# THE EFFECT OF PREVIOUS DIET ON SUBSEQUENT FEEDLOT PERFORMANCE

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## Story in Brief

Twenty-seven crossbred steers (708 lb) were stratified by weight into three treatment groups for a 130 day feeding trial. Steers in Group 1 were given ad libitum access to a 78% corn diet, those in Group 2 were limit fed (15 lb/d) of this 78% corn diet for 62 days after which they were fed the 78% corn diet, and those in Group 3 were given ad libitum access to a higher roughage (36% corn) diet for 62 days after which they were fed the 72% corn diet. All cattle were housed individually and fed once daily. On day 62, six steers were slaughtered and at the end of the trial, the remaining steers were slaughtered. Carcass data, body composition (carcass specific gravity) and organ weights were gathered. Feed intakes during Period 1, by design, were significantly different among treatements but were not different in Period 2 suggesting previous intake does not affect subsequent intake. Average daily gains and feed efficiencies during both periods were significantly affected by treatment but was highly dependent upon whether adjustments were applied to correct for differences in dressing percentage. Limit feeding concentrate and adlibitum feed roughage during period 1 tended to reduce protein but not fat deposition at day 62 and to reduce fat but not protein deposition on day 130. Additionally, limit feeding concentrate resulted in decreased organ and body part (dress off items) weights during Period 1, but did not affect carcass weight. During Period 2, rate of carcass protein was higher for steers previously fed roughage or limit fed than for steers fed concentrate ad libitum throughout the trial. By the end of the trial limit and ad libitum fed concentrate steers had similar efficiencies and both were superior to ad libitum fed roughage cattle. Final carcass weights favored ad libitum fed roughage steers followed by ad libitum concentrate with limit fed concentrate steers having the lightest carcass weights.

(Key Words: Steers, Limit Feeding, Carcass Composition, Fat Deposition.)

## Introduction

Three ways are used commonly to grow and finish cattle: 1) full feed a high energy diet from start to finish, 2) limit feed a high energy diet during the early portion of the finishing period and thereafter full feed a high energy diet, and 3) full feed a low energy diet and then full feed a high energy diet. Diet

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and feed intake during the first half of the finishing period may alter subsequent performance and efficiency, carcass characteristics, and body composition. Many producers believe that a grazing period is necessary for cattle to "stretch their gut" to consume an adequate amount of feed during the finishing period. The objectives of this research were to evaluate the effects of diet type and intake level on the subsequent performance of steers finished on high concentrate diets.

## Materials and Methods

***Diets and Animals***: Twenty-seven crossbred yearling steers (708 lb) were stratified by weight into three treatment groups (nine weight replications per treatment) for a 130 day feeding trial. Steers in Group 1 were given ad libitum access to a 78% corn diet (Table 1) for the entire 130 d. Each steer in Group 2 was limit fed (15 lb/day) of the same 78% corn diet for 62 days (Period 1) and given ad libitum access to the 78% corn diet for the remaining 68 days (Period 2). Steers in Group 3 were given ad libitum access to a roughage (36% corn) diet for 62 days (Period 1) and then given ad lib access to the 78% corn diet for 68 days (Period 2). All steers were individually fed once each morning. Each steer received vaccinations (blackleg, IBR, BRSV, BVD, PI3), were dewormed (Ivomec), and were implanted with Revalor®. Prior to the initiation of feeding all cattle were grazed on native range pastures together.

