# Nutrition and Management Programs for Newly Received Feedlot Cattle

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## Take Home Message

Newly received calves are at various risks to contract bovine respiratory disease (**BRD**). Following purchase, calves should be delivered to the feedlot as soon as possible, immediately and quietly unloaded into clean pens, and provided free-choice, high-quality grass hay and clean water. Depending on the source of calves, initial signs of BRD can occur one to fourteen days after arrival. Prior to receiving calves, regardless of risk, a veterinarian should be consulted to develop a health program that will fit the needs of cattle purchased. The health management program should include vaccinations, antibiotic treatments, dehorning and castration. This program should also include training of personnel responsible for health care of calves relative to procedures for identifying calves to be treated, proper treatment administration, proper storage and handling of drugs, and cleaning of equipment. Proper nutritional management of newly received stressed calves is key to recovery from shipping stress. Newly received, stressed calves do not have different nutrient requirements than non-stressed calves. However, some nutrients in the diet may need to be concentrated due to low feed intake during the first two to three weeks following arrival.

## Introduction

Key components of a successful receiving program include providing good nutrition through quality diets and getting calves off to a healthy start. It has become clear through ranch-to-rail experiments that after calves get sick, the economics of all subsequent segments of the beef industry are negatively affected. Several studies have compared the economics and performance of cattle that become sick and require treatment to those that remain healthy throughout the growing and finishing phase. These studies repeatedly demonstrate that if an animal gets sick, the combination of deads, medical costs, decreased performance, and reduced carcass quality result in reduced net returns that range from $25 to $150 for those calves compared to calves that remain healthy through the growing/finishing phase of production.

Opportunities exist to purchase calves of unknown background or preconditioned calves where, at a minimum, health management practices (e.g., dehorning, castration, vaccination at least 30 days before shipping calves) are standardized, known, and potentially validated. Working with calves of either type can result in successful backgrounding, stocker and feedlot programs. However, calves with unknown backgrounds, management, and potentially commingled from a number of sources will require more intensive management and typically incur more health costs when they arrive than preconditioned calves. Estimates of healthcare costs for calves of unknown background (non-preconditioned) are highly variable depending on the incidence of sickness and implemented health care protocols. An average of $35 to $50 for many operations is common. Regardless of the source, newly received calves will have been subjected to stress and limited consumption of feed and water during transport. As the length of time and number of commingling events increases between leaving the home farm or ranch and arrival, there is an increased health risk for light-weight, recently weaned calves.

A recent Oklahoma State University study (Step et al., 2008) with 509 calves indicated that calves shipped directly from a ranch to our receiving facility and maintained separately exhibited less health problems, lower health cost, and greater daily gains than calves purchased from multiple sources and commingled prior to shipment. Health costs and daily gains from commingled groups made up of freshly weaned calves shipped immediately from the ranch and market-sourced calves were not different from market-sourced calves that were not commingled. However, compared to ranch calves weaned and then immediately shipped or market-sourced calves, this study indicated that weaning calves for 45 days on the ranch before shipping resulted in less health problems and lower medicine costs when they arrived at the receiving facility whether they were maintained separately or commingled with market-sourced calves.

Whether one purchases preconditioned calves or market-sourced calves, the objectives of the receiving health and nutrition program are to assist the calf in recovering from stress, optimize the immune response, and shorten the time to begin productive weight gain. These goals can be met by a variety of health and nutritional programs. By following a well designed animal management / beef quality assurance plan, producers can optimize animal health and performance, and prevent adverse effects on carcass quality of cattle.

## Bovine Respiratory Disease (BRD)

Bovine respiratory disease causes the majority of health problems in newly received calves. Bovine respiratory disease is a multifaceted disease generally caused by a combination of stress with viral and bacterial infections. The primary stressors encountered by calves during the marketing process include feed and water deprivation, exposure to new animals and pathogens, weaning, castration/dehorning, among others (Duff and Galyean, 2007). These stressors weaken the immune system and allow infection to occur. The major viruses normally involved are infectious bovine rhinotracheitis (**IBR**); bovine viral diarrhea (**BVD**); parainfluenza-3 (**PI-3**); and/or bovine respiratory syncytial virus (**BRSV**). The virus further weakens the immune defenses and allows secondary infection by bacteria to occur. Bacteria most commonly isolated from lungs are *Mannheimia* (formerly *Pasteurella*) *haemolytica*, *Pasteurella multocida*, and *Histophilus somni* (formerly *Haemophilus somnus*). Bovine viral diarrhea virus has been isolated alone or in combination with other viral and bacterial pathogens in animals diagnosed with BRD. Cattle persistently infected (**PI**) with BVDV have been reported as the main source of disease transmission in feedlot settings (O'Connor et al., 2005), and the presence of an animal PI with BVDV in a feedlot pen has been reported to increase the risk of antimicrobial treatment for BRD by 43% compared with non-exposed cattle (Loneragan et al., 2005).

