FEED INTAKE BY FEEDLOT BEEF STEERS: INFLUENCE OF INITIAL WEIGHT AND TIME ON FEED

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Story in Brief

Feed intake records from a large commercial feedlot were analyzed to determine the influence of initial weight and time on feed on dry matter intake (DMI) by yearling beef steers. Information was available for DMI of a high concentrate feedlot diet at 14 day intervals from 675 pens of cattle over a period of one year. Pens held a mean of 175 beef steers per pen for a total of 119,482 animals. Initial weight averaged 687 pounds and all animals were rapidly switched to their high concentrate finishing ration. Mean DMI for pens of cattle averaged 21.5 pounds per day and increased as mean feeding weight increased ($ADF=.258W^{.656}$; $R^2=.54$; $N=212$). DMI was about 20 percent greater than predicted from published equations. This relationship of DMI to animal weight did not fit DMI during a feeding period, however. Instead, considering all feed intake intervals, DMI was more curvilinearly related to body weight ($DMI=.978W^{.455}$; $R^2=.30$; $N=3896$). Mean DMI increased about 1.5 pounds per hundred pound increase in starting weight. The feed intake curves consisted of three different segments with intake during the first 14 days on feed being proportional to body weight ($DMI=.0214W^{1.02}$), an intake plateau from day 28 to day 140 followed by a slight decrease as steers reached slaughter weight. Since the observed shape of the DMI curve during the feeding period differs from that used to calculate nutrient requirements, requirements during different parts of the finishing period need to be reconsidered and recalculated.

(Key words: Feed intake, Dry matter intake, Starting weight, Time on feed.)

Introduction

Performance of feedlot steers can be predicted quite accurately when net energy content of the diet and feed intake are known. Net energy values can be estimated from tables of feed composition, but less information is available to predict feed intake. Equations to predict feed intake have been advanced by several workers (Table 1). Most of these equations were developed from AVERAGE feed intakes from feeding trials and AVERAGE feeding weight and relate intake to metabolic body size (body weight to the three-quarter power). This means that intake would increase continually as steers gain weight. Such is not the case based on field experience of cattlemen. Instead, feed intake during a feeding period first increases and later declines with time on feed. Three of the equations predict this rise and decline in intake, but two predict a gradual rise and fall while the third predicts a relatively flat plateau during the feeding period.

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Table 1. Dry matter intake equations for feedlot cattle[a].

Gill (1979)

$$DMI, lb = (.08968+.0000498INWT+.00498FG)W^{.75} -((WT-500)/210.8)^2$$; with feeder grade (FG) between 1 and 10, usually near 5.

ARC (1980)

$$DMI, lb = W^{.75}(.1423-.0129ME);$$

Goodrich & Meiske (1981)

$$DMI, lb = 3.39+.1249W^{.75}-1.571ME;$$

Owens & Gill (1982)

$$DMI, lb = -11.21+.0636W-.0000325W^2+.0039(INWT-610);$$

NRC (1984)

$$DMI, lb = W^{.75}(.1819NE_m-.056NE_m^{\ 2}-.0239);$$

Plegge et al. (1984) for mean intake

$$DMI, lb = -16.87+.0063MW+.0000085MW^2+20.73ME-4.187ME^2;$$

Plegge et al. (1984) for intake during a feeding trial

$$DMI, lb = -95.21-.004INWT+.0000136INWT^2+81.22RELWT-45.89RELWT^2 +53.9ME-9.696ME^2;$$

Fox & Black (1984)

$$DMI, lb = W^{.75}(.11 \text{ to } .12 \text{ depending on } W)[1+(.03(1.27-NE_g))]$$

[a]Terms include DMI, daily dry matter intake; W, shrunk weight in pounds; INWT, starting shrunk weight in pounds; ME, metabolizable energy in mcal/kg feed dry matter; MW, mean shrunk weight for the feeding trial; NE_m, net energy for maintenance in mcal/kg feed dry matter; RELWT, current shrunk weight as a fraction of slaughter weight; NE_g, net energy for gain in mcal/kg feed dry matter.