**M*easurements and Calculations***: Initial weight was calculated as the mean of weights taken on two consecutive days. On day 62, six steers (2 steers/ treatment) were slaughtered; these were the heaviest and lightest weight replicate of each treatment. Carcass traits, organ weights and body composition determined. All body and organ weights were taken as they were removed from the body. Each rumen and large intestine was weighed full and then emptied, rinsed, excess water removed, and the empty organ was weighed. Fill was calculated as the difference between the full and the empty organ weight. Steers slaughtered at the end of Period 1 (day 62) were not shrunk in order to examine true differences in dressing percentage due to diet. The remaining 21 steers were slaughtered on day 130; carcass traits and body composition were determined. Chemical composition of the carcass on day 62 and day 130 was calculated from specific gravity. Specific gravity was measured after approximately 48 h of chilling at 2°. Specific gravity measures were determined on half the carcass in water at 4°C. Carcass weights of protein, fat, and water of animals fed beyond day 62 for each treatment was assumed to equal the mean dressing percentage of those slaughtered on day 62; these values were 56.7%, 58.4%, 60.4% for steers fed concentrate ad libitum, those limit fed, and those fed roughage multiplied by individual unshrunk live

weight. Pounds of fat water and protein on day 62 was calculated as these carcass weights multiplied by the mean body composition (percentages of fat, protein and water) of slaughtered animals fed similarly. Adjusted live weight was calculated by dividing individual carcass weight by a standard (58%) dressing percentage.

Period 1 gains and efficiencies were calculated based on two different methods: 1) unshrunk live weight, and 2) adjusted day 62 (carcass weight/.58) weight. Period 2 gains and efficiencies were calculated based on four different methods: 1) unshrunk live weight, 2) adjusted final (carcass weight/.64) and adjusted day 62 (carcass weight/.58) weight, 3) unshrunk final but adjusted day 62 weight, and 4) adjusted final and unshrunk live day 62 weights. Final or overall gains were calculated based on final live weight adjusted to a standard (64%) dress and based on unshrunk final weight. All carcass measurements were taken after a 48 h chill. Digestibility was determined by chromium dilution at the end of Period 1.

All data were analyzed as a randomized complete block design using the general linear models procedures of SAS. Least squares means will be presented with means compared by both fishers protected F and a contrast between steers that were limit fed vs ad libitum fed during the first 62 days of the trial.

## Results and discussion

***Animal Performance***: Performance results are summarized in Table 2. During Period 1, ADG was lower (P<.01) for steers fed a limited amount of feed. Although there was no statistical difference in ADG between steers fed concentrate vs roughage ad libitum, steers fed roughage had slightly faster gains due to 54% greater (P<.05) feed intake. This more than compensated for the 10% lower digestibility and 34% lower net energy of the roughage diet. Rates of gain predicted for large framed steers making compensatory gains according to the 1984 NRC equations and the diet net energy values and feed intakes corresponded quite well to the observed rates of gain (4.44 predicted vs 4.56 lb/d observed for steers fed roughage and 4.06 vs 4.03 lb/d for steers fed concentrate ad libitum. This agreement is not surprising since the animals and diets were similar to those used to develop the net energy equations. However, NRC equations underpredicted gains of limit fed cattle (2.68 vs 2.78 lb/d) for reasons that are not clear. Even though limit fed cattle gained slower during Period 1, carcass weights were not significantly different from steers fed ad libitum and numerically was greater. Limit feeding resulted a trend for higher dressing percentage (3.4 and 6.5% greater than steers fed roughage and ad lib concentrate) due primarily to 55 lb less weight in body parts removed during slaughter (Table 3). The gastrointestinal tract and contents accounted for 55%

of the total weight lost between live weight and carcass weight with remainder consisting of hide, head, feet, blood, and internal organs all of which, with the exception of feet, were numerically and sometimes statistically ($P<.05$) lower than either group of steers fed ad libitum. When adjusted for these differences in dressing percentage, ADG of the limit fed steers was not significantly different from those ad libitum fed concentrate although both were less ($P<.05$) than for steers fed roughage ad libitum.

Feed intakes were very similar during Period 2 indicating that the previous intake level did not affect the subsequent feed intake. These results cast doubt on the concept that cattle fed roughage to "stretch the gut" will consume more feed and gain faster than steers grown on concentrate diets. Indeed, maximum intakes may not be desirable for maximizing efficiency and some previous trials with longer term grazing have shown that greater intakes were not translated into greater rates of gain. However, those differences in intake probably were associated with greater animal age, not diet. Day to day variation in feed intake was substantially lower with limit fed steers during Period one. However, this decreased variation did not continue into the second period; day-to-day variation was similar among all treatments. Large fluctuations in intake from day-to-day may predispose cattle to subclinical acidosis.

