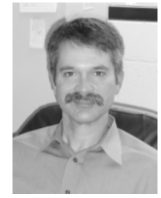
GRAIN PROCESSING EFFECTS ON MANAGEMENT: ADAPTATION DIETS



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ABSTRACT

Methods for adapting cattle to high-concentrate diets are important to consider due to potential effects on animal health and performance throughout the finishing phase. In general, transition diets allow the rumen microorganisms to adapt from predominantly fibrolytic bacteria to predominantly amylolytic bacteria in a manner that minimizes ruminal acidosis. This traditionally has been accomplished by gradually increasing the grain (or concentrate) and decreasing the roughage level over a 3 to 4 week period using a series of "step-up" diets. More recently, some feedyards have begun using two diets (a starter and finisher) and increasing the finisher:starter ratio over an established period of time. The concept of limiting maximum intake based on multiples of maintenance was established to prevent intake reductions during transitions and ensure maximum intake of the final high-concentrate diet. Adaptation also has been achieved by limit feeding the final finishing diet with feed supply gradually increasing until cattle are full fed. This potentially could decrease costs associated with purchasing and processing roughage sources in the feedyard. We conducted an experiment to evaluate effects of different methods for adapting calves with a high-risk of morbidity to a high-concentrate, program-fed diet. Steer and bull calves (n = 534) were purchased from auction markets in Florida, Missouri, Oklahoma, and Texas during November and December 2006 and delivered to Stillwater, OK. Calves were adapted to an 88%-concentrate diet either 1) traditionally using 3 transition diets, 2) with intake of each transition diet limited to 2.1, 2.3, and 2.5 times their initial maintenance energy requirements, 3) fed a 64%-concentrate (receiving) diet for 28 days before being transitioned traditionally, or 4) were program fed the final 88%-concentrate diet from day 1 through the end of the experiment. Results suggested that feeding a high-roughage diet for an extended period (28 days) after arrival resulted in the greatest gain during the 60-day growing period. However, when those cattle were adapted to being fed a high-concentrate program-fed diet, they were less efficient than traditional or program-fed steers. Either free choice intake or limit feeding the high-concentrate diet initially resulted in increased morbidity due to bovine respiratory disease. Therefore, extending the period during which a high-roughage diet is fed or limiting the maximum intake during the adaptation period may reduce morbidity in high-risk calves.

INTRODUCTION

Managing nutrition during adaptation of beef cattle to a high-grain diet has carryover effects on performance and health (Brown et al., 2006). Different methods for adapting cattle to high-concentrate diets have been investigated (Bartle and Preston, 1992; Choat et al., 2002) and the results have been reviewed (Brown et al., 2006). Brown et al. (2006) summarized that adapting feedlot cattle to a high-energy diet too rapidly (14 d or less) with incremental increases in concentrate (approximately 55 to 90% of diet DM) can decrease performance over the entire feeding period. In addition, Bevans et al. (2005) suggested that because high-energy diet adaptation can affect the number of health-impaired or poor-performing animals in a pen of feedlot cattle, management of diet adaptation should be tailored for the most susceptible cattle within the pen.

Adapting cattle to a high-concentrate diet involves adapting the microorganisms in the rumen towards a greater number of amylolytic and a lesser proportion of fibrolytic bacteria (Goad et al., 1998; Tajima et al., 2001). This was traditionally accomplished by using transition or "step-up" diets with increasing grain (or concentrate) and decreasing roughage concentration during a 3 to 4 week period (Bevans et al., 2005). With a gradually increasing concentrate supply, populations of ruminal microorganisms can adjust to a ruminal environment with a lower pH so that subacute acidosis and intake variation is minimized. An abrupt change from a high-forage to a high-concentrate diet can result in acute or subacute acidosis (Goad et al., 1998; Coe et al., 1999; Bevans et al., 2005). Ruminal acidosis, as extensively reviewed by a number of researchers (Dunlop, 1972; Counette and Prins, 1981; Britton and Stock, 1987; Owens et al., 1998), has been characterized by a rapid decline in ruminal pH, following starch ingestion, with an accompanying rise in ruminal concentrations of total volatile fatty acids (VFA) and lactate. The increased concentrations of ruminal VFA and lactate are the result of production of organic acids exceeding rates of utilization, absorption and/or ruminal dilution. The physiological effects of acidosis in feedlot cattle can range from a temporary loss in appetite to acute physiological alterations resulting in death (Koers et al., 1976; Owens et al., 1998; Brown et al., 2006). Much of what is known about the acidotic condition in ruminant animals is the result of extensive studies using models of acute acidosis; more information is needed under commercial feedlot settings (Titgemeyer and Nagaraja, 2006). This paper summarizes the importance of diet adaptation and current methods for adapting cattle to high-concentrate diets.

