Controlling Intake of Feedlot Cattle

Steven C. Loerch
The Ohio State University, Wooster, OH 44691

Abstract

Offering cattle unlimited access to feed has been the standard feeding practice of the cattle industry for decades. When less than maximum energy intake is desired (such as for breeding or stocker cattle), low energy diets are fed at ad libitum intakes. This system may not be the most cost effective or efficient. Controlling feed intake of feedlot cattle may impact performance, feed efficiency, carcass composition, and profitability. Several strategies have been developed for controlling and manipulating feed intake of feedlot cattle. This paper will review programmed feeding strategies for backgrounding and finishing cattle.

Introduction

Feed costs represent about 65% of total costs for cattle feeders. Maximizing efficiency of feed utilization is a critical profitability factor. What goes into the bunk and strategies for feed delivery can improve health, performance, and profitability.

Four general strategies for controlling intake of cattle have been identified: 1) bunk management, 2) limit-feeding to limit energy intake, 3) continuous limit feeding, and 4) programming step-wise increases in feed intake. The implementation and results of these different systems are discussed below.

Bunk Management. The objectives of feed bunk management are to maximize feed efficiency and animal performance, minimize digestive disorders, and keep cattle consuming a consistent amount of feed daily. Offering cattle unlimited access to feed has been the standard feeding practice of the cattle industry for decades. In this system, the bunk is never empty and cattle always have feed in front of them. This is not bunk management; the effort simulates a high labor, high cost, self-feeder. A clean or slick bunk management system may improve feed efficiency by reducing feed wastage and eliminating wide variation in day-to-day intake. Animals do not require continuous access to feed in order to achieve their maximum feed intake. Cattle can be trained quickly and easily to consume their feed in less than 24 hours. Prawl et al. (1997) demonstrated that cattle exposed to feed for only 9 h actually consumed more feed than those with feed present in the bunk 24 hours a day. With calves on feed in the spring and summer (long days and short nights), Vogel et al. (2001) reported cattle trained to consume their feed in 16 h had equal intakes as those with continuous access to feed. Robbie Pritchard and his colleagues at South Dakota State University have developed several innovative strategies for feed delivery (Bierman and Pritchard, 1996). In their studies, slick bunk management reduced dry matter intake by 11%, improved feed efficiency by 11% and did not decrease daily gains, compared to a feed system where bunks were infrequently slicked. Feed costs were reduced by 11.7¢/kg of gain for the slick bunk management. Pritchard's Bunk Scoring system is as follows: 0 = no feed in the bunk; .5 = scattered feed in the bunk, most surface is exposed; 1 = thin layer of feed in the bunk, depth of about 1 kernal of corn; 2 = 25-50% of previous feed delivery remaining; 3 = crown of feed is thoroughly disturbed, about 50% of previous feed remaining; 4 = feed has not been disturbed. The procedures for utilizing a slick bunk management system require keeping a continuous record of feed deliveries for each pen and the morning and afternoon bunk scores. To achieve slick bunk management, never increase or decrease pen feed delivery by more than 10%. Never increase feed deliveries two days in a row. Bunks should be slick (clean) about 3 times per week. Increase feed deliveries 5-10% if bunks are slick on 2 consecutive days. Decrease feed delivery by 5-10% if bunk scores are 0.5 or greater on 2 consecutive days. Observe bunks closely for problems such as: inadequate mixing, excessive fines, sorting, spoiled or moldy feed, wet feed, manure or contaminants. Clean bunks and discard old feed or contaminants when necessary. Do no attempt to force cattle to consume spoiled feeds. This will cause erratic intake behavior and increase chances of acidosis and poor performance. Provide at least 20 cm of bunk space per calf.

Limit-feeding to Limit Energy Intake. Beef cattle, like all species, require a defined amount of energy (calories) for a particular physiological function. A hypothesis put forth in this paper is that energy is energy and the source of energy is not nearly as critical as the amount of energy consumed. Traditionally, beef cattle are allowed to consume feed ad libitum during all stages of production. Energy intake is controlled by providing low energy dense feeds when maximum energy intake is not desired. This is the case for breeding females during gestation and for cattle in backgrounding programs. At The Ohio State University, we have developed limit-feeding programs with corn-based diets that successfully meet the energy needs of replacement heifers as well as beef cows and ewes in both gestation and lactation (Susin et al., 1995a; Susin et al., 1995b; Loerch, 1996). This system also has been successful for Holstein cows during the dry period (Driedger and Loerch, 1999). Interestingly, this strategy has also been shown to reduce excretion of manure dry matter, N and P (Murphy et al., 1994a; Driedger and Loerch, 1999).