Gains and efficiencies during Period 2 were highly dependent on the method of calculation, namely live or carcass-weight adjusted bases. None of the second period gains differed significantly due to the small sample size. However, numeric differences indicate how drastically gut fill and dressing percentage can alter interpretation of results. First, on a live final weight (unshrunk) basis or adjusted final and live weight at 62 days, limit fed cattle gained faster than either group previously fed ad libitum. However, when gain was calculated adjusting for differences in dressing percentage at both the start and the end of Period 2, limit fed cattle gained slower than cattle previously fed ad libitum. When using adjusted 62 day weights and final live weight, differences were smaller with fastest gains for those fed concentrate ad libitum.

Similar to rate of gain, efficiencies of gain (feed/gain) during Period 2 depended on the method of calculation but in this case, intake entered the equation to magnifies differences further. Based only on live weights or live 62 day weight and adjusted final weight, limit fed cattle tended to be more efficient during Period 2. At first glance one might assume that compensatory gain might be involved. However, using carcass weight adjustments for both day 62 and final weight, the limit fed cattle were the least efficient group. Using adjusted 62 day and a live final, cattle fed roughage appeared inferior in efficiency. Considering that the only difference between these calculations is in use of either a live of adjusted final weight, and considering that intakes were similar during Period 2 (so gut fill should have been similar), it is surprising

that calculation method causes such a large discrepancy in interpretation. One explanation may be that error associated with calculating the adjusted 62 day is magnified when by subsequent calculations. Indeed, dressing percentage on day 62 was based on a sample of only six animals. Nevertheless, because differences in intake during Period 1 were substantial, it seems important to attempt to correct for potential differences in dressing percentage. These results indicate that interpretation of previous conditions on growth traits need to be interpreted with care.

Over the entire trial unadjusted ADG was not affected by feeding system, but tended to favor the ad libitum fed groups. Adjusted ADG was not different within the ad libitum fed groups, but both were superior in ADG to the limit fed cattle. Averaged over both periods intakes were greatest for cattle fed roughage and lowest for those limit fed concentrate. On a live weight basis, limit feeding improved feed efficiency by 4.7 and 23.6% over steers fed concentrate or roughage ad libitum. On a carcass adjusted final weight basis, the difference between those limit or ad lib fed concentrate was small, but both were more than 20% superior to steers fed roughage. Perhaps intake restriction level during Period 1 (21%) was excessive in this trial. Generally, efficiency improvements have been greatest with intake restrictions for the total feeding period of 5 to 7% or for the first half of the feeding period of 10 to 15%.

***Carcass Characteristics and Body Composition.*** Carcass characteristics and body composition at the end of Period 1 are summarized in Table 4. Few carcass measurements were different. Carcass backfat thickness tended to mirror rate of gain with limit fed cattle having less backfat followed by those ad lib fed concentrate with those fed roughage being the greatest. Ribeye area followed the same pattern as backfat with roughly one square inch difference between these comparisons. These measurements both paralleled carcass weight or growth rate. However, body composition determined by specific gravity and expressed on a percentage basis yielded slightly different conclusions. Steers that had been limit fed or fed roughage had about 1% more carcass fat than steers ad lib fed concentrate. Multiplied by carcass weight, this means equals differences of 9 and 19% less fat ($P<.01$) in carcasses of steers fed concentrate ad libitum. Differences in weights of carcass protein and water also were noted, due primarily to differences in carcass weight. Steers fed roughage also had greater ($P<.06$) marbling scores at the end of Period 1.

By the end of the trial, cattle fed concentrate ad libitum during Period 1 tended to be fattest (Table 5). Although rate of gain of carcass weight was least for limit fed steers, rate of fat gain was greater for those fed concentrate ad libitum followed by those fed roughage and those limit fed concentrate. Rates of protein and water gain were least for steers fed concentrate ad libitum. In general, the limit fed and roughage fed steers tended to make faster rates of

carcass protein and water gain when they were given ad libitum access to a high concentrate diet. Nevertheless, the majority of the tissue gain for all cattle during the second period was fat.