IMPORTANCE OF GRAIN ADAPTATION

Although our knowledge of the etiology of ruminal acidosis is fairly extensive (Owens et al., 1998), less is known about how the amounts and the number of increases in feed consumption during adaptation to a high-energy diet can impact cattle performance throughout the entire growing/finishing period (Brown et al., 2006). For growing and finishing cattle, optimizing ruminal function is very important because VFA provide 65 to 75% of the metabolizable energy needs of the animal (Bergman, 1990). Disrupting VFA production by bacteria or impairing VFA absorption and/or metabolism by the ruminal epithelium most likely will have a negative impact on animal performance. Although care must be taken during the adaptation process to prevent acidosis, establishing DM and therefore caloric intake seems to be one of the most important aspects of the diet adaptation period. There is a strong positive correlation between DMI and ADG (Figure 1) and between DMI and saleable weight (Figure 2) in feedlot cattle. After accounting for total cost of gain, cattle value increased by $13/animal for each 1 lb increase in DMI assuming an $85 cash market (Figure 2). Whereas a portion of this intake response most likely is driven by initial BW, the data reflect the total value realized from additional DMI when corrected for cost of gain. Therefore, early in the finishing period, successful transitioning to the finishing diet presents an opportunity for establishing high feed consumption that ultimately can increase ADG and saleable weight.

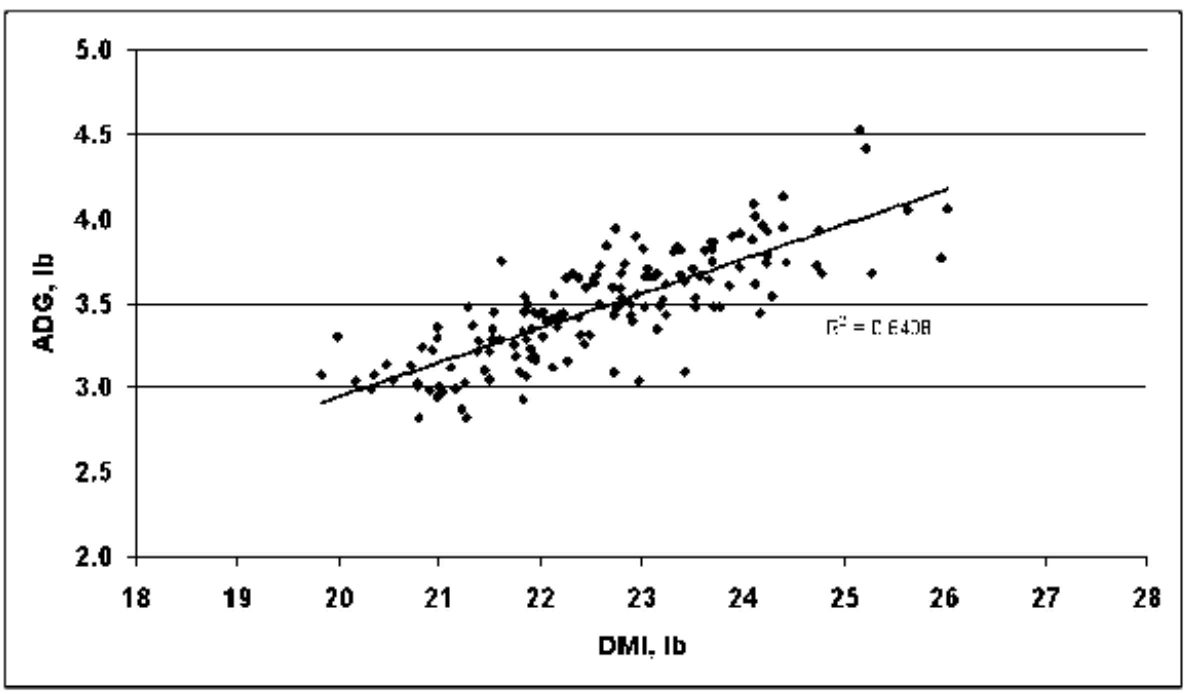

Figure 1. Relationship of DMI to ADG within feedyard in 700 to 800 lb steers (Milton, 2005; personal communication).

HOW DO FEEDYARDS PUT CATTLE ON FEED?

Many factors are involved with how cattle are placed on feed; these include animal factors, feed milling capabilities, economics and overall feedyard efficiency. Animal factors include cattle biological type, age and/or weight (calves vs. yearlings), previous management (forage amount and quality, days in a backgrounding yard, etc.), and expected days on feed. In North American feedlots, adapting cattle to high-concentrate diets commonly is characterized by a few days of feeding long-stemmed hay, followed by a series of transition or "step-up" diets, where concentrate levels are gradually increased while roughage levels are decreased to promote ruminal adaptation to the high-concentrate finishing diet. This approach generally involves 3 to 6 transition diets and a total period of 21 to 28 days. In a recent survey, Vasconcelos and Galyean (2007) reported that of 29 feedlot consulting nutritionists questioned, 22 used a series of transition diets as the exclusive adaptation program, and 2 used transition diets in combination with other methods.