Since feed intake is the basis on which both nutrient requirements and gain and profit are predicted, the shape of the feed intake equation needs to be defined. The objective of this study was to determine the pattern of the feed intake of commercially fed yearling steers and the impact of starting weight on feed intake.

Materials and Methods

Daily pen records from a large feedlot in Western Kansas were analyzed to determine the impact of various factors on feed intake of finishing cattle. Mean DMI for sequential 14 day intervals of 246 feedyard pens were obtained from feeding records from December 1981 until November 1982. This represented 675 different sets of non-dairy steers including primarily steers of British breeding, usually crossbred and a small percent of steers with some Brahman breeding. Most cattle were yearlings or older when placed on feed and were fed for 98 to 168 days. For analysis, pens with less than 50 head were removed to reduce variation, so that the mean number of animals in each pen was 175 (range of 50 over 500; standard deviation = 82). Hence, intakes for the year represented values from a total of 119,482 cattle. A mean of 18 observa-

Table 2. General information on beef steers.

Item	Mean	Standard deviation
Pens	675	
Cattle/pen	175	82
Total cattle	119,482	
Pen-period observations	3897	
Weights		
Initial	687	80
112 days	1029	79
ADG	2.97	
Bullers, %	2.8	2.7
Hospital, %	1.4	3.0
Dead, %	.7	1.2
Dry Matter Intake		
Across all pens		
0-14 days	17.4	3.0
15-28 days	21.8	2.7
29-42 days	21.9	2.1
43-56 days	22.1	2.0
57-70 days	22.3	2.0
71-84 days	22.4	2.1
85-98 days	22.3	2.1
99-112 days	21.9	1.9
113-126 days	20.9	1.6
129-140 days	19.7	1.6
Within the same set of cattle		
0-112 days	21.5	1.9

tions were available per pen for a total of 3897 period-pen observations. Further information on the sets of cattle are presented in Table 2.

Data available for each set of cattle included starting feedlot weight (weight on arrival into the feedyard typically after trucking at least 24 hours), sex, breed, number of cattle in the pen, number in the hospital pen for all reasons, deaths per pen for all reasons and number of animals removed due to riding by other animals (bullers), projected current weight which was updated daily based on initial weight, feed intake and NE_m plus NE_g content of the diet. No information on origin, length of haul or backgrounding of cattle was available. All cattle were dipped at the start, received routine medical attention and growth-stimulating ear implants. During the first 28 days on feed, level of roughage in the diet was decreased stepwise from about 40 percent to the 14 percent of the finishing diet. This diet was fed thereafter. The high energy diet consisted primarily of high moisture harvested corn grain, corn silage, chopped alfalfa hay and soybean meal or urea. Monensin was included between 20 and 25 g per ton of feed. On a dry basis, the diet contained 3.18 mcal ME per kg or 2.18 mcal NE_m per kg throughout the year. For statistical analysis and comparisons, components included initial weight, days on feed and current weights. To calculate mean weights and DMI for a pen of cattle, data from the first 112 days of feeding were averaged.

Results and Discussion

Mean DMI for 212 pens of steers for 112 days or longer were calculated from intakes at 14 day intervals are plotted in Figure 1. Mean feed intake increased as mean weight increased. This is similar to most feed intake equations which have been developed (Table 1). Generally, feed intake has been expressed relative to body weight raised to a power or exponent, usually .75. Mean feed intake in this study was related to mean body weight during the feeding period taken to the .656 (± .044; R^2=.54) power as drawn in Figure 1. This power changed with time on feed, however. The power function best matching feed intake during individual 14 day intervals ranged from a low of .47 at feeding intervals beyond 56 days on feed to 1.02 during the first 14 days on feed. This means that the relationship of DMI to body weight changes during the feeding period.