In the past decade, feeding programs that restrict the intake of cattle, and feeding cattle to achieve a desired rate of gain have been used with some success (Hicks et al., 1990; Loerch, 1990; Murphy et al., 1994b). Limit feeding of high-energy diets can be used in backgrounding programs as an alternative to feeding free choice forage. In many circumstances, corn or other grains may be a cheaper source of calories than harvested forages. Breakeven price for alfalfa hay and corn on a calorie basis is presented in Table 1. For instance, if corn is priced at $100/tonne (U.S.), then the value of late-bloom alfalfa hay on an energy basis is $50/tonne (U.S.). Intake of a high-energy diet can be restricted to achieve any desired rate of gain (from 0 to the genetic maximum).

The dry matter intake required for a 270 kg steer to achieve a variety of gains is shown in Table 2. For instance, stocker steers on hay require 8.3 kg of hay to achieve a gain of .5 kg/d. It would require 4.8 kg of corn silage dry matter or 3.9 kg of a high grain finishing diet to achieve the same gain. Forage may not be the cheapest way to put on this gain.

Continuous Limit-feeding. Several studies have demonstrated the increases in efficiencies resulting from continuous limit feeding of high-energy diets to finishing cattle. By definition, limit feeding is offering feed in amounts less than ad libitum. Limit feeding for a programmed rate of gain is achieved by controlling dry matter intake of a high-energy diet so that a predicted rate of growth is attained. According to net energy equations (NRC, 1984) it would be expected that an increase in intake would increase the rate of gain and increase efficiency of conversion of feed to weight gain by animals. This would be predicted, because the proportion of feed used to meet an animal's maintenance requirements theoretically decreases as feed intake increases. Thus, a greater proportion of energy is available for body weight gain. However, in many instances, limiting feed intake has actually improved feed efficiency (Plegge, 1987; Hicks et al., 1990; Murphy et al., 1994b). In the study by Murphy et al. (1994b) with 300 kg steers, feeding at 90 or 80% of ad libitum intake reduced daily gains by .1 and .2 kg/d (respectively) vs steers fed ad libitum (Table 3). However, steers fed at 90 or 80% of steers fed ad libitum required 42 and 135 kg less feed (respectively) to achieve similar total gains.

Several factors have been suggested for the improvement in feed efficiency found with restricted feeding, or programmed gain systems, compared with what NRC (1984) equations predict (Plegge, 1987). Increased diet digestibility due to slower digesta passage rates, reduced visceral organ mass (thus reducing maintenance energy requirements), increased lean and decreased fat accretion, and changes in the metabolism of animals fed at restricted intakes have all been hypothesized as possible explanations for the improvements noted (Hicks et al., 1990). It seems probable that these factors working together in the animal account for the improvements in feed efficiency observed.

Programming Step-wise Increases in Feed Intake. One disadvantage of systems that limit intake throughout the feeding period is that daily gains are lower and more time is required for the animals to reach market weight compared with offering feed ad libitum (Murphy et al., 1994b). This problem can be overcome if cattle are fed to achieve step-wise increases in growth rate through the feeding period (Knoblich et al., 1997; Loerch and Fluharty, 1998; Rossi et al., 2001). A feeding program to achieve step-wise increases in intake may result in compensatory growth responses, which offset periods when growth rates are reduced.

Cattle typically undergo compensatory growth the first 30-60 d after arrival at the feedlot following the introduction of high-energy diets. The majority of both newly weaned and yearling cattle are placed in feedlots after the end of the summer grazing period. At the end of summer, both forage quality and availability are low. Therefore, the increased growth rate following introduction of high concentrate diets is a response to a previous period of energy intake restriction. We have developed methodologies to create several additional compensatory growth periods while cattle are in the feedlot. Cattle typically grow the fastest early in the feeding period and then growth rate is slowed as cattle reach market weight. Programming step-wise increases in intake changes the cattle growth curve. Cattle are caused to grow slower when they are young and efficient. Increases in intake cause compensatory growth responses so cattle grow more rapidly late in the feeding period when they are typically large, slow growing and inefficient. The step-up intake system allows cattle to reach similar end weights in the same number of days (i.e., similar average daily gain) as full-fed cattle. This performance is achieved with up to 136 kg less feed per animal at a feed savings of about $25.00 per head. Performance of a group of cattle fed in this manner is presented in Table 4 (Knoblich et al., 1997). Carcass evaluations revealed that cattle fed on the step-up intake system tend to have leaner carcasses (Table 5). Another potential benefit of this system is increased flexibility at marketing; marketing could be delayed if necessary because cattle are still growing efficiently at finished weights (Rossi et al., 2001). In this study, steers offered continuous ad libitum access to feed were compared with steers on a programmed feeding regimen similar to that described above. Steers from both groups were harvested after 168 or 203 days on feed. For the first 168 d, feed efficiency was 5.5% greater and gains were 5% slower for steers on the programmed feeding regimen than for steers continuously fed ad libitum. However, for cattle fed for an additional 5 weeks (203 days on feed), the programmed intake steers had significantly better performance and lower costs of gain than steers fed ad libitum for the entire 203 days (Table 6).

