# Influence of Fluctuating Feed Intake on Feedlot Cattle Growth-Performance and Digestive Function

R. A. Zinn
Department of Animal Science, Imperial Valley Agricultural Center, University of California, El Centro 92243

## ABSTRACT

A growth-performance trial and a metabolism trial were conducted to evaluate the influence of a 20% fluctuation in daily feed intake on performance and digestive function in Holstein steers. Steers were programmed to gain 1.1 kg/d. Treatments consisted of a 92% concentrate fed at a constant or variable rate. Overall, feed intake was the same for both groups. However, the variable feeding group had a 20% day-to-day fluctuation in feed allowances. There were no treatment effects. Growth-performance and digestive function were similar for both treatment groups.

## Implications

A daily fluctuation in feed intake of 20% (1.5 kg/d) was not sufficient to adversely affect growth-performance or digestive function in calf-fed Holstein steers during the late finishing phase.

## Introduction

Very little research has been conducted to determine the quantitative aspects of intake fluctuations on steer performance. Nevertheless, fluctuations in feed intake are thought to be a primary cause of both acute and chronic digestive disturbances. Recently, Galyean et al (1992) evaluated the effects of varying intake patterns on performance of feedlot steers fed a 90% concentrate finishing diet. Treatments were 1) constant feed intake (steers were programmed to gain 1.25 kg/d); 2) 10% daily fluctuation in feed intake relative to treatment 1 and 3) 10% weekly fluctuation in feed intake relative to treatment 1. The pattern for fluctuating feed intake relative to treatment 1 was as follows: 10% greater, equal, 10 less, equal, 10% greater (thus, the net intake swing was 20% every third interval). As planned, daily feed intake averaged the same (7.8 kg) for all 3 treatment groups across the 84-d trial. Daily weight gain and feed efficiency were also similar for the constant intake and weekly variation treatment groups. However, daily weight gain decreased 6.5% and feed/gain increased 6.9% with the daily intake variation group. These decreases in performance responses with daily fluctuation in feed intake can be explained as either an 8% increase in maintenance energy requirements or a 4% decrease in the $NE_m$ value of the diet. The objective of the present study is to gain further insight into the effects of daily fluctuations in feed intake on both growth-performance and digestive function.

## Experimental Procedures

Trial 1 . Forty Holstein steers (363 kg) were used in a 138-d feeding trial to evaluate the effects of variable feed intake during the late finishing phase. Steers were blocked by weight and

randomly allotted to 8 pens equipped with automatic waterers and fence-line feed bunks. The trial was initiated May 20, 1993. Because the trial was conducted during summer months (when feed consumptions typically drops in Holstein cattle due to heat stress), steers were programmed to gain 1.1 kg/d according to the following equation:

$$FI = ((.0557W^{.75}(G^{1.097}))/NE_g) + (.084W_{.75}/NE_m),$$

where FI is daily feed intake in Kg, G is daily weight gain in kg, W is the average full weight reduced 4% to account for digestive tract fill, and $NE_m$ and $NE_g$ are expressed in Mcal/kg. Feed intake was adjusted at weekly increments according to projected changes in live weight. Composition of the diet is shown in Table 1. Steers were fed twice daily. Two treatments were compared: constant daily feed intake versus variable daily feed intake. With the variable feeding group steers were fed in a cycle of 10% more followed by 10% less than that of the constant feeding group. That is, the first day they received 10% more than the constant feeding group, the second day they received 10% less than the constant feeding group, the third day they received 10% more than the constant feeding group, etc., until the end of the trial. Thus, the change in feed intake from day to day was 20%. Upon initiation of study and at day 56, steers were implanted with Synovex-S (Syntex, Des Moines, IA). Diets were prepared at weekly intervals and stored in plywood boxes located in front of each pen. Energy retention (ER, megacalories) was derived from measures of live weight (LW, kilograms) and ADG (kilograms/day) according to the following equation :

$$\text{Steers EG} = (.0557\ LW^{.75})\ ADG^{1.097}$$

(NRC, 1984). Net energy content of the diet for maintenance and gain were calculated assuming a constant fasting heat production (MQ) of $.084LW^{.75}$ Mcal/d. From estimates of ER and MQ, the NEm and NEg values of the diets were obtained by process of iteration ( Zinn, 1987) to fit the relationship: NEg = (.877NEm) - .41 (NRC, 1984). This trial was analyzed as a randomized complete block design experiment (Hicks, 1973).