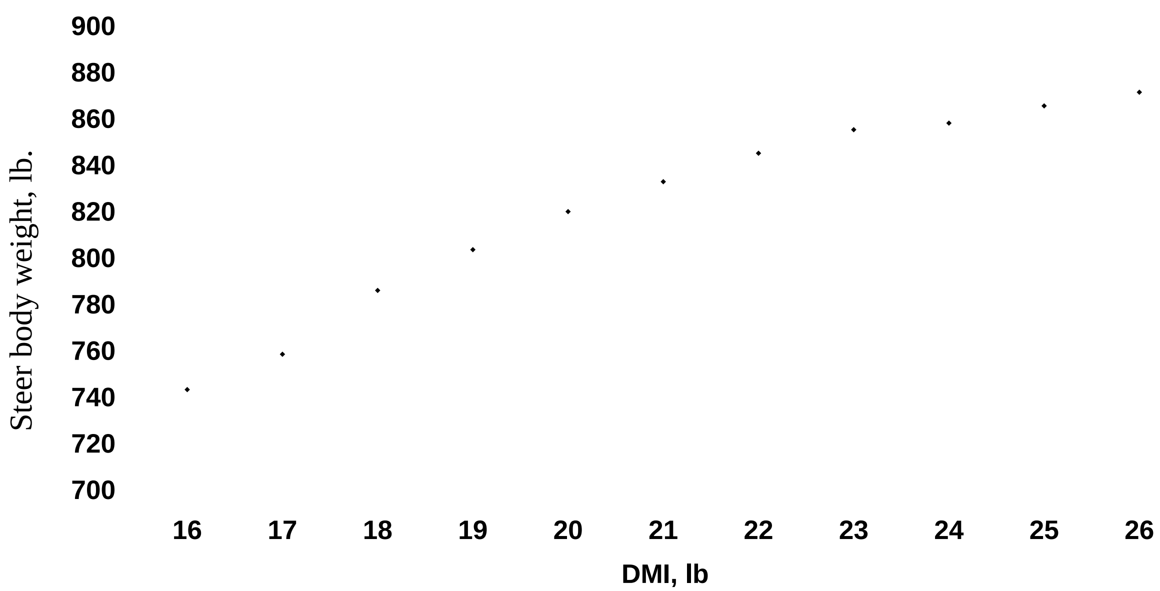

Figure 2. Relationship of DMI to saleable weight dollars minus total cost of gain in Central Plains 700 to 899 lb steers (VetLife Benchmark; Milton, 2005; personal communication).

As an alternative to this traditional approach, Xiong et al. (1991) and Bartle and Preston (1992) initiated the concept of feeding at multiples of maintenance by establishing an upper energy intake limit during adaptation based on the animal's calculated maintenance requirement. The stated purpose was to control peaks in DMI and decrease daily intake variation rather than to program energy intake. More recently, some feedyards have begun using two diets (a starter and finisher) gradually increasing the finisher:starter ratio over the same 21 to 28 d period of time as used for the traditional approach (Milton, 2005; personal communication). Alternatively, rumen microbial adaptation can be achieved by limit feeding the final finishing diet, with gradual increases in feed supply until the cattle are full fed (Bierman and Pritchard, 1996; Weichenthal et al., 1999; Choat et al., 2002). If this can be achieved without causing ruminal disorders and days off feed, then the cost of feeding cattle could be decreased due to the reduced cost for purchasing and handling harvested roughages in the feedlot. These adaptation methods are discussed in more detail below.

"Traditional" Transition Diets

Theoretically, a greater the number of transition diets, the smaller the changes in forage and energy intake at each step and the greater the potential for smooth adaptation to the final finishing diet. This should result in greater DMI and improved animal performance. However, problems associated with using a large number of transition diets include inefficiency of feedyard operations associated with an increased number of required feed loads (especially a greater number of small loads), an increased number of feeding times, and lack of storage capacity for finished feed. Therefore, a compromise between feedlot management and nutrition has most commonly resulted in the use of 2 to 5 transition rations fed from 4 to 11 days each (Vasconcelos and Galyean, 2007). Figure 3 is an example of a pen of cattle started using 3 rations prior to the finisher being fed on d 22.