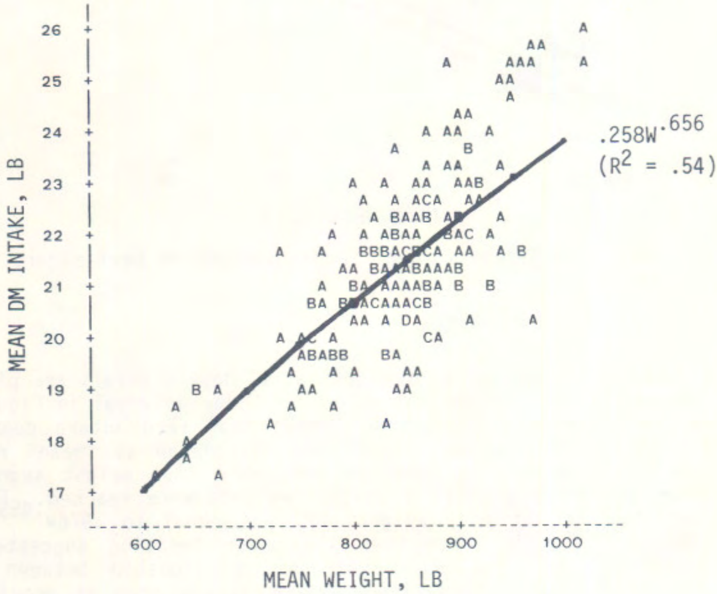

Figure 1. Mean weight vs feed intake (n=188).

Measured mean feed intakes are compared with predicted mean intake values from equations of the ARC (1980), NRC (1984) and Plegge et al. (1984) data from Minnesota in Figure 2. Since these equations incorporate values for energy content of the diet, those for the finishing diet (3.18 mcal ME or 2.18 mcal NE_m per kg feed dry matter) were used. Measured mean feed intakes exceeded predicted feed intakes by 20 to 30 percent though all equations predict intake at zero when weight is zero. This discrepancy may be due to differences in environment or in background of the cattle. Further, the predicted reduction in feed intake for higher energy diets in various equations may exceed that observed with implanted, monensin-fed yearling beef steers. Few equations were developed for cattle rapidly adapted to a diet this high in energy.

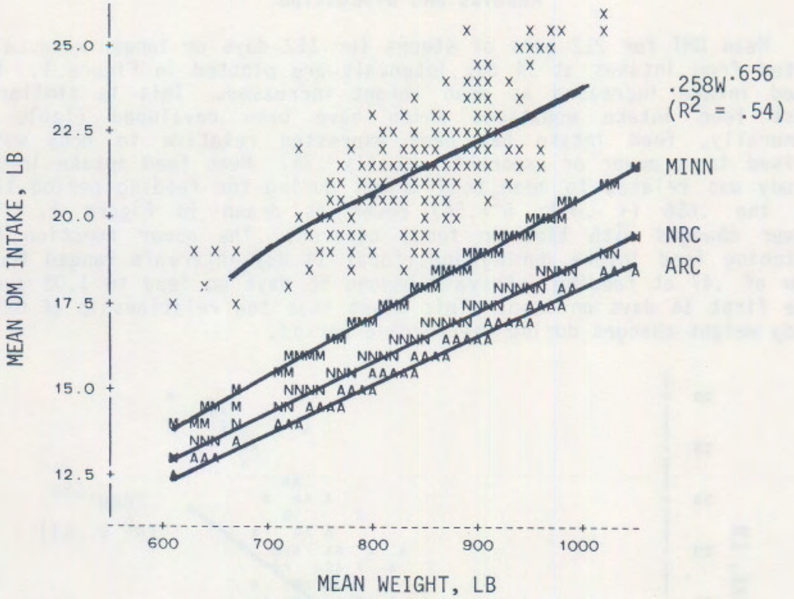

Figure 2. Mean feed intake vs mean feeding weight of beef steers (n=188).

Feed intakes for all pens of steers at 14 day intervals are plotted against shrunk weights at the end of each 14 day interval in Figure 3. This line is definitely curved indicating that feed intake does not increase linearly with weight. The line designated as "mean" represents intakes of animals grouped in 100 pound live weight segments. Feed intake tended to plateau as higher weights were reached. Fitted to a power function of body weight, DMI was equal to $.976W^{.455 \pm .011}$ (R^2 = .301). This is lower than the power function suggested by others (Table 2) and indicates that the relationship between feed intake and body weight changes as feedlot steers grow as previously suggested by Gill (1979), Owens and Gill (1982), Plegge et al. (1984) and Fox and Black (1984). A lot of variation remains, however, as individual letters represent the number of pens of cattle at each point (A=1; B=2; Z=26 or more). The low initial point on the "mean" line represents either lighter starting weights or earlier periods of feeding. To subdivide these effects, feed intake was plotted against starting weight (Figure 4). Feed intake definitely increased as starting weight increased, with daily feed intake increasing about 1.5 pounds for every increase in starting weight of 100 pounds.