Early signs of BRD are slight depression and going off feed. Calves suffering from BRD may stand away from the main group with a lowered head, drooping ears, and half closed eyes. Their nose may be rough and dry with nasal discharge and light coughing possibly observed. Once a calf has been determined to require closer attention, rectal temperature is commonly used as an objective indicator of health problems. A rectal temperature of 40.0°C is commonly used to indicate sickness, but temperatures can be highly variable. As a rule of thumb, calves should be worked quietly in groups that can be processed in less than 30 minutes and the rectal temperature should be taken when each calf first enters the chute.

Calves that are sick on arrival can spread common respiratory viruses and bacteria to home raised calves by direct contact, exhaled aerosols, or feed and water contaminated by nasal or oral discharges. Consequently, when purchased calves are to be combined with home raised calves, it is important to ensure that purchased calves are healthy and that the disease resistance of home raised calves is maximized before commingling them. Increased resilience of calves can be created by vaccinating, weaning, branding, dehorning, and castrating calves (i.e., preconditioning calves) at least 30 days before introduction of outside calves.

## Management at Arrival

The best management practices for a load of calves will vary depending on factors such as season of year calves are purchased, calf genetics, length of time in the marketing/transport process, previous management/vaccination, among others (Duff and Galyean, 2007). Cattle purchased directly from a ranch generally have fewer health problems (Step et al., 2008). In general, the longer an animal is in the marketing chain, the more health problems will potentially be encountered. Calves that have spent several days in the marketing channel may develop clinical disease before or very soon after arrival at the feedlot; whereas, cattle with less time in the marketing chain may get sick later (2 to 3 weeks), simply due to the length of time it takes for the BRD to develop.

On or before arrival, calves should be given a risk score (High, Medium, Low) that relates to the quantity of stress they have encountered and the probability they will develop BRD. High risk calves normally will have been recently weaned, have received no vaccinations, have not been castrated or dehorned, have been commingled with other calves, and have moved through at least one auction barn. Low risk calves in general will come from a single source ranch and will have gone through a preconditioning program that may include vaccination, castration, dehorning, weaning, and adaptation to feed bunks. Of course, these risk categories will not always hold true. Many groups of auction market cattle have few health problems and some groups of preconditioned calves have high incidence of BRD. Therefore, the feedlot operator must be willing and able to make changes in management in order to meet the needs of the individual loads of cattle.

In general, calves should be processed within 12 to 24 hours after arrival. Calves that arrive in the afternoon may need to rest overnight in a dry holding area with fresh water and good quality hay. However, treatment of calves that arrive sick should not be delayed. Low-stress handling techniques should be adhered to, including no use of electric cattle prods. In most cases the vaccination history of calves is not known, and, unless the history is known, it is best to assume calves were not vaccinated prior to arrival. At arrival, calves should be vaccinated against infectious bovine herpes virus-1, bovine viral diarrhea virus (types I and II), bovine parainfluenza-3, and bovine respiratory syncytial virus (5-way viral) and clostridial pathogens (7- or 8-way clostridial), dewormed, any horns tipped, and bulls castrated. A number of vaccines are also available for *Mannheimia haemolytica*, *Pasteurella multocida*, and *Histophilus somni*. Vaccine types available include bacterins, toxoids, live suspensions, killed/inactivated, intranasal modified-live, injectable modified-live, and antisera/ antitoxins. The best type is dependent upon calf stress level and other factors, and a veterinarian should be consulted. Factors such as stress, underlying illness, or depressed immune systems can result in inadequate response to vaccine.

Based on the 1997 U.S. National Animal Health Monitoring System, 25.5% of the cow/calf operations do not castrate their bull calves before selling their calf crop. In addition, up to 60% of the male calves that arrive at auction markets are not castrated (Cole and McCollum, 2007). Bretschneider (2005) suggested that weight gain during the month after castration was about 10 kg less in calves castrated at 8 months of age than in calves castrated at birth, or 4.5 kg less than calves castrated at 4 months of age. Therefore, the earlier the calf is castrated, the less the effect on weaning weight. Lents et al. (2006) reported that intact bulls did not have greater weaning weights than bull calves banded at birth, or bull calves banded at 2 to 3 months of age and implanted with zeranol. Therefore, early castration and use of estrogenic implants appear to counteract the negative effects of castration on weight gain.

Data suggests that BRD affects steers and bulls more than heifers (Snowder et al., 2006). During the initial feedlot period, intact bulls and steers (castrated before arrival) typically perform better and experience lower morbidity and mortality than bulls castrated upon arrival (Bretschneider, 2005; Massey et al., 2011). Duff and Galyean (2007) reported that bulls castrated upon arrival have a 92% greater chance of requiring antibiotic treatment than their steer counter parts. Penchak et al. (2004) reported that sick calves returned $11 to $67 less than healthy calves grazed on native range in north central Texas. They also noted that morbid steers had performance similar to healthy bulls that were castrated upon arrival. Thirty three percent of steers were treated for BRD; whereas, 67% of bulls castrated upon arrival were treated for BRD. On average, over a 153 day grazing period, bull calves (mean starting weight = 215 kg) castrated on arrival returned $37.91 less than steers of similar weight. This difference ($7.98/45.4 kg) is greater than typical discounts for bulls at Arkansas and Oklahoma auction markets ($4 to 5/45.4 kg; Gadberry and Troxel, 2006; Troxel et al., 2006; Ward et al., 2006).