Another important study by Rossi et al. (2000) investigated protein requirements of steers on a programmed intake-feeding regimen. In this study, and a previous study of Murphy et al. (1994b) we found that energy intake is controlling growth rate and protein concentrations do not need to be elevated for limit-fed cattle. This would suggest that standard finishing rations are adequate for limit-fed cattle and special diet formulations are not required.

There are several precautions that should be noted regarding limit feeding. Uniformity within the pen is advantageous. Little research has been conducted regarding bunk space requirements. When bunk space limits access to feed by all animals at once, feeding twice a day, 1 to 2 hours apart (rather than 6 hours apart) will reduce animal variation in intake.

In summary, manipulating intake, feed delivery, and bunk management can all impact efficiency and profitability. In the future, feedlot managers will continue to implement new and creative strategies for feed delivery. We may see the day when feed calls for a pen of cattle are determined months in advance by computer program. Prescription intake and limit feeding programs reduce errors in feed deliveries, daily variation in feed deliveries and feed wastage by over-feeding pens. Decisions on feed delivery for specific pens can be made by one person (in advance), thus reducing chances of mistakes.

Procedures for Prescribing Intake to Achieve a Specific ADG

To calculate amount of feed needed to achieve a specific ADG you need the following information:

a. Dry matter, NE_m and NE_g concentration of your diet

b. Average body weight of animals in the pen

c. Desired ADG

d. NE prediction equations

In my opinion (as well as those of many other respected nutritionists) the 1984 Beef NRC equations are more accurate than the 2000 Beef NRC although the actual differences are small. Here is an example of the procedures.

1. Determine the % of each ingredient in your diet on a dry matter basis. Multiply this % times the concentration of NE_g (Mcal/kg DM) and NE_m (Mcal/kg DM) for each ingredient. These energy values are published in the beef NRC or can be calculated from laboratory analysis. The sum of these products is the concentration of NE_m and NE_g of your diet in Mcal/kg of DM.

For this example we will use:

In feed, Mcal/kg						In diet, Mcal/kg	
NE_m	NE_g		Ingredients	% of diet		NE_m	NE_g
2.18	1.50		Corn	75		1.64	1.13
1.11	0.55		Hay	10		.11	.06
1.80	1.20		Supplement	15		.27	.18
			Total	100		2.02	1.37

2. Determine the average weight of cattle in the pen for a 14 day period. Let's assume it is 200 kg.

3. Let's assume the target gain is 1.5 kg/d.

4. Calculate the energy required for maintenance

   NE_m required = $.077\ (BW)^{.75}$
   = $.077\ (200)^{.75}$
   = 4.095 Mcal NE_m req'd.

5. Calculate feed required for maintenance

   $$\frac{4.095 \text{ Mcal } NE_m \text{ req'd}}{2.02 \text{ Mcal } NE_m/\text{kg feed}} = 2.03 \text{ kg feed req'd for maintenance}$$

6. Calculate the energy required for gain of 1.5 kg/d

   For a medium framed steer

   NE_g req'd = $.0557\ (BW)^{.75}\ (ADG)^{1.097}$
   = $.0557\ (200\text{kg})^{.75}\ (1.5\text{kg/d})^{1.097}$
   = 4.62 Mcal NE_g req'd

7. Calculate feed required for gain

   $$\frac{4.62 \text{ Mcal } NE_g \text{ req'd}}{1.37 \text{ Mcal } NE_g/\text{kg feed}} = 3.37 \text{ kg feed req'd for gain}$$

8. Total feed DM required is feed for M + feed for G (2.03 + 3.37 = 5.4 kg/d)

9. If diet is 88% DM then with humidity, you need 6.14 kg of as-fed diet per steer. This would be 3.1% of their body wt.

10. Feed this amount for 14 days and then recalculate assuming BW has increased by 21kg (14d x 1.5 kg/d).

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Table 1. Breakeven for corn and late bloom alfalfa on a NE basis

Corn	Alfalfa
$/tonne	$/tonne
100	50
140	70
180	90
220	110
Corn NE_m is 2.2 Mcal/kg. Alfalfa NE_m is 1.00 Mcal/kg.	