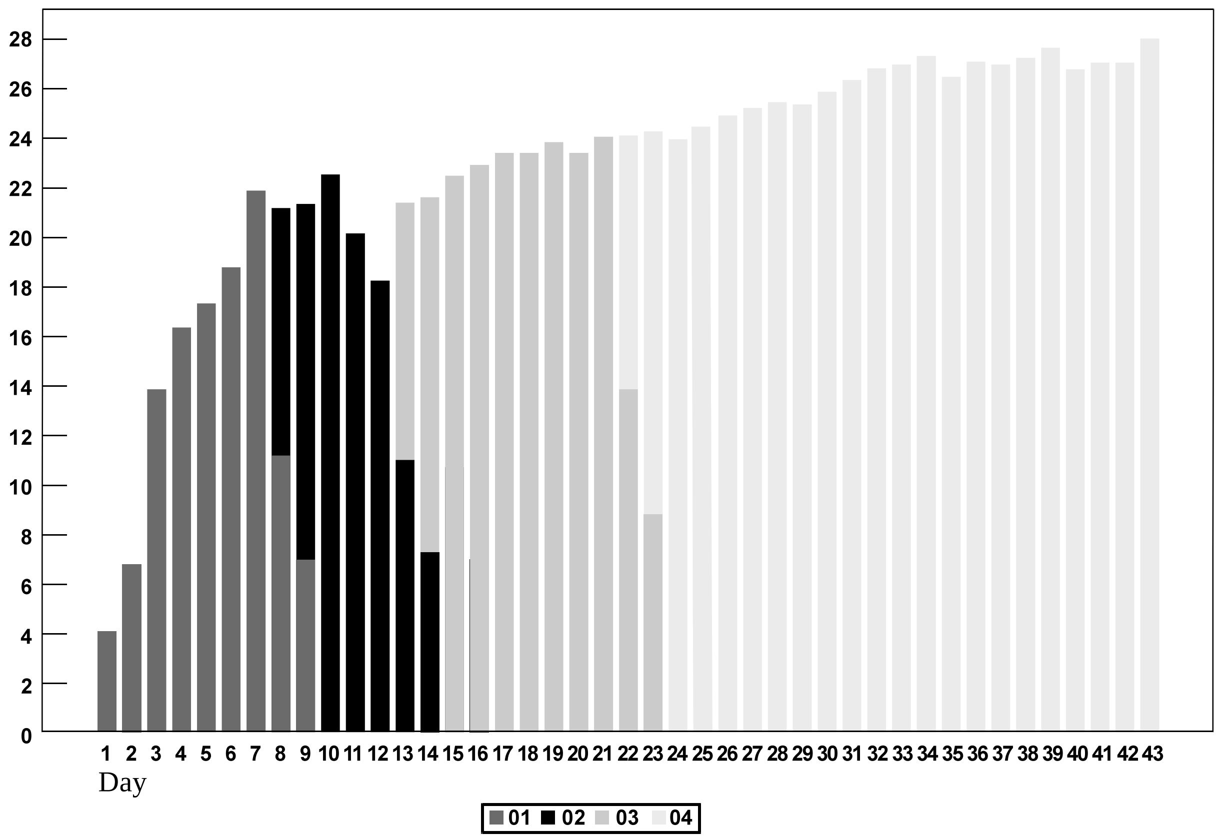

Figure 3. Example of a four-ration "step-up" approach to adapting cattle to a high-concentrate diet. 01, 02, 03, and 04 represent increasing levels of concentrate and decreasing levels of roughage. Note that on transition days 8 and 9, both 01 and 02 rations are fed, with an increased amount of 02 on day 9. Likewise, on transition days 13 and 14, and days 22 and 23, ration 02 and 03, and 03 and 04, respectively, are fed with an increased amount of 03 on day 14 and 04 on day 23 of the adaptation period.

Multiples of Maintenance

Limiting maximum intake based on multiples of maintenance energy requirements when feeding a series of diets that decrease in the fraction of roughage has resulted in comparable or improved performance relative to cattle offered the same diets free choice (Xiong et al., 1991; Bartle and Preston, 1992). Predicting consumption and setting targeted intakes is useful particularly when training feed bunk callers with little experience. Using an intake "guide" can help to prevent lost intake during transition, and ensure maximum intake on the highest energy diet. The ultimate goal is to achieve maximum DMI following transition to the final diet. One potential downside is training feed callers to rely exclusively on numeric targets rather than evaluation of the feedbunks and behavior of the cattle when determining the amount of feed to be delivered.

Xiong et al. (1991) fed steers steam-flaked grain sorghum-based diets to appetite using either typical feedlot bunk management practices or feeding at multiples of maintenance (MM). Steers on the MM regimen were fed in a similar manner to free choice steers except that an upper intake limit was established for each pen based on their calculated maintenance requirement. For the MM regimen, the upper limits for feed energy offered were set at 2.3, 2.5, and 2.7 times maintenance for wk 1, 2, and 3 of the diet adaptation period. At and beyond the 4th wk, the maximum feeding level was 2.9 times maintenance. Step-up diets fed during each of the four weeks contained 35, 25, 18, and 9% roughage for wk 1, 2, 3, and 4, respectively. Maintenance requirements were calculated from the initial BW for the first 4 wk; thereafter, the most recent BW was used. It was assumed that on days when the assigned upper limit was offered, MM steers were not fed to their maximal voluntary intake. However, the degree of restriction was not determined. The overall frequency of restricted feeding was 26, 80, 66, and 66% for wk 1, 2, 3, and 4, respectively. However, when the 9% roughage was fed, cattle adapted using the MM did not show improved ADG or feed efficiency. In a subsequent experiment, Bartle and Preston (1992) used a similar approach with two sets of MM limits that were 2.1, 2.3, 2.5, and 2.7 times maintenance (2.7MM) or 2.3, 2.5, 2.7, and 2.9 times maintenance (2.9MM) during wk 1, 2, 3, and 4, respectively. During the concentrate step-up period, limiting maximum intake to an assigned multiple of maintenance decreased feed intake by 4.7 (2.7MM) and 5.8% (2.9MM), respectively, when compared with the free choice treatment. The 2.7MM treatment also resulted in a numeric increase in ADG and tended to improve gain efficiency during the step-up period. After the step-up period, MM steers had numerically greater DMI and a slight advantage in ADG and gain efficiency, so that over the entire feeding period, the 2.7MM treatment tended to improve ADG (6%) and gain efficiency (4%) compared with steers given free choice access to feed. Performance of cattle fed at 2.9MM was intermediate. There were no differences among limiting maximum intake strategies for carcass characteristics. In conclusion, limiting maximum intake to a multiple of the estimated maintenance energy requirement (2.7MM) tended to improve ADG and efficiency. Although frequency of use of this strategy in commercial feedyards is unknown, the basic theory has potential as an easily implemented method to control fluctuating feed intake during the concentrate step-up period.