Dehorning can have significant negative effects on animal performance. However, tipping horns is normally acceptable and causes little negative effect on animal weight gain if bleeding is limited (Bartle and Preston, 1990). On average, castrating and dehorning calves 30 days before sale will result in about a 3% decrease in sale weight. However, for each month earlier the procedures are done, the loss in sale weight will decrease by about 0.5% (i.e., if done 3 months before sale the weight loss will be about 2%: Cole 1992, 1996; Cole and McCollum, 2007). Calves that are castrated and dehorned upon arrival at a feedyard normally have 30% more sickness and death loss, 3% poorer weight gain, and lower quality grade compared with polled steers (Cole and McCollum, 2007).

The use of an effective dewormer should be an essential part of the processing program. Many excellent anthelmintics are available. Pour-on's have the advantage of one less injection given to the animal. However, in many parts of the Southeast liver flukes are a concern. Therefore a flukicide may also need to be included in the processing program. Although bloody diarrhea may not be evident, many calves that pass through auction markets have evidence of coccidia in their feces. Therefore, a coccidiostat should be given during processing and/or be included in the starter supplement or ration. As summarized by Cole and McCollum (2007), results from Kansas and Texas studies suggest feeding a coccidiostat to stressed calves will decrease morbidity rates by 7 to 40%, decrease death loss 10 to 40% and increase weight gains during the receiving period by as much as 17%.

Hormonal implants are approved for use in cattle of all ages and may be used to enhance growth during the suckling, growing, and finishing phases of production. Steers and heifers destined for finishing and harvest should be implanted within 21 days of arrival unless they are destined for a specialty market such as a "natural" or "organic" beef program. On average, implanting will increase weight gain of stocker calves by 6 to 20% (Highfill et al., 1997). A number of excellent implants are available. Because aggressive implanting may decrease marbling score due to inadequate energy intake early in the feeding period, delaying implanting until newly received cattle are "on feed" may decrease the negative effects of the implant on quality grade (Bruns et al., 2005).

## Mass Medication (Metaphylaxis) on Arrival

When the risk for BRD in a load of calves is high, or expected to be high, it may be more feasible (economically or because of labor concerns) to mass-treat all calves with an antibiotic (called metaphylaxis) to reduce subsequent disease and/or performance problems. Duff et al. (2000) demonstrated that pre-shipment medication programs given at the sale barn are not more effective than arrival medication programs. However, the effectiveness of metaphylaxis is in part dependent upon the stage of infection. In general, mass medication of high-risk cattle is beneficial in decreasing the incidence and severity of BRD. For example, Galyean et al. (1995) noted that when wheat pasture calves were mass treated with tilmicosin (Micotil, Elanco Animal Health) upon arrival, the incidence of BRD was decreased from 33 to 12%; however average daily gain (**ADG**) was not affected. Treatment of calves based on their off-truck rectal temperature reduced antibiotic costs and gave similar improvements in the incidence of BRD to mass medicating all the calves. Daniels et al. (2000) demonstrated that calves receiving a metaphylactic antimicrobial treatment for BRD had greater ADG than those that did not during the first 21 days after arrival. In addition, Booker et al. (2007) observed that calves receiving tulathromycin (Draxxin, Pfizer Animal Health) on arrival had improved ADG compared to calves receiving other metaphylactic antimicrobials. The improvements observed in performance are often attributed to improved calf health. A rule of thumb is that if more than 40% of calves will be ultimately treated for BRD, mass medication may be economically beneficial (Cole and McCollum, 2007). Other factors, such as labor and facilities, will also affect the decision to mass medicate (Cole and McCollum, 2007).

If antibiotics are fed during the receiving period, they should be fed at therapeutic levels. In general, feeding antibiotics appears to be more beneficial when morbidity rates are low and less beneficial when morbidity rates are high. This is likely because sick or highly stressed calves do not consume enough of the antibiotic- fortified-diet to obtain a therapeutic dose of the antibiotic (Cole and McCollum, 2007).