The overall curve (Figure 3) was averaged across pens and initial weights. Intakes of individual pens might differ from this curve. To look at DMI with individual pens of cattle without being confounded by differences in initial weight, data from 5 pens which had starting weights which were similar to each other (685 to 688 pounds) and near to the mean starting weight for all cattle were plotted (Figure 5). Feed intake was lowest for virtually all pens during the first 14 days

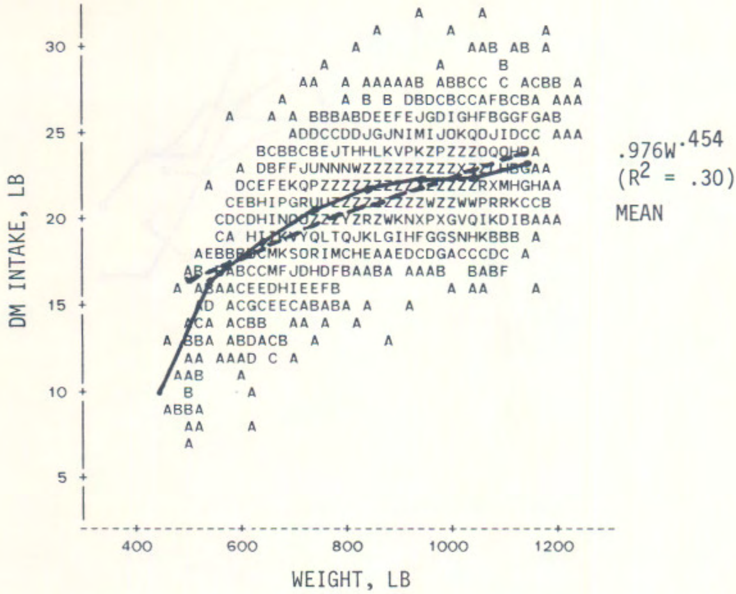

Figure 3. Feed intake and steer weight at 14-day intervals (n=3896).

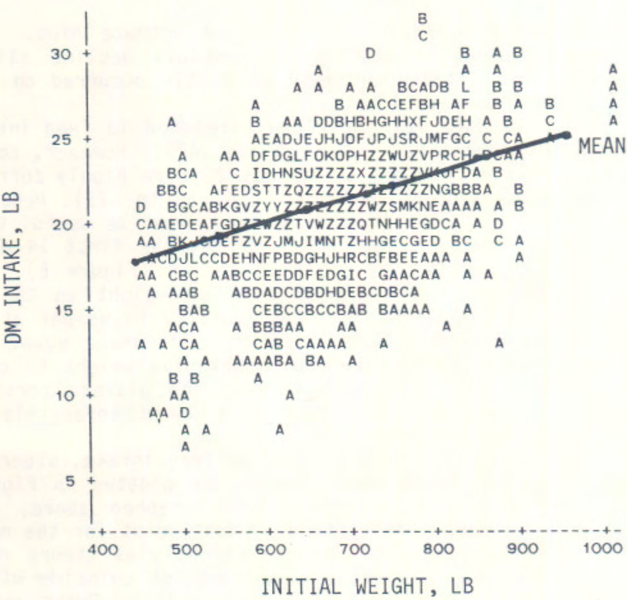

Figure 4. Feed intake vs initial weight.