Two Ration Approach

Recently feedyards have begun using two diets (a starter and finisher) with an increase in the ratios of finisher:starter over a 21 to 28 d period of time to adapt cattle to a high-concentrate diet. With this approach, various proportions of a starter (40 to 45% roughage) and a finisher diet are fed daily starting at approximately day 3 to 5 after feedlot arrival. Similar to a large number of transition or “step-up” diets, small increases in energy and small decreases in roughage daily theoretically should improve the potential for microbial adaptation in the rumen and result in greater DMI and improved animal performance. Rather than mixing the two feeds in the delivery truck or wagon, the two diets can be fed at separate times during the day. One example of this approach using a three times per day feeding schedule is shown in Table 1. The starter diet is fed for 3 days, followed by increasing proportions of the finishing diet every 4th day through day 12. On days 13 through 15, the finishing diet is fed at feedings 2 and 3. From days 16 through 21, the finisher diet is fed at the first and third feedings, and the starter is fed at the second feeding with increasing finisher:starter at 3 day intervals. By day 22, cattle are on the finishing diet only. An alternative method used involves feeding the starter diet for the initial 3 to 5 days, and then, beginning on day 4 to 6, feeding a proportion of each diet (starter and finisher) at each feeding time. The starter diet is fed first followed by the finishing diet within a set period of time. Advantages of using a two-ration approach with altered delivery times include improved feeding efficiencies resulting from reduced milling of multiple rations, trucks always carrying a maximum load, and a reduction in the number of total loads fed throughout the day. Feeding times should be consistent for a given pen of cattle. As previously indicated, small incremental changes in energy and forage content should promote smoother adaptation of the microbial populations in the rumen and of the host animal to the final diet. Disadvantages generally involve increased complexity in management of feed trucks and feed delivery within the feedyard because feed distribution and timing are critical. Coordination of feeding with the two rations being fed to various pens at various times throughout the day results in more intensive management. This approach also makes the assumption that all cattle in a pen consume equal proportions of each ration daily, an assumption that may not be correct. The risk associated with the increased management constraints and possibilities of mistakes may be why only 6 of 29 consultants used this method to any extent (Vasconcelos and Galyean, 2007).

Limit Feeding the Finishing Diet

Little information is available concerning the use of restricting intake of the final finishing diet as a means of adapting cattle to a finishing diet (Bierman and Pritchard, 1996; Weichenthal et al., 1999; Choat et al., 2002). Choat et al. (2002) hypothesized that restricting intake of the final finishing diet would reduce DMI and increase digestibility during adaptation and improve overall feed efficiency by cattle, compared with free choice feeding of adaptation diets. They reported results from two experiments where effects of restricting intake of the final finishing diet as a means of dietary adaptation were compared with diets increasing in grain over a period of 20 to 22 d. In their first experiment, restricting intake of yearling steers during adaptation had no effect on overall feed efficiency, but it decreased DMI compared with free choice access to adaptation diets. Overall ADG was not affected by treatment. In their second experiment, restricting intake of steer calves decreased overall ADG (3.33 vs 3.64 lb/d) and DMI (19.1 vs 20.2 lb/d) compared with steers given free access to feed; however, feed efficiency was not influenced by this adaptation method. The results of the first experiment concurred with results of Bierman and Pritchard (1996) and Weichenthal et al. (1999). In their studies, limiting intake during diet adaptation did not influence ADG but decreased DMI, resulting in improved feed efficiency by those steers limit-fed the final diet compared with steers given free access to their adaptation diets. Therefore, limiting intake of the final diet as a method of adaptation appears to be effective for adapting cattle (at least yearlings) to high-concentrate diets. This method of adaptation may produce other benefits, such as simplified bunk management, decreased feed waste (Lake, 1987), and the potential for decreased manure and nutrient output. The results from Choat et al. (2002) indicate that limit-feeding of the final diet as a means of dietary adaptation can be used for finishing cattle with few problems from acidosis or related intake variation. However, for calf-fed steers, disruptions in intake during the adaptation period might result in restriction for an extended period and result in decreased hot carcass weight.

Table 1. Two ration method for adapting cattle to a high-concentrate diet

Feeding 1		Feeding 2		Feeding 3		Days
Ration	%	Ration	%	Ration	%	
1	33	1	33	1	34	3
1	45	4	15	1	40	3
1	35	4	30	1	35	3
1	30	4	45	1	25	3
1	40	4	30	4	30	3
4	33	1	33	4	34	3
4	45	1	15	4	40	3
4	33	4	33	4	34	3

ADAPTING HIGH-RISK CALVES

Until the recent increase in the price of corn, the prevalence of calves placed in feedlots was increasing in most feedyards; this increased the risk for morbidity and mortality. Debate has raged over the degree of impact that diet formulation and management can have on morbidity and mortality. Rivera et al. (2005) suggested that performance is lost equal to approximately $20/head by feeding 40% compared with 100% roughage. In their review, morbidity of lightweight, highly stressed cattle due to bovine respiratory disease (BRD) was decreased when roughage concentration in the diet was increased. However, the change was small, and the authors concluded that the disadvantage in ADG and DMI that occurs when cattle are fed greater roughage concentrations in receiving diets likely would be offset by favorable effects of increased roughage concentration on BRD morbidity. Anecdotal information indicates that higher morbidity in the starting period often results in a higher incidence of morbidity at later in the feedlot, and that feeding a higher roughage starting ration (40 to 45% roughage) may decrease the incidence of morbidity throughout the feeding period.