Table 2. Dry matter intake required for a 270 kg steer to achieve a variety of gains

Gain, kg	Grass hay	Corn silage	90% grain
0	4.7	3.0	2.5
.5	8.3	4.8	3.9
1.0	M.I.E.[a]	6.4	5.2
1.5	M.I.E.	8.0	6.4
[a]Maximum intake exceeded.			

Table 3. Effects of restricting intake on steer performance

	Intake level, % of ad libitum		
Item	100	90	80
	Corn silage diet		
Initial wt, kg	298.6	298.8	297.4
Daily gain, kg[a]	1.16	1.01	.92
Daily feed, kg of DM[a]	7.18	6.44	5.74
Feed efficiency, gain/feed	.162	.157	.159
	Corn diet		
Initial wt, kg[a]	396.0	383.9	374.3
Daily gain, kg[a]	1.49	1.37	1.28
Daily feed, kg/ of DM[a]	9.4	8.3	7.0
Feed efficiency, gain/feed[a]	.159	.166	.182
Final wt, kg	519.6	516.3	513.5
Days fed[a]	83.3	97.4	110.8
	Entire feeding period		
Total gain, kg	221.0	217.5	216.2
Daily gain, kg[a]	1.32	1.20	1.12
Total feed intake, kg of DM[a]	1386	1344	1251
Daily feed intake, kg of DM[a]	8.28	7.41	6.45
Feed efficiency, gain/feed[a]	.160	.162	.173
Days fed[a]	167	181	195
[a]Linear treatment effect ($P < .005$). [b]Linear treatment effect ($P < .01$).			

Table 4. Effects of restricted feeding on carcass characteristics

	Intake level, % of ad libitum		
Item	100	90	80
Hot carcass wt, kg	313.3	312.1	315.2
Longissimus muscle area, cm^2	75.4	76.5	78.1
Kidney, pelvic, and heart fat, %	3.13	3.38	3.08
Backfat, cm	1.12	.94	.98
Quality grade[a]	3.50	3.25	3.33
Yield grade	3.11	2.91	2.85
Carcass ether extract, %[a]	33.47	28.50	27.68
Carcass protein, %[b]	14.31	15.07	15.19
Intramuscular fat, %	5.73	4.88	4.34
Daily protein growth, kg	.16	.16	.16
Daily fat growth, kg[a]	.59	.42	.39
[a]Linear treatment effect ($P < .02$). [b]Linear treatment effect ($P < .06$).			

Table 5. Effect of programming intake on performance

	Finishing system treatment	
Item	Programmed intake	Full feed
Predicted gain, 1.13 kg/d		
Actual gain, kg/d	1.16	1.63
DM intake, kg/d	6.2	8.1
F/G	5.3	5.0
Total gain, kg	81	114
Total feed, kg	434	568
Days	70	70
Predicted gain, 1.36 kg/d		
Actual gain, kg/d	1.88	1.57
DM intake, kg/d	8.3	9.0
F/G	4.4	5.7
Total gain, kg	119	110
Total feed, kg	524	631
Days	63	70
Fed ad libitum		
Actual gain, kg/d	1.66	1.22
DM intake, kg/d	10.3	9.4
F/F	6.3	7.7
Total gain, kg	45	23
Total feed	279	178
Days	27	19
Overall		
Gain, kg/d	1.53	1.57
Feed intake, kg/d	7.7	8.7
F/G	5.1	5.5
Days fed	160	159
Total intake, kg	1234	1374
Total feed cost (U.S.)	$250.00	$278.00

Table 6. Effect of programming intake on carcass characteristics

	Finishing system	
Item	Programmed intake	Full feed
Hot carcass wt, kg	331	335
Dressing, %	60.2	60.6
Ribeye area, cm^2	83	81
12^{th} rib backfat, cm	.76	1.09
USDA yield grade	2.5	3.0
% Choice	77	81
Carcass fat, %	27	31
Carcass protein, %	14.8	14.0

Table 7. Performance of steers from the first (168 d) to the second harvest date (203 d)

	Treatment[a]	
Item	AL	PI
Gain, kg/d	1.38	1.60
DMI, kg/d	9.4	10.5
F/G	6.8	6.6
Feed cost/kg gain[b] (U.S.)	$.864	$.820

[a]AL = offered feed ad libitum for 203 d, PI = prescription intake of feed for 203 d.
[b]Calculated using the following prices: corn = $.095/kg, corn silage = $.029/kg, supplement = $.229/kg (U.S.).