## Receiving Calf Nutrition

The effects of BRD on performance of feedlot cattle has been investigated by several groups, both in regard to the effects during the disease process and the effects of disease on subsequent performance and carcass characteristics. Feed intake by lightweight stressed calves averages only 1.5% of BW during the first 2 weeks after arrival to a feeding facility (Hutcheson and Cole, 1986; Galyean and Hubbert, 1995). In a summary of 18 experiments involving transit-stressed calves, only

83.4% of morbid calves and 94.6% of healthy calves had consumed any feed by day 7 following arrival to the feedlot (Hutcheson and Cole, 1986). In addition, measured dry matter intake (**DMI**) of morbid calves was 58, 68, and 88% of healthy calves across days 1 to 7, 1 to 14, and 1 to 56, respectively. Similarly, Sowell et al. (1999) recorded the frequency and timing of visits made to the feed bunk by newly received calves during receiving and growing periods. In one experiment, 94% of calves identified as healthy and 87% of morbid calves visited the feedbunk on the day of arrival, but 100% of healthy calves and only 91% of morbid calves had visited the bunk by day 3 (Exp. 1). However, in a second experiment, only 13 and 10% of healthy and morbid calves, respectively, visited the feedbunk on day 1 (Exp. 2). Again, all healthy calves had visited the bunk by day 4, but only 76% of morbid calves were observed at the feedbunk. In both trials, healthy calves had more overall feeding events per day and spent more time at the bunk daily than morbid animals, both during the first 4 days and throughout the 32-day experiment. In Exp. 1, 52% of calves were identified as morbid, and 82% were classified as morbid in Exp. 2. In both experiments, a similar 80% of morbid calves were identified within 10 days of arrival.

Jim et al. (1993) sorted calves by elevated rectal temperature, classifying them as sick or healthy. Sick calves were required to have an elevated rectal temperature (≥ 40.5°C) both 48 and 72 h after processing. Dry matter intake could not be measured during the first 48 h after processing because all animals were commingled from processing on day -3 to day 0, when sick animals were determined and pens were allocated. During days -3 to 0, sick animals lost 0.5 kg/d, while healthy calves gained 1.53 kg/d. However, during the next 27 days, sick animals gained 11% more than healthy animals while eating 0.3 kg/d less DM. Overall, day 0 to slaughter ADG and DMI were not different between sick and healthy calves, but the ratio of DMI:ADG (i.e., feed efficiency; **F:G**) was 3.15% lower for animals identified as sick upon arrival. However, when DMI and F:G were extrapolated from processing to day 0, no differences were observed. The improvement in efficiency likely resulted from shrink occurring in the sick animals between processing and allocation when they were likely not consuming feed. The subsequent compensatory response in early gain and efficiency was most likely due to regaining lost gut fill. An additional 6.6 and 4.7% morbidity was observed in sick and healthy calves, respectively, after allocation (Jim et al., 1993). Therefore, the differences in finishing DMI and efficiency could be biased by the timing of subsequent morbidity.

It is apparent that newly received, highly stressed calves consume less feed than healthy calves exposed to fewer stress factors. As such, current recommendations are for nutritionists to increase the density of nutrients in diets of stressed calves so that animal requirements for nutrients are met even when intake is low (NRC, 2000). It is unclear, in commercial settings, whether disease causes decreased intake, or decreased intake is responsible for disease incidence. After recovery, DMI may remain low or be similar compared to non-treated animals. However, there is evidence that, upon recovery, morbid animals experience compensatory gain compared to non-treated animals. This compensation may be due to recovering gastrointestinal fill or reduced competition for nutrients when cattle are moved from preconditioning pens to pasture (Montgomery et al., 2009) or are adapted to a finishing diet (McBeth et al., 2001). McBeth et al. (2001) segregated heifers by the number of BRD treatments (0 or 1) administered during a 42-day preconditioning period and observed subsequent finishing performance. At the beginning of the finishing phase, no difference in BW between healthy and morbid steers existed. However, ADG was increased 14.4 and 5.8% for treated heifers during day 0 to 28 and day 0 to 112, respectively. While DMI was not different at any time during the 140-day finishing period, the increase in ADG made treated heifers more efficient during the first 28 days on feed. A recent experiment by Holland et al. (2010) showed that receiving-phase and overall (arrival to end) ADG were 59 and 8.7% lower, respectively, for heifers treated 3 times for BRD compared with heifers that remained healthy throughout the feeding period. After the low growing phase gain by morbid animals, a compensatory response was noticed in those animals, such that overall finishing-phase ADG was similar across BRD treatment categories, and F:G was improved. Therefore, segregation according to previous number of BRD treatments during finishing may result in a compensatory response in ADG and improved F:G for treated animals. Although increased days on feed may be required to reach similar final BW and carcass characteristics, a 're-start' program may be a viable alternative to 'realizing' or 'railing' animals treated multiple times for BRD.

Duff and Galyean (2007) concluded that, with the possible exception of potassium, the stressors of weaning, marketing, transport, and disease do not appear to increase total nutrient requirements of calves. However, because of low feed intakes (Table 1), the concentrations of nutrients in the diet need to be increased to meet the nutrient requirements of the animals (Table 2).

**Table 1. Dry matter intake of newly arrived calves transported from Tennessee to Texas (% of body weight).[1]**

| Days after arrival | Healthy calves | Sick calves |
|---|---|---|
| 0 to 7 | 1.6 | 0.9 |
| 8 to 14 | 1.9 | 1.4 |
| 15 to 28 | 2.7 | 1.8 |
| 28 to 56 | 3.0 | 2.7 |

[1]Hutcheson and Cole, 1986.