We recently conducted an experiment to evaluate receiving and adaptation programs on health and performance of high-risk calves program-fed a high-concentrate diet during the receiving phase. The experiment was designed as a randomized complete block in which steers (n = 536 with an initial BW = 626 ± 46 lb) were allocated to pens assuring homogeneity among groups within and among pens. The design included 4 treatments and 6 replications/treatment for a total of 24 pens holding 20 to 25 calves/pen. Four diets with increasing concentrate levels (64, 72, 80, and 88% concentrate) were fed during the adaptation to the high-concentrate diet and the subsequent growing phase. During the growing phase of the experiment, calves were fed to a similar target BW (NRC, 1996). This target weight was calculated as initial BW plus 150 lb (ADG of 2.5 lb/d for 60 d). Calves originated from auction markets in Florida, Missouri, Oklahoma, and Texas. Individual BW was recorded approximately 1 h after arrival and steers were identified by an individual numbered ear tag. Based on this weight, calves were allocated into treatments and pens. Twenty-four to 48 h later, calves were processed; processing included a 5-way viral vaccine (revaccination on d 11), clostridial bacterium/toxoid, oral and topical dewormers, castration and dehorning, recording weight, and sorting into pens. Subsequently, individual BW were recorded on d 21, 42, and 60. The day prior to weighing, steers were fed one-half their previous day's allotment of feed and withheld from water for approximately 12 to 16 h to reduce differences in fill.

Experimental treatments included: 1) TRAD; the three adaptation diets were offered ad libitum for 7-d intervals until d 21. On d 1, 2.5% of initial BW of diet 1 was offered with feed supply increasing 1.5 lb/steer daily when no feed remained in the bunk. The final diet was offered on d 21 with intake restricted such that cattle would attain their final target weight on day 60; 2) PF; the 88% concentrate diet was offered d 1. The metabolizable energy delivery/steer was equivalent to TRAD calves initially. However, when no feed remained in the bunk, feed delivered was increased 0.5 lb/steer daily until the amount of feed delivered reached that required for the calves to gain to the target weight; 3) REC; the 64% concentrate diet was offered free choice during a 28-d receiving period followed by traditional adaptation using a series of diets with increasing concentrate levels fed for 7-d intervals (72 and 80% concentrate, respectively). The final diet (88% concentrate) was initially offered on d 42. Bunk management during the 42-d adaptation period was the same as TRAD; and 4) **LMI**; the four adaptation diets were offered such that maximum metabolizable energy intake was restricted to 2.1, 2.3, and 2.5 times that required for maintenance during wk 1, 2, and 3, respectively (Bartle and Preston, 1992). The final diet was fed on d 21.

Based on BW of steers on d 21 (treatments 1, 2, and 4) and d 42 (treatment 3), steers were program fed so they reached their target weights on d 60. Steers were fed twice daily at approximately 0700 and 1000 in the morning throughout the trial. Bunks were evaluated twice daily and feed deliveries were called so that approximately 10% orts remained prior to feeding each morning during the ad libitum periods for TRAD and REC. Bunks were swept and remaining feed was weighed weekly, and if necessary, throughout the remainder of the experiment. Diet samples were collected twice each week and composited within diet and weigh period. Proximate analyses were conducted on composite diet samples. Trained personnel evaluated cattle for signs of BRD daily and treatments were administered based on standard protocol. Health and performance data were analyzed on a pen basis using the Mixed procedure of SAS.

Performance

Growth performance results for cattle in the study are shown in Table 2. Steers fed the four adaptation treatments had similar BW ($P = 0.55$) and ADG ($P = 0.41$) on d 21. However, from d 22 to 42, REC steers gained faster ($P > 0.001$) and therefore weighed more ($P < 0.001$). Even though steers given free choice access to feed had their feed removed on the day prior to weighing, a portion of the advantage of REC steers on d 42 most likely can be attributed to gastrointestinal fill because on d 60, after all steers had been program-fed a common diet for 18 d, the difference in BW between REC (BW=772 lb) and PF steers (BW=760 lb) was numerically less than on d 42. However, REC steers still had the greatest ($P = 0.06$) BW and PF the least BW with TRAD and LMI steers being intermediate. Over the entire growing period, ADG was greatest ($P = 0.02$) for REC steers, intermediate for TRAD and LMI, and least for PF steers. As intended, REC steers consumed the most feed ($P < 0.05$) and PF consumed the least amount of feed. However, no significant intake differences existed between TRAD and LMI steers, even though LMI steers were restricted to some extent during the first 21 d while TRAD steers had free choice access to feed. Using yearling cattle, Bartle and Preston (1992) reported that steers fed limited maximum intake consumed less feed during the adaptation period than steers with free access to feed, but they detected no difference in BW or feed efficiency. With our steer calves, Choat et al. (2002) reported similar results to the present study with decreased DMI and ADG of calves limit-fed the finishing diet compared with traditional adaptation using multiple diets with intermediate levels of concentrate. This effect was consistent throughout the 173-d feeding period. In another experiment in the same report, yearling steers limit-fed consumed and gained less during the initial 28 d, but gains were similar when averaged over the entire 70 d finishing period. Calves and yearlings may differ in their response to limiting intake of high-concentrate adaptation diets.