Fat thickness of the carcass measurement supports the composition that steers fed concentrate ad libitum were fatter. Carcass weight was less ($P<.06$) for limit fed cattle than either of ad libitum group suggesting that the restriction imposed was too great to compensate in the remaining 68 days of the trial. Even though carcass weight was less for limit fed cattle, ribeye area was not different among any of the treatments supporting the concept that lean growth had more than compensated during Period two. Indeed, compared with steers fed concentrate diets ad libitum, rate of protein gain for the entire feeding period was 20 and 30% greater for limit fed and roughage fed steers. Leaner, lighter carcasses of limit fed steers coupled with equal ribeye areas resulted in numerically lower yield grades. Although limit fed and roughage fed cattle tended to have less backfat and carcass fat, marbling scores were not depressed. Had energy intake been restricted until steers were marketed, perhaps marbling would have been reduced.

**Table 1. Diet and nutrient composition.**

| Ingredient, % | Concentrate | Roughage |
|---|---|---|
| Corn | 78.15 | 35.89 |
| Alfalfa hay | 4.00 | 19.40 |
| Cottonseed hulls | 4.00 | 31.04 |
| Cane molasses | 3.41 | 3.39 |
| Soybean meal | 8.44 | 8.39 |
| Limestone | .94 | .93 |
| Salt | .33 | .33 |
| Rumensin 60 | .0256 | .0254 |
| Tylan 40 | .0128 | .0127 |
| Vitamin A-30,000 | .0113 | .0112 |
| Manganous Oxide | .0034 | |
| Urea | .56 | .56 |
| Calculated composition: | | |
| NEm, Mcal/cwt | 94.79 | 73.04 |
| NEg, Mcal/cwt | 60.78 | 40.30 |
| Crude protein, % | 14.06 | 14.15 |
| K, % | .77 | 1.14 |
| Ca, % | .51 | .84 |
| P, % | .31 | .26 |

**Table 2. Effect of feeding program on cattle performance and the subsequent feedlot performance.**

| Diet Intake | Concentrate Ad libitum | Concentrate Limited | Roughage Ad libitum | SEM | P< | Lim vs Ad libitum |
|---|---|---|---|---|---|---|
| Average daily gain | | | | | | |
| Period 1 live | 4.03[a] | 2.78[b] | 4.56[a] | .24 | .01 | .01 |
| Period 1 adj | 3.69[a] | 3.37[a] | 4.66[b] | .24 | .01 | .01 |
| Period 2 live | 3.48 | 4.16 | 3.61 | .29 | .27 | .12 |
| Period 2 adj[x] | 3.06 | 2.63 | 2.82 | .33 | .62 | .43 |
| Period 2 adj[y] | 3.79 | 3.63 | 3.52 | .29 | .82 | .94 |
| Period 2 adj[z] | 2.75 | 3.16 | 2.91 | .31 | .64 | .40 |
| Total trial, live | 3.79 | 3.47 | 3.99 | .20 | .44 | .11 |
| Total trial, adj | 3.41 | 2.95 | 3.62 | .22 | .14 | .06 |
| Feed intake | | | | | | |
| Period 1 | 18.9[a] | 14.9[b] | 29.1[c] | .72 | .01 | .01 |
| Period 2 | 24.4 | 23 | 24.7 | 1.26 | .62 | .34 |
| Total trial | 21.9[a] | 19.1[b] | 26.0[c] | .88 | .01 | .02 |
| Feed/gain | | | | | | |
| Period 1, live | 4.84[a] | 5.44[a] | 6.40[b] | .23 | .01 | .53 |
| Period 1, adj | 5.34[a] | 4.47[b] | 6.26[c] | .24 | .01 | .01 |
| Period 2, live | 7.13[a] | 5.64[b] | 6.99[a] | .42 | .05 | .02 |
| Period 2, adj[x] | 8.44 | 9.39 | 8.97 | .86 | .74 | .54 |
| Period 2, adj[y] | 6.51 | 6.53 | 7.19 | .53 | .53 | .57 |
| Period 2, adj[z] | 9.61 | 7.59 | 8.69 | .87 | .30 | .18 |
| Total trial, live | 5.81[a] | 5.55[a] | 6.57[b] | .14 | .01 | .01 |
| Total trial, adj | 6.38 | 6.51 | 7.33 | .39 | .19 | .44 |