**Table 2. Recommended nutrient concentrations in receiving diets for stocker calves (DM basis).[1]**

| Nutrient | Concentration | Comment(s) |
|---|---|---|
| Dry matter, % | 80 - 94 | Limit high moisture feeds |
| NEm, mcal/cwt | 50 - 72 | Lower values for calves |
| NEg, mcal/cwt | 25 - 41 | Lower values for calves |
| TDN, % | 50 - 72 | |
| Crude protein, % | 13.5 - 15.0 | Limit urea to < 30 g/d |
| Calcium, % | 0.6 - 0.8 | |
| Phosphorus, % | 0.4 - 0.5 | |
| Potassium, % | 1.2 - 1.4 | Avoid high Cl levels |
| Sodium, % | 0.2 - 0.3 | Check water |
| Magnesium, % | 0.2 - 0.3 | |
| Sulfur, % | 0.15 - 0.25 | Check water |
| Manganese, ppm | 40 - 70 | |
| Cobalt, ppm | 0.1 - 0.2 | |
| Copper, ppm | 10 - 15 | Higher if high S or Mo |
| Iron, ppm | 100 - 200 | |
| Zinc, ppm | 75 - 100 | |
| Selenium, ppm | 0.1 - 0.2 | |
| Vitamin A, IU/lb | 2,000 - 3,000 | 2 X if pelleted |
| Vitamin E, IU/lb | 35 - 60 | 2 X if pelleted |

[1]Cole, 1992, 1996; NRC, 2000.

## Energy

Feedlot studies suggest that the incidence of BRD in market-transport stressed calves is increased when the diet contains more than 60% concentrate. In most receiving diets, it is unlikely that the energy concentration of the diet will be excessive. In contrast, it is possible that an energy deficit could occur due to poor forage quality and/or an inadequate supply of forage. Lofgreen (1983, 1988) reported that calves fed low-quality hay diets upon arrival were not able to compensate for their lost early weight gain later in the feeding period.

California researchers conducted a series of experiments with market-stressed calves to determine optimal dietary energy concentrations of receiving diets (Lofgreen et al., 1975). In Exp. 1, diets with concentrations of 0.84, 1.01, and 1.10 Mcal/kg of $NE_g$ (DM basis) were fed for 29 days followed by all treatment groups being fed the intermediate diet an additional 34 days. Calves on the intermediate- and high-energy dietary treatments consumed more feed and gained more weight during the 29-day receiving period with the high-energy treatment group gaining more than the intermediate-energy treatment group. Calves on the high-energy and low-energy diets had lower morbidity rates than calves on the intermediate energy treatment; however, calves receiving the high-energy diet had higher medical treatment costs due to extra days morbid. All treatment groups had the highest morbidity during the first week of the receiving period. Given the outcome of this study, the researchers replaced the 0.84 Mcal/kg of $NE_g$ diet with a 1.19 Mcal/kg $NE_g$ diet to determine if gain would increase further with increased dietary energy concentration. Intake actually decreased when the higher energy diet was added and ADG was not increased. Unlike the previous study, calves on the 1.10 Mcal/kg of $NE_g$ diet consumed more feed than calves on the 1.01 Mcal/kg of $NE_g$ diet. Morbidity tended to increase with increasing energy concentration.

Fluharty and Loerch (1996) fed corn silage-based diets with 1.15, 1.21, 1.25, or 1.30 Mcal/kg of $NE_g$ to individually housed steers in a 28-day receiving study. There was a linear increase in DMI with increasing dietary energy concentration but there was no difference in ADG, feed efficiency, or health status for the 28-day period. Similarly, DMI was improved and ADG was not different between high energy (1.17 Mcal/kg $NE_g$) and low energy (1.01 Mcal/kg $NE_g$) in a 28-day preconditioning study conducted by South Dakota researchers (Pritchard and Mendez, 1990). Unlike other studies, however, cattle on the low energy diet had a superior feed/gain.

## Protein Concentration and Source

Dietary protein requirements for beef cattle can be calculated using the NRC (1984) factorial equations or the NRC (1996) metabolizable protein system. These systems are both integrated with body weight (BW) and energy intake. Energy intake seems to be the first-limiting factor involved with weight gain; therefore, protein deposited in gain is largely dependent on energy intake (Galyean et al., 1996). Since newly received stressed calves often have very low intakes during the first few days, protein requirements might be low. Requirements would then increase as energy intake increases.