Due to the design of the experiment with dietary restriction and free choice intake treatments occurring at the same time, we calculated the efficiency of converting metabolizable energy intake to gain (calculated as average daily ME intake/ADG) rather than calculating efficiency of conversion of DMI to ADG. Over the 60 d growing period, REC steers consumed the greatest ME/d ($P < 0.001$), but they tended to be least ($P = 0.06$) efficient in converting energy to gain.

Table 2. Performance of steers on four different programs for adaptation to a high-concentrate diet

	Treatment[1]				
Item	TRAD	REC	LMI	PF	$P > F^{\dagger}$
BW, lb					
Initial	624	622	626	624	0.55
d 21	675	674	670	666	0.58
d 42	730[a]	761[b]	728[a]	721[a]	0.001
d 60	772[ab]	776[a]	765[bc]	761[c]	0.055
ADG, lb/d					
d 0 – 21	2.34	2.38	1.98	1.92	0.41
d 22 – 42	2.54[a]	4.06[b]	2.78[a]	2.60[a]	0.001
d 43 – 60	2.54[b]	0.90[a]	2.18[b]	2.29[b]	0.001
d 0 – 60	2.49[bc]	2.58[c]	2.34[b]	2.29[a]	0.017
ME intake, Mcal/d					
d 0 – 21	16.18[a]	16.02[a]	16.77[a]	13.26[b]	0.003
d 22 – 42	18.41[b]	23.99[a]	18.47[b]	18.73[b]	0.001
d 43 – 60	19.01[b]	19.54[a]	18.09[b]	18.97[b]	0.002
d 0 – 60	17.67[bc]	19.75[a]	17.93[b]	16.72[c]	0.001
ME:Gain, Mcal/lb					
d 0 – 21	9.15	7.45	8.81	7.25	0.48
d 22 – 42	9.73	5.97	7.29	2.41	0.10
d 43 – 60	8.52[b]	21.50[a]	11.68[b]	8.76[b]	0.003
d 0 – 60	7.37	7.81	7.79	7.39	0.057

[1]TRAD = three adaptation diets (64, 72, and 80% concentrate; DM basis) offered ad libitum for 7-d intervals; REC = 64% concentrate diet offered ad libitum during a 28-d receiving period followed by traditional adaptation fed for 7-d intervals (72 and 80% concentrate, respectively); LMI = four adaptation diets offered such that maximum intake was restricted to 2.1, 2.3, and 2.5 times that required for maintenance during wk 1, 2, and 3, respectively; and PF = final 88% concentrate diet offered d 1.

[†]Probability of overall F test.

[a,b,c,d]Means within a row without a common superscript differ ($P < 0.05$).

Morbidity

In the reports mentioned previously, incidence of morbidity due to BRD was never reported. In the case of Bartle and Preston (1992) and Choat et al. (2002; Exp. 1), yearling cattle, that presumably are at low risk for BRD, were used. Therefore, one of our goals was to obtain cattle with a relatively high risk for BRD and use pens with adequate population numbers to provide a robust indication of the impact of various treatments on the incidence of BRD. Bovine Respiratory Disease morbidity was relatively high with 38.7% of calves being treated at least once for BRD. Total BRD morbidity was greater (P = 0.02) for TRAD and PF steers compared with REC and LMI steers (Table 3). The number of steers treated three times for BRD (chronics) was greatest (P = 0.03) for PF steers, intermediate for TRAD steers, and least for REC and LMI steers. These results are consistent with those reviewed by Rivera et al. (2005). The reasons for increased morbidity with an increased percent of dietary concentrate are not known. While the fecal pH results in the present study and metabolism data in the Choat et al. (2002) study did not detect an increased prevalence of digestive upsets, one postulate is that the higher concentrate diet results in more cases of sub-clinical ruminal acidosis that are diagnosed incorrectly as BRD. Also of interest, though not significant statistically, steers on the LMI and PF treatments initially were detected as being sick an average of 1 to 5 days earlier than TRAD and REC steers. Perhaps a decreased gastrointestinal fill of steers limited in intake altered the perception of personnel seeking visual signs of morbidity and allowed BRD events to be detected earlier.

In summary, feeding a higher roughage diet for an extended period (28 d) after arrival resulted in the greatest ADG. However, when those cattle subsequently were adapted to their high-concentrate program-fed diet, they were less efficient. A 21-d adaptation period with free access to feed or feeding the high-concentrate diet initially increased the incidence of morbidity from BRD. Therefore, extending the period during which a higher roughage diet is fed or limiting the maximum intake during the adaptation period can reduce morbidity in newly received feedlot steers.

