31.76
Feed[kl]	173.63	167.08
Days on feed	106.4	105.9
Total costs, $[m]	775.47	765.87
Final wt, lb[n]	1154	1175
Slaughter breakeven $/100 lb	66.99[a]	64.99[b]

[a,b]Means in rows with unlike superscripts differ (P<.05).
[c]20 = average Choice, 19 = low Choice, 18 = high Select.
[d]Initial weight × $80/cwt.
[e]9% interest rate.
[f]Health costs = implants, fly tags, etc.
[g]Receiving costs at $.64/d, stalk grazing costs at $.12/d; spring feed costs at $.40/d; receiving, winter, and spring yardage costs at $.10/d.
[h]Supplement cost at $12/d; 1.5 lb/d (as fed).
[i]Grazing costs = $.35/hd/d.
[j]Yardage cost $.30/hd/d.
[k]Average diet cost = $.0543/d (DM) and 9% interest for ½ of feed.
[l]Calculated using 15 year average corn price = $2.41/bu.
[m]Total costs includes 2% death loss for each system.
[n]Calculated from hot carcass weight adjusted for 62% dressing percentage.

Table 2. Probability of taste panel ratings and shear force values of loin (longissimus muscle) steaks from cattle of different systems (percentage)

	System								
	Calf			Yearling			High-forage yearling		
Item	Undesirable[b] tough[c]	Slightly desirable tender	Desirable, very tender	Undesirable tough	Slightly desirable, tender	Desirable very tender	Undesirable, tough	Slightly desirable tender	Desirable very tender
Juiciness	.17	31.04	68.79	.37	40.15	59.48	1.43	58.05	40.52
Tenderness	.03	12.27	87.70	.52	40.38	59.10	2.83	56.27	40.90
Flavor	.08	38.89	61.03	.51	60.52	38.97	.51	60.52	38.97
Overall acceptability	.05	29.12	70.83	.28	49.72	50.00	1.36	69.52	29.12
Shear force	.004	.836	99.16	.18	9.52	90.30	.10	6.70	93.20

[a]Rossi et al. (1994).
[b]Acceptability rate: Undesirable = consumer taste panel rating less than 4.5; slightly desirable = consumer taste panel rating between 4.5 and 5.5; desirable = consumer taste panel rating greater than 5.5.
[c]Shear force rate: < 8.5 lb = very tender; > 8.5 <10 lb = tender; > 10 lb = tough.

Table 3. CALF vs. yearling steer performance and carcass data (Jordon et al., 2001)

Item	CALF	FAST	SLOW
Winter			
Initial weight, lb	–	521	524
ADG, lb	–	1.54	0.42
Summer			
Initial weight, lb	–	763	592
ADG, lb	–	1.21	1.65
Finishing			
Days on feed	182	91	105
Initial weight, lb	612[a]	931[b]	814[c]
ADG[d]	3.47	4.59	4.39
Slaughter weight, lb[e]	1234[a]	1360[b]	1254[c]
DM intake[d]	21.0	31.0	29.5
Feed/Gain[d]	6.06	6.76	6.71
Carcass			
Weight, lb	777[a]	858[b]	790[c]
Fat, in	0.47	0.49	0.47
Yield grade	2.44[a]	2.64[b]	2.59[b]
Marbling score[f]	497	555	531
Economics			
Breakeven	$68.10	$66.00	$69.21
Profit	-$23.18	$21.00	-$20.66

[a,b,c]Means within a row with unlike superscripts differ ($P < 0.05$).

[d]Year × treatment interaction ($P < 0.05$; Figures 1-3).

[e]Calculated from hot carcass weight adjusted to a common dressing percentage (63).

[f]400^{00} = slight, 500^{00} = small; treatment × year ($P < .01$).