Effects of various protein levels and sources for newly received calves have been characterized. Galyean et al. (1993) fed three levels (12, 14, or 16%) of supplemental CP from soybean meal to 120 calves (185 kg) in a 42-day receiving trial. Daily gain increased and DMI tended to increase linearly with increasing CP concentration. Morbidity was higher for calves fed the high-protein diet compared with the 14% CP diet. Ohio researchers (Fluharty and Loerch, 1995) conducted a series of experiments to access protein requirements of newly arrived cattle. In Exp. 1, newly weaned Simmental x Angus crossbred (243 kg) steers were fed increasing CP concentrations (12, 14, 16, or 18%) from two sources; spray-dried blood meal or soybean meal. Feed efficiency improved linearly with increasing CP concentration for the first 7 d and for the entire 42-d feeding period. Daily gain increased linearly with increasing CP concentration during the first week after arrival. For the entire receiving period, calves fed the blood meal diets had a 7.4% increase in gain compared with calves fed the soybean meal diets. Similar to data reported by Galyean et al. (1993), morbidity also increased linearly with increasing CP concentration. A second experiment was conducted in which 246-kg Simmental x Angus steers were fed 11, 14, 17, 20, 23, or 26% CP diets with protein supplied by spray-dried blood meal or soybean meal. In this experiment DMI was not affected by CP concentration. Daily gain and feed efficiency both responded quadratically, with the 20% CP diet yielding superior performance. There were no differences in health status between treatment groups.

In a summary of several experiments, Galyean et al. (1999) noted that as the protein concentration in receiving diets increased up to approximately 20% of DM, animal performance improved, but the incidence of BRD increased. Cole (1992, 1996) reported that a CP concentration of approximately 14.5% is probably optimal for freshly received feeder calves.

A study at South Dakota State (Pritchard and Boggs, 2006) indicated that dried distiller's grains could effectively replace soybean meal as a protein supplement for incoming feedlot cattle. However, morbidity rates in their study were very low (< 3%), so the effects of feeding corn byproducts in heavily stressed calves is not known. Van Koevering et al. (1991) reported that replacing soybean meal with dried distiller's grains in a receiving supplement decreased performance but did not affect the incidence or severity of BRD.

In general, young calves have a limited capacity to use dietary urea. Cole and McCollum (2007) suggested urea should be limited to less than 30 g/animal daily during the receiving period. The use of ingredients high in ruminally undegraded intake protein (**UIP**) has been beneficial in some studies with calves on forage-based diets. However, it appears that UIP concentrations of 5.4% of dietary DM are generally adequate for stressed calves (Cole and McCollum, 2007).

## Minerals

Because of low feed intakes, the concentrations of most minerals need to be increased in receiving diets. However, with the possible exception of K, the actual mineral requirements (i.e., grams/day) of stressed calves do not appear to be increased (Galyean et al., 1999).

Copper, zinc, and selenium have been shown to be essential for optimal immune function. Although a number of studies have reported a beneficial effect of supplemental Cu, Se, and Zn on some indicators of immune function, data has been inconsistent, and few studies have demonstrated a positive effect on animal health or performance when the control diet was not deficient in these minerals. In general, beneficial effects of supplementing these trace minerals on immunity or the incidence of BRD in beef calves would most likely occur in animals with marginal or deficient mineral status. Because the mineral status of calves is rarely known, it is probably advantageous to supplement with these minerals, especially because most forages are marginal or deficient in at least one of these minerals or contain elevated concentrations of antagonists, such as Mo and S.

However, feeding excessive quantities of the trace minerals may not be helpful and is potentially harmful. A good rule of thumb is to provide 50% or more of mineral requirements in the daily supplement (Cole and McCollum, 2007) .

Although some studies have reported improved immune responses when calves were supplemented with organic forms of Cu, Zn, Se or Mn (proteinates, amino acid complexes, etc.) other studies have reported no effect (Galyean et al., 1999; Duff and Galyean, 2007).

## Vitamins

A number of studies with feedlot diets suggest that feeding vitamin E in excess of requirements may be beneficial to animal health. In general, results have been better when vitamin E was fed than when it was injected (Cole, 1992, 1996). In a summary of results of cattle feedlot receiving studies, Elam (2006b) noted that as vitamin E supplementation increased from 0 to 2,000 IU/d, BRD decreased 0.35% for every 100 IU increase in vitamin E intake. Results with supplementation of other fat soluble and B vitamins have been inconsistent (Cole, 1996).

## Detecting Sick Calves

Currently in feedlots, pen riders look at cattle and pull calves they believe to be sick based on subjective criteria (Galyean et al, 1999). Signs, such as lack of attention, rapid breathing, reluctance to move or altered gait, and lots of all nasal discharge can be early indicators of BRD (Deyhle, 1996). The next stages of respiratory illness can result in loss of "gut fill," lowered ears, and low head carriage with nasal discharge. Cattle that had previously recovered from BRD, exhibit symptoms much more quickly, because of possible prior lung damage, and must be pulled earlier than cattle who had never been sick before. All these symptoms are very subtle and require skilled personnel to make decisions on which cattle should be treated. In several experiments (Wittum et al., 1996a, Gardner et al., 1999), more animals had lung lesions at slaughter than the number treated for BRD, and there were individuals who had never been treated but had lung lesions present at slaughter.

Detecting sick calves early in the disease process is critical because delayed treatment of calves with BRD can result in increased death loss and an increased percentage of chronically ill animals. Calves should be checked early in the morning (and again in the evening if they are high risk cattle); especially before the heat of the day. The feed bunk is a useful tool to detect sick animals. Calves that are slow in coming to the bunk, or fail to come to the bunk, should be closely observed. A lack of appetite is one sign of sickness that often appears before a fever develops. On high-fiber diets, sick calves also may not ruminate. Other signs of BRD include dull eyes, droopy ears, depression, diarrhea, runny nose, dry nose, cough (especially a deep rasp) and runny eyes.