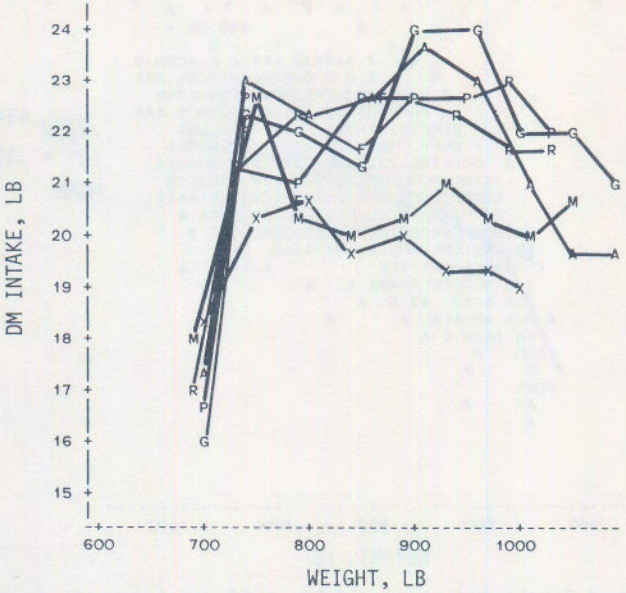

Figure 5. Feed intakes by selected pens of steers (685-688 lb) initial weight.

when animals were being adapted to a high concentrate diet. Thereafter, feed intake tended to plateau or possibly decline slightly. Often, the maximum feed intake for pens of cattle occurred on day 28 (the mean feed intake from day 14 to day 28).

Intake the first 14 days was not closely related to feed intake at day 56 or for periods thereafter (R^2 = .37 to .47). However, correlations between feed intake from day 14 to day 28 were highly correlated with feed intakes at subsequent periods (R^2 = .53 to .73). Hence, intake during the third to the sixth week on feed might be useful to predict subsequent feed intake. Feed intake during the first 14 days on feed was most closely related to starting weight (Figure 6). During this interval, feed intake was related to body weight to the first power. Feed intake increased almost proportionally to weight at which the steers entered the feedyard. Some of the feed intake equations in the literature adjust for initial weight or relative weight to correct for this difference. Since this differs from the plateau portion of the intake curve, it probably should be considered separately as a component of the total feed intake curve.

To determine the effect of time on feed on feed intake, steers were grouped by time periods. Daily feed intakes are plotted in Figure 7. As was apparent for the few individual pens graphed above, intake reached a plateau at 28 days and remained at that point for the next 96 days. Thereafter, intake tended to decline slightly as steers reached slaughter weights. The shape of these curves do not coincide with the shape of the feed intake curve suggested previously by Owens and Gill (1982) or by Plegge et al. (1984) who determined that intake continued to increase to a peak when cattle reached 88 percent of slaughter

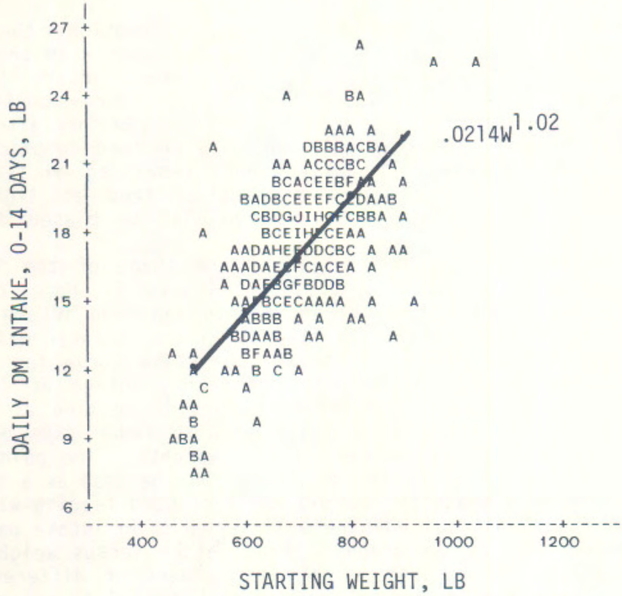

Figure 6. Intake vs weight first two weeks on feed (n=445).