[a,b,c] means within same row with different superscripts differ (P< .05).
[x] calculated based on adjusted final and adjusted day 62 weight.
[y] calculated based on live final and adjusted day 62 weight.
[z] calculated based on adjusted final and live day 62 weight.

**Table 3. Body part weights of cattle slaughtered at the end of Period 1.**

| Diet | Concentrate | Concentrate | Roughage | SEM | P< | Lim vs |
|---|---|---|---|---|---|---|
| Intake | Ad libitum | Limited | Ad libitum | | | Ad libitum |
| Body part weights | | | | | | |
| Blood | 28.4 | 26.65 | 31.85 | 1.52 | .24 | .20 |
| Feet | 19.5 | 17.9 | 16.5 | 1.47 | .50 | .95 |
| Head | 31.8 | 28.5 | 31.5 | .13 | .01 | .01 |
| Hide | 76[a] | 66[c] | 81[b] | .65 | .01 | .01 |
| Liver | 15.8 | 11.4 | 15.7 | .31 | .68 | .01 |
| Pluck | 15.9 | 13 | 13.6 | 1.92 | .61 | .53 |
| Heart | 4.0 | 3.7 | 3.8 | .24 | .68 | .53 |
| Tail | 2.8 | 2.8 | 2.8 | .19 | .95 | .81 |
| Kidney | 2.3 | 1.8 | 2.3 | .18 | .27 | .15 |
| Spleen | 2.0 | 1.8 | 2.0 | .18 | .68 | .44 |
| Digestive tract weights | | | | | | |
| Rumen, full | 142 | 120 | 140 | 3.72 | .08 | .04 |
| Rumen, empty | 31.4 | 27.9 | 34.7 | 1.58 | .18 | .12 |
| Ruminal fill | 111 | 92 | 105 | 5.28 | .23 | .13 |
| Small intestine | 33.7 | 26.5 | 32.7 | 4.37 | .56 | .33 |
| Large intestine, full | 15.6 | 19.7 | 25.9 | 2.16 | .14 | .52 |
| large intestine, empty | 9.4 | 10.7 | 16.3 | 2.07 | .24 | .47 |
| Large intestinal fill | 6.1 | 8.0 | 9.5 | 1.53 | .45 | .94 |
| Total tract | 191 | 165 | 199 | 5.94 | .10 | .05 |
| Mesenteric fat | 12.8 | 10.2 | 12.1 | 2.24 | .74 | .50 |

**Table 4. Body composition and carcass traits of cattle slaughtered at the end of period 1.**

| Diet<br>Intake | Concentrate<br>Ad libitum | Concentrate<br>Limited | Roughage<br>Ad libitum | SEM | P< | Lim vs<br>Ad libitum |
|---|---|---|---|---|---|---|
| Composition data | | | | | | |
| Fat, % | 16.3 | 17.7 | 17.5 | 1.31 | .74 | .68 |
| Water, % | 61.4 | 60.3 | 60.4 | .99 | .74 | .68 |
| Protein, % | 18.6 | 18.3 | 18.3 | .26 | .74 | .68 |
| Energy, kcal/g | 2.53 | 2.66 | 2.64 | .11 | .26 | .64 |
| Protein, lb | 100[a] | 101[a] | 113[b] | 1.58 | .05 | .20 |
| Fat, lb | 89[a] | 98[c] | 108[b] | .80 | .01 | .18 |
| Water, lb | 330[a] | 333[a] | 371[b] | 5.22 | .05 | .20 |
| Carcass traits | | | | | | |
| Backfat, inches | .2 | .18 | .3 | .04 | .29 | .30 |
| Adj. backfat | .34 | .28 | .38 | .03 | .32 | .20 |
| Ribeye area, inches | 9.75 | 8.7 | 11.0 | 1.30 | .56 | .40 |
| KPH, % | 1.5 | 1.9 | 1.6 | .40 | .82 | .59 |
| Yield grade | 2.5 | 2.8 | 2.5 | .49 | .89 | .66 |
| Maturity | 130 | 125 | 132 | 4.33 | .56 | .36 |
| Marbling score | 290[a] | 310[a] | 380[b] | 11.54 | .06 | .22 |