GRAIN SOURCE AND PROCESSING DURING ADAPTATION

Few experiments have evaluated the effects of grain source or degree of processing during the adaptation period on animal performance. In the experiment of Bartle and Preston (1992), feeding whole-shelled corn resulted in 12% greater DMI, 4% greater ADG, and a 7% poorer gain efficiency compared with steers fed steam-flaked milo for the overall experiment. The observed differences in ADG and DMI occurred within the first 28 days of the experiment. Results indicate that grain source and processing may have a much greater effect on performance than the method of adaptation. Similarly, the relative ranking of performance variables remained similar across the adaptation and feeding period when grain sorghum was processed to various degrees in the experiment of Xiong et al. (1991). In their experiment, an increased degree of grain processing resulted in a decreased frequency of restricted feedings during the periods from d 0 to 7, d 8 to 14 and d 22 to 28 and during the periods from d 29 to 56 and d 57 to 84. The decrease in the frequency of restricted feeding with increased degree of grain processing was associated with a similar decrease in DMI, and suggested that net energy content was improved as flake density decreased (Xiong et al., 1991). In addition, flaking may make batches of grain more consistent and thereby decrease daily fluctuations in metabolizable energy content of the diet. These data indicate that degree of grain processing has a greater impact on feeding period performance than grain adaptation method and that more extensive grain processing may simplify diet adaptation.

Finding ways to ensure maximum feed intake while minimizing the risk of ruminal acidosis would be beneficial to the feedlot industry, due to increased performance with increased DMI. Lee et al. (1982) reported greater DMI and ADG with ratios of 75% whole-shelled corn:25% steam-flaked corn and 25% whole-shelled corn:75% steam-flaked corn compared with 100% steam-flaked corn. The authors concluded that up to 25% whole-shelled corn could substitute for steam-flaked corn without influencing animal performance. Based on the increased DMI with the addition of less processed grain, slowly adapting cattle to processed grains may help to maximize feed intake. However, more research is needed.

Table 3. Morbidity of steers on four different programs for adaptation to a high-concentrate diet.

Item	Treatment[1] TRAD	REC	LMI	PF	*P* > F†
Total Morbidity	45.94[a]	33.97[bc]	29.64[c]	43.56[ab]	0.021
Second Treatments	22.95	15.18	18.52	28.38	0.107
Third Treatments	4.48[ab]	1.45[a]	2.24[a]	7.98[bc]	0.032
Total Mortality	4.48	0.72	1.48	0.69	0.138
Case fatality rate	7.66[d]	1.52[c]	0[a]	1.39[b]	0.034
DOF to 1st Treatment	10.91	12.79	7.21	9.28	0.124

[1]TRAD = three adaptation diets (64, 72, and 80% concentrate; DM basis) offered ad libitum for 7-d intervals; REC = 64% concentrate diet offered ad libitum during a 28-d receiving period followed by traditional adaptation fed for 7-d intervals (72 and 80% concentrate, respectively); LMI = four adaptation diets offered such that maximum intake was restricted to 2.1, 2.3, and 2.5 times that required for maintenance during wk 1, 2, and 3, respectively; and PF = final 88% concentrate diet offered d 1.

†Probability of overall F test.

[a,b,c,d]Means within a row without a common superscript differ ($P < 0.05$).

SUMMARY

Multiple approaches can be used to adapt cattle to high-concentrate rations successfully. With challenges related to cost of production, feedyard size, and personnel all increasing, we likely will see more customization of feeding programs to specific individual operations. Basic nutritional knowledge, feedyard capabilities, management, and cost of doing business most likely will dictate the specifics of an individual's starting program. Establishing a high DMI early in the finishing period is important to optimize overall finishing performance and profitability. The industry will continue to struggle with starting calves and other high-risk cattle. More data are needed to better define specific interaction of nutrition/management and animal health. In addition, although differences in performance due to grain source and/or degree of grain processing appear to be greater than for adaptation method, more data are needed to clarify these effects and their interactions.

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QUESTIONS AND ANSWERS

Q: Clint, today many of the cattle entering the feedyard are backgrounded. Can backgrounded cattle be brought onto feed more rapidly?

A: I did not address previous management of cattle in my talk. Yes, certainly. It helps to understand the history of the cattle and the type of substrate fed previously, whether it was low-quality forage, high-quality forage like wheat pasture, or a limit or program fed concentrate diet in a receiving or growing program. Certainly we can move backgrounded cattle to their final diet at a faster pace because the rumen already has been primed to utilize starch and can deal with a larger concentration of starch.

Q: Clint, will you comment about preconditioning and what role preconditioning can play in adaptation at the yard?

A: Todd addressed preconditioning recently at the Alpharma Symposium. One of our greatest challenges is adapting higher risk calves to high-concentrate diets. Anything we can do in terms of a 45-day PreVac program, in which calves are trained to eat from a bunk so they know what a bunk is and will eat readily is going to be advantageous. Substrate fed during preconditioning has received little research attention. The types of feedstuffs fed during a preconditioning program are very diverse. We have defined the importance of vaccines clearly, but we have not defined how important energy supplementation and adequate protein may be during the preconditioning period and how preconditioning nutrition can influence performance not only during the first month on feed but during the entire feedlot period.

Q: Clint, for these different ration adaptation strategies that you described, is information available about the incidence of sick pulls and not just intake patterns and performance?

A: Some data are available, but effects on health have not been well characterized. In Bartle's work, the pull rate was too small for statistical analysis. Galyean wrote a review about the effect of energy level during the receiving period and how energy level can affect morbidity. As we increase concentrate level, we increase morbidity, but the cost of the increased morbidity does not outweigh the benefit from greater feed efficiency from a higher concentrate. Steve, you have as much data as anyone on animal health responses and have done a nice job of characterizing morbidity in various receiving systems.