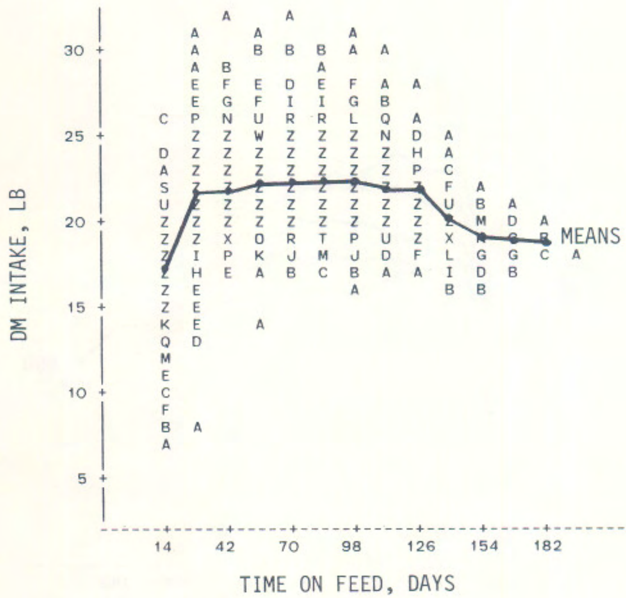

Figure 7. Feed intake vs time on feed (n=3896).

weight. In contrast to previous prediction equation, these feedlot records indicate that intake is considerably higher with shorter times on feed and rapidly reaches a plateau. Later, intake declines as steers reached market weight. Differences in energy content of the diet, cattle background or age may be involved. Another alternative is that initial weights, final weights and days on feed complicate interpretation of the curves. The only steers remaining on feed for 140 days or longer are those which started on feed at light initial weights. Hence, the average intake curve will be biased downward at that point.

The influence of starting weight on the shape of the feed intake curve with time on feed is illustrated in Figure 8. Here, cattle have been grouped by 100 pound weight increments and mean intake at 14 day intervals was plotted. Little overlap in intakes between weight groups is apparent, but the overall shape of the intake curve for all weight groups is surprisingly similar. In all cases, intake at 28 days was near or at the maximum. Feed intake tended to decline as cattle approached slaughter weight which would be with fewer days on feed for cattle at heavier than at lighter initial weights. The point at which feed intake for a pen of cattle declines might be used as a signal that cattle have reached slaughter weight and continued feeding will be less economical. To illustrate how these differences in intake pattern give a curved appearance to the graph of feed intake versus weight, intakes were plotted against current weights for steers of different initial weights in Figure 9. The overall curve of Figure 3 is can be ascribed to lower feed intakes of cattle during the first period on feed as well as lower feed intakes of cattle started at lighter weights. Means here, however, suggest that at heavier initial weights, feed intake may not plateau but continue to increase gradually as such cattle gain weight.

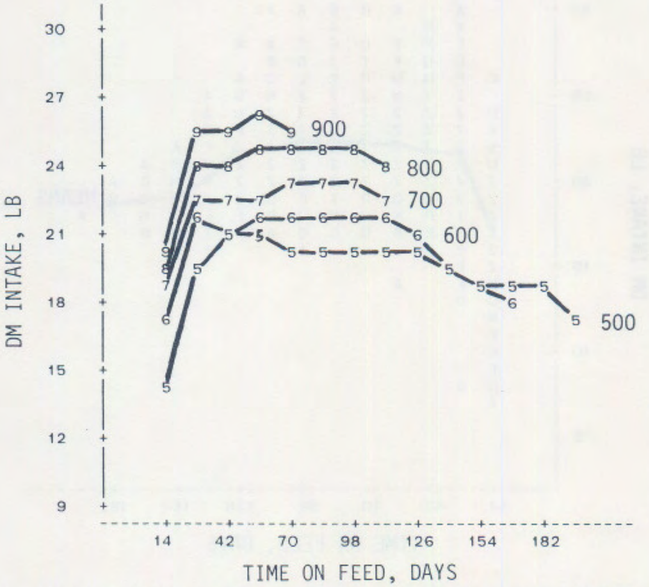

Figure 8. Feed intake vs time on feed for steers with different initial weights.