[a,b,c] means within same row with different superscripts differ (P< .05).

**Table 5. Body composition and carcass traits for cattle at the end of the trial.**

| Diet<br>Intake | Concentrate<br>Ad libitum | Concentrate<br>Limited | Roughage<br>Ad libitum | SEM | P< | Lim vs<br>Ad libitum |
|---|---|---|---|---|---|---|
| Carcass composition | | | | | | |
| Fat, % | 30.3 | 27.9 | 28.18 | 1.14 | .32 | .38 |
| Water, % | 50.7 | 52.5 | 52.3 | .87 | .34 | .38 |
| Protein, % | 15.8 | 16.2 | 16.2 | .23 | .36 | .42 |
| Protein, lb | 115.6[a] | 113.2[a] | 122.8[b] | 2.38 | .06 | .07 |
| Water, lb | 371.3[a] | 366.3[a] | 396.7[b] | 7.7 | .06 | .10 |
| Fat, lb | 223.9 | 194.4 | 213.4 | 12.52 | .29 | .15 |
| Gain | | | | | | |
| Carcass, lb | 2.78 | 2.48 | 2.68 | .20 | .56 | .33 |
| Fat, lb | 30.26 | 27.93 | 27.73 | 1.12 | .17 | .45 |
| Water, lb | 50.74 | 52.5 | 52.65 | .86 | .58 | .46 |
| Protein, lb | 15.79 | 16.23 | 16.29 | .23 | .64 | .50 |
| Fat, lb/day | 1.98 | 1.48 | 1.65 | .18 | .14 | .15 |
| Water, lb/day | .53 | .70 | .71 | .13 | .62 | .65 |
| Protein, lb/day | .20 | .24 | .26 | .04 | .74 | .84 |
| Carcass traits | | | | | | |
| Carcass wt, lb | 734 | 697 | 758 | 18.40 | .13 | .06 |
| Backfat, inches | .52 | .37 | .43 | .06 | .27 | .20 |
| Adj. backfat, in | .53 | .38 | .48 | .05 | .18 | .09 |
| Ribeye, sq in | 11.98 | 11.97 | 11.94 | .34 | .99 | .98 |
| Marbling score | 368 | 370 | 384 | 16.99 | .80 | .77 |
| Yield grade | 3.10 | 2.60 | 3.1 | .20 | .20 | .37 |
| Dressing % | 61.4 | 60.4 | 61.6 | .69 | .25 | .21 |

[a,b,c] means within same row with different superscripts differ (P< .05).

**Table 6. Weight summaryand digestibility**

| Diet Intake | Concentrate Ad libitum | Concentrate Limited | Roughage Ad libitum | SEM | P< | Lim vs Ad libitum |
|---|---|---|---|---|---|---|
| In weight | 706 | 708 | 718 | 4.33 | .14 | |
| Final live weight | 1196 | 1155 | 1232 | 27.22 | .33 | .11 |
| Final adj. weight | 1147 | 1089 | 1184 | 28.79 | .13 | .06 |
| DM digestibility | 81.8[a] | 81.0[a] | 73.3[b] | 1.07 | .01 | .02 |

[a,b] means within same row with different superscripts differ (P< .05).