One of the most useful tools in detecting and fighting BRD is the rectal thermometer. However, rectal temperatures can be affected by factors other than fever caused by disease. Therefore, good judgment must also be used. The normal rectal temperature for cattle is between 38.3 and 39.0°C. However, during the heat of the day, the temperature of healthy calves can run as high as 40.5°C. Generally a temperature, taken in the morning before calves are warmed by solar radiation, greater than 39.5 (winter) to 40.0°C (summer) is considered febrile. However, environmental conditions can affect body temperature of calves. Cole (1992; 1996) noted that during hot weather, or as calves waited in an alley to be processed, average rectal temperatures increased approximately -17.5°C per hour; whereas, during cool weather with rain events rectal temperatures could decrease approximately -17.5°C per hour (Cole, 1992, 1996). Galyean et al. (1995) noted that during moderate weather (15 to 21°C) the average rectal temperature of calves increased from 39.3 to 40.0°C in approximately 1.5 hours. During cooler weather (8°C), temperature did not increase with time of processing. Therefore, common sense, good management and observation must be combined with the rectal temperature measurements for detecting sick calves (Cole and McCollum, 2007).

## Bovine Respiratory Disease and Carcass Quality

Many of the existing beef alliances require verification of some type of prior health or preconditioning program for feeder calves before they begin the finishing phase of production. With the demand for higher quality products, the increase in value-based marketing, and the increase in vertical coordination systems, both cow-calf producers and feedlot operators have become more in-tune to health management practices that have the potential to increase overall profitability. The health status of calves upon arrival to the feedyard has been shown to impact the efficiency of cattle in the feedyard, and also to affect the quality attributes of the cattle at slaughter. McNeill (1994, 1995, 1996, 1997, 1998) and Montgomery et al. (1984) documented that morbid cattle during the finishing phase of production had carcasses with a lower degree of marbling and subsequently lower USDA Quality Grades. Therefore, although the medical costs attributable to the treatment of BRD are substantial (Martin et al., 1982; Perino, 1992), the economic impact of BRD on animal performance, carcass merit, and meat quality are likely even more devastating.

Morbidity rates account for approximately eight percent of all production costs without consideration of losses due to decreased performance (Griffen et al., 1995). McNeill et al. (1996) reported that "healthy" steers had greater daily gains and 12% more U.S. Choice carcasses than cattle identified as "sick" at some point during the finishing period. Gardner et al. (1999) showed that steers with lung lesions plus active lymph nodes had $73.78 less net return, of which 21% was due to medicine costs and 79% due to lower carcass weight (8.4% less) and lower quality grade (24.7% more U.S. Standards). This negative impact on carcass traits 200 days after receiving the cattle illustrates the importance of preventing BRD.

## Conclusions

Proper nutritional management of newly received stressed calves is key to recovery from the marketing process. However, due to low initial intakes, nutrient deficiencies are difficult to meet and may limit the recovery process. More nutrient-dense diets should be formulated to aid calves in recovery, although it may take several days to return stressed calves to positive energy and protein balances. Current research conflicts as to the effects of energy and protein concentrations in diets on health parameters of newly received calves. Research in the area of increased requirements of calves facing immune challenges could prove beneficial in formulating nutritional management plans for stressed calves.

## References


Bartle, S.J., and R.L. Preston. 1990. Effects of horn tipping on the gain of feedlot steers. Texas Tech Univ. Agric. Sci. Tech Rept. T-5-283:25.

Booker, C.W., S.M. Abutarbush, O.C. Schunicht, G.K. Jim, T. Perrett, B.K. Wildman, P.T. Guichon, T.J. Pittman, C. Jones, and C.M. Pollock. 2007. Evaluation of the efficacy of tulathromycin as a metaphylactic antimicrobial in feedlot calves. Vet. Therap. 8:183-200.

Bretschneider, G. 2005. Effects of age and method of castration on performance and stress response of beef male cattle: A review. Livestock Prod Sci. 97:89-100.

Bruns, K.W., R.H. Pritchard, and D.L. Boggs. 2005. The effect of stage of growth and implant exposure on performance and carcass composition in steers. J. Anim. Sci. 83:108-116.

Cole, N.A. 1992. Receiving nutrition and management for feedlots. Proc. XXV American Association of Bovine Practitioners Conference. St. Paul, MN Aug 31-Sept 4, 1992. Vol. 2: 309-314.

Cole, N.A. 1996. Review of bovine respiratory disease: Nutrition and disease interactions. Bovine Respiratory Disease: Sourcebook for the Veterinary Professional. Pg 57-74. Schering-Plough Animal Health.

Cole, N.A., and F.T. McCollum. 2007. Receiving Nutrition: Getting Calves Started Right. pg 8-35. Proceedings Mid-South Stocker Conf.