Trial 2. Six Holstein steers (421 kg) with "T" cannulas in the rumen and proximal duodenum (Zinn, 1993) were used in a crossover design experiment to evaluate treatment effects on characteristics of ruminal and total tract digestion. Composition of the experimental diets was the same as in trial 1 (Table 1) with inclusion of .5% chromic oxide as a digesta marker. Diets were fed in equal proportions at 0800 and 2000 daily. Daily feed intake of the constant feeding group was restricted to 6.7 kg/d (90% of feed intake of steers in Trial 1). Experimental periods were of 14-d duration. Following a 10-d treatment adjustment period, duodenal and fecal samples were taken from each steers twice daily over a period of four successive days. The time sequence for sampling steers during the collection periods was as follow: d 1, 0750 and 1350; d 2, 0900 and 1500; d 3, 1050 and 1650 and d 4, 1200 and 1800. Individual samples consisted of approximately 500 ml of duodenal chyme and 200 g (wet basis) of fecal material. Fecal samples represented a composite of fecal material which accumulated on the floor slats during a collection interval. Duodenal and fecal samples from each steer, within each period, were composited for

analysis. During the final day of each collection period, ruminal samples were obtained from each steer at approximately 4 h after feeding via the ruminal cannula. Ruminal fluid Ph was determined and subsequently, 2 mL of freshly prepared 25% (wt/vol) metaphosphoric acid was added to 8 mL of strained ruminal fluid. Samples were then centrifuged (17,000 x for 10 min) and supernatant fluid stored at -20 C for VFA analysis. Upon completion of the trial, ruminal fluid was obtained from all steers and composited for isolation of ruminal bacteria, via differential centrifugation. The microbial isolates were prepared for analysis by oven drying at 70 C and then grinding with mortar and pestle. Feed, duodenal and fecal samples were prepared for analysis by oven drying at 70 C and then grinding in a lab mill (Micro-Mill , Bell-Arts Products, Pequannock, NJ). Samples were then oven dried at 105 C until no further weight loss and stored in tightly sealed glass jars. Samples were subjected to all or part of the following analyses: Ash, Kjeldahl N, ammonia N (AOAC, 1975); starch (Zinn, 1990); purines (Zinn and Owens, 1986); VFA concentrations of ruminal fluid (gas chromatography) and chromic oxide (Hill and Anderson, 1958). Microbial organic matter (MOM) and N (MN) leaving the abomasum were calculated using purines as a microbial marker (Zinn and Owens, 1986).Organic matter fermented in the rumen is considered equal to OM intake minus the difference between the amount of total OM reaching the duodenum and MOM reaching the duodenum. Feed N escape to the small intestine is considered equal to total N leaving the abomasum minus ammonia N and MN and, thus, includes any endogenous contributions. Methane production was calculated based on the theoretical fermentation balance for observed molar distribution of VFA and OM fermented in the rumen (Wolin, 1960). This trial was analyzed as a crossover design experiment (Hicks, 1973).

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Table 1. Ingredient composition of experimental diet fed to steers (Trials 1 and 2[a])

| | Basal diet |
|---|---|
| Ingredients, % DM | |
| Sudangrass hay | 8.00 |
| Steam-flaked corn | 77.45 |
| Yellow grease | 3.00 |
| Cane molasses | 8.00 |
| Limestone | 1.78 |
| Urea | 1.27 |
| Trace mineral salt[b] | .50 |
| Nutrient composition (DM basis)[c] | |
| NE, Mcal/kg | |
| Maintenance | 2.24 |
| Gain | 1.55 |
| Crude protein, % | 12.0 |
| ADF, % | 5.7 |
| Calcium, % | .9 |
| Phosphorus, % | .3 |

[a]Chromic oxide (.5%) was added as a digesta marker in Trial 2.

[b]Trace mineral salt contained: $CoSO_4$, .068%; $CuSO_4$, 1.04%; $FeSO_4$, 3.57%; ZnO, 1.24%; $MnSO_4$, 1.07%; KI, .052%; and NaCl, 93.4%.

[c]Based on tabular NE values for individual feed ingredients (NRC, 1984) with exception of supplemental fat that was assigned $NE_m$ and $NE_g$ values of 6.03 and 4.79, respectively.