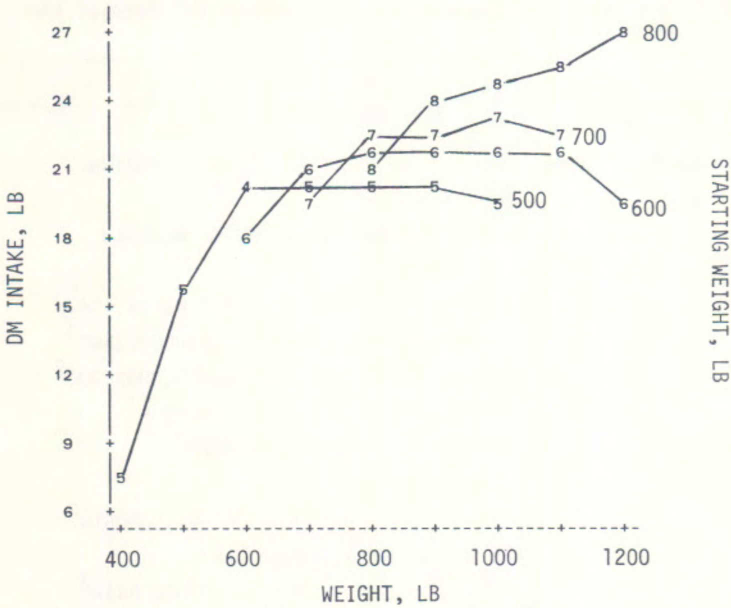

Figure 9. Feed intake vs weight for steers with different starting weights.

Based on these data, the feed intake curve for cattle moved to a high concentrate diet rapidly appears to consist of three segments. During the first 14 days, when cattle are moved through diets containing sequentially less roughage, feed intake is proportional to body weight. During the next 84 to 140 days, feed intake plateaus or gradually creeps upward at a level proportional to starting weight. After 84 days for heavier cattle or 140 days for lighter starting weight cattle, feed intake will decline slightly. Equations relating feed intake during the feeding period are presented in Table 3. Input variables chosen were those which could be appraised easily. Variables known at the time cattle are delivered such as initial weight and days on feed would be preferable for prediction purposes. Variables were chosen by stepwise regression procedures and were included only when significant at a probability level of 20 percent and when addition improved the precision of prediction. Percent of finished (market) weight was not included as a variable since the time of marketing is dictated by many factors in addition to carcass fat.

Weight gains and nutrient requirements can be predicted from these feed intakes and body weights. Formulas provided by NRC (1984) permit requirements to be calculated at various rates of gain providing feed intake is specified. When contrasted with requirements predicted from NRC (1984), predictions from these intake curves indicate that the protein needed, expressed as a percentage of the diet, is lower than predicted by NRC (1984) for cattle at lighter weights. However, the requirement for protein does not decrease as steeply as predicted by NRC since feed intake does not increase with time on feed as the NRC equation projects.

Table 3. Dry matter intake prediction equations for feedlot beef steers[a].

Time period	Equation	R^2
First 14 days	$DMI=.0214W^{1.02}$	.54
Total feeding period	$DMI=3.91+.259DOF-.0027DOF^2+.0162INWT$ $+.0000083DOF^3$	.50
	$DMI=4.36+.207DOF-.00286DOF^2+.0164W$ $.0000095DOF^3$	.55
	$DMI=-3.04-.175INWT+.000235INWT^2+.196W$ $-.000196WT^2+.00000007W^3-.0000001INWT^3$	.39
	$DMI=4.73+.0177INWT+.0716DOF+.00024DOF^2$ $+.0001DOF*INWT-.0000016INWT*DOF^2$	.47
After 14 DOF	$DMI=15.27+.042DOF-.00028DOF^2$ $+.0000113INWT^2$	.38
	$DMI=-2.81-.00051DOF^2+.0655W-.000061W^2$ $+.0000013DOF^3+.000000024W^3$	.47
	$DMI=1.22+.109W-.00012W^2+.000000044W^3$ $-.0729INWT+.000112INWT^2-.000000048INWT^3$	.36
	$DMI=10.27+.0106INWT+.0000059INWT^2$ $+.0528DOF-.00000053INWT*DOF^2$	.39

[a]Terms include DMI, daily dry matter intake in pounds; W, shrunk weight in pounds; INWT, starting shrunk weight in pounds; DOF, days on feed.

Since feed intake can vary with breed, sex, season, initial weight and environmental conditions, diets can be tailored to meet specific conditions providing the impact of these factors can be measured. In addition, seasonal effects on feed intake of feedlot cattle in various regions of the US need to be studied to more accurately estimate requirements and the economics of cattle feeding of various types and backgrounds.

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