Table 2. Influence of a 20% variation in daily feed intake on growth-performance of feedlot steers (Trial 1)

| Item | Daily feed allowance | | SD |
|---|---|---|---|
| | Constant | Variable | |
| Days on test | 138 | 138 | |
| Pen replicates | 4 | 4 | |
| Live wt, kg[a] | | | |
| Initial | 363.5 | 363.1 | 4.8 |
| Final | 514.2 | 517.9 | 12.3 |
| Weight gain, kg/d | 1.09 | 1.12 | .10 |
| DM intake, kg/d | 7.51 | 7.57 | .23 |
| DM intake/gain | 6.92 | 6.75 | .54 |
| Diet net energy, Mcal/kg | | | |
| Maintenance | 2.21 | 2.23 | .09 |
| Gain | 1.52 | 1.54 | .08 |
| Observed/expected diet net energy[b] | | | |
| Maintenance | .98 | .99 | .04 |
| Gain | .98 | 1.00 | .05 |

[a]Initial and final weights were reduced 4% to account for digestive tract fill. Final weight adjusted for carcass weight by dividing carcass weight by the average dressing percentage.

[b]Expected NE based on tabular NE values for individual feed ingredients (NRC, 1984) with exception of supplemental fat which was assigned $NE_m$ and $NE_g$ values of 6.03 and 4.79, respectively (Table 1).

Table 3. Influence of a 20% variation in daily feed intake on carcass characteristics (Trial 1)

| Item | Daily feed allowance | | SD |
|---|---|---|---|
| | Constant | Variable | |
| Carcass wt, kg | 323.9 | 326.3 | 7.7 |
| Dressing percentage | 63.0 | 63.0 | .5 |
| Rib eye area, $cm^2$ | 79.4 | 80.2 | 1.4 |
| Fat thickness, cm | .84 | .82 | .09 |
| KPH, %[a] | 2.32 | 2.35 | .18 |
| Marbling score, degrees[b] | 4.16 | 4.62 | .38 |
| Retail yield, % | 50.8 | 50.9 | .4 |
| Preliminary yield grade | 2.96 | 2.96 | .22 |
| Liver abscess, % | 5.0 | 15.0 | 24.5 |

[a]Kidney, pelvic and heart fat as a percentage of carcass weight.

[b]Coded: Minimum slight = 3, minimum small = 4, etc.

Table 4. Influence of a 20% variation in daily feed intake on characteristics of ruminal and total tract digestion (Trial 2)[a]

| Item | Daily feed allowance | | SD |
|---|---|---|---|
| | Constant | Variable | |
| Intake, g/d | | | |
| DM | 6,720 | 6,720 | |
| OM | 6,346 | 6,346 | |
| Starch | 3,077 | 3,077 | |
| ADF | 501 | 501 | |
| N | 146 | 146 | |
| Leaving abomasum, g/d | | | |
| OM | 2,840 | 2,840 | 141 |
| Starch | 350 | 378 | 37 |
| ADF | 361 | 349 | 62 |
| N | 132 | 131 | 6 |
| Ammonia N | 5.9 | 6.1 | .6 |
| Non-ammonia N | 126 | 125 | 6 |
| Microbial N | 68.3 | 66.6 | 2.6 |
| Feed N | 57.8 | 58.3 | 5.0 |
| Ruminal digestion, % intake | | | |
| OM | 66.0 | 65.7 | 2.2 |
| Starch | 88.6 | 87.7 | 1.2 |
| ADF | 28.0 | 30.0 | 12.4 |
| Feed N | 60.5 | 60.2 | 3.5 |
| Microbial efficiency[b] | 16.3 | 16.0 | .8 |
| N efficiency[c] | .86 | .85 | .04 |
| Fecal excretion, g/d | | | |
| OM | 955 | 958 | 58 |
| Starch | 19.3 | 17.7 | 5.6 |
| ADF | 253 | 265 | 17 |
| N | 32.9 | 31.8 | 1.6 |
| Total tract digestion, % | | | |
| OM | 85.0 | 84.9 | .1 |
| Starch | 99.4 | 99.4 | .2 |
| ADF | 49.4 | 47.0 | 3.5 |
| N | 77.5 | 78.3 | 1.1 |

[a]Six Holstein steers (421 kg).
[b]Microbial N, grams/kilogram of OM fermented.
[c]Duodenal non-ammonia N/ N intake.

Table 4. Influence of a 20% variation in daily feed intake on ruminal pH, VFA molar proportions, and estimated methane production (Trial 2)[a]

| Item | Daily feed allowance | | SD |
|---|---|---|---|
| | Constant | Variable | |
| Ruminal pH | 5.89 | 5.92 | .27 |
| Ruminal VFA, mol/ 100 mol | | | |
| Acetate | 62.3 | 62.1 | 4.5 |
| Propionate | 25.5 | 25.0 | 3.4 |
| Butyrate | 12.1 | 12.9 | 1.8 |
| Methane[a] | .55 | .55 | .05 |

[a]Methane, mol/mol glucose equivalent fermented.