Daniels, T.K., J.G.P. Bowman, B.F. Sowell, M.E. Branine, and M.E. Hubbert. 2000. Effects of metaphylactic antibiotics on behavior of feedlot calves. Prof. Anim. Sci. 16:247-253.

Deyhle, C.E. 1996. Processing, handling, pen riding, pulling sick cattle, and sampling procedures. In: R.C. Albin and G.B. Thompson (eds.). Cattle Feeding: A Guide to Management (2nd Ed.). pp 182-189. Trafting Printing. Amarillo, TX.

Duff, G.C., D.A. Walker, K.J. Malcolm-Callis, M.W. Wiseman, and D.M. Hallford. 2000. Effects of preshipping vs. arrival medication with tilmicosin phosphate and feeding chlortetracycline on health and performance of newly received beef calves. J. Anim. Sci. 78:267-274.

Duff, G.C., and M.L. Galyean. 2007. Invited Review: Recent advances in management of highly stressed, newly received feedlot cattle. J. Anim. Sci. 85:823-840.

Elam, N.A. 2006a. Effects of long- or short-term exposure to a calf identified as persistently infected with Bovine Viral Diarrhea Virus on the performance of freshly weaned, stressed, receiving beef heifers. Clayton Livestock Res. Ctr. Prog. Rept. No. 109. NM Agri. Exp. Stn., Las Cruces.

Elam, N.A. 2006b. Impact of vitamin E supplementation on newly received calves. Proc. Colorado Nutr. Roundtable, Colorado State Univ., Ft. Collins.

Fluharty, F.L., and S.C. Loerch. 1995. Effects of protein concentration and protein source on performance of newly arrived feedlot steers. J. Anim. Sci. 73:1585-1594.

Fluharty, F.L. and S.C. Loerch. 1996. Effects of dietary energy source and level on performance of newly arrived feedlot calves. J. Anim. Sci. 74:504-513.

Gadberry, M.S., and T.R. Troxel. 2006. Nine-year summary of the Arkansas steer feedout program: Factors contributing to value and return. Prof. Anim. Sci. 22:454-462.

Galyean, M.L., S.A. Gunter, and K.J. Malcolm-Callis. 1995. Effect of arrival medication with Tilmicosin phosphate on health and performance of newly received beef cattle. J. Anim. Sci. 73:1219-1226.

Galyean, M.L., and M.E. Hubbert. 1995. Effects of season, health, and management on feed intake by beef cattle. In: Symposium: Intake by Feedlot Cattle. Okla. Agric. Exp. Sta. P-942. pp 226-234. Oklahoma State Univ., Stillwater.

Galyean, M.L. 1996. Protein levels in beef cattle finishing diets: Industry application, university research, and systems results. J. Anim. Sci. 74:2860-2870.

Galyean, M.L., L.J. Perino, and G.C. Duff. 1999. Interaction of cattle health/immunity and nutrition. J. Anim. Sci. 77:1120-1134.

Gardner, B.A., H.G. Dolezal, L.K. Bryant, F.N. Owens, and R.A. Smith. 1999. Health of finishing steers: effects on performance, carcass traits, and meat tenderness. J. Anim. Sci. 77:3168-3175.

Griffin, D., L. Perino, and T. Whittum. 1995. Feedlot respiratory disease: Cost, value of preventives and intervention. Proceedings, Annual Convention - Am. Assoc. of Bovine Prac., Vol. 27, San Antonio, TX. Am. Assoc. Bovine Prac., Rome, GA.

Highfill, G.A., D.R. Gill and D.L. Lalman. 1997. Gains of wheat pasture stocker heifers implanted with Ralgro, Synovex-H or Revalor-G. 1997 OSU Research Report. http://www.ansi.okstate.edu/research/1997rr/022.htm. Accessed December 5, 2006.

Holland, B.P., L.O. Burciaga-Robles, J.N. Shook, D.L. VanOverbeke, D.L. Step, C.J. Richards, and C.R. Krehbiel. 2010. Effects of clinical bovine respiratory disease during preconditioning on subsequent feedlot growth performance, carcass characteristics, and meat quality of heifers. J. Anim. Sci. 88:2486-2499.

Hutcheson, D.P., and N.A. Cole. 1986. Management of transit-stress syndrome in cattle: Nutritional and environmental effects. J. Anim. Sci. 62:555-560.

Jim, G.K, C.W. Booker, C.S. Ribble, P.T. Guichon, and B.E. Thorlakson. 1993. A field investigation of the economic impact of respiratory disease in feedlot cattle. Can. Vet. J. 34:668-1993.

Lents, C.A., F.J. White, L.N. Floyd, D.L. Gay, and R.P. Wettemann. 2006. Effects of method and timing of castration and the use of an estrogenic growth stimulant on weight gain of bull calves. Prof. Anim. Sci. 22:126-131.

Lofgreen, G.P., J.R. Dunbar, D.G. Addis, and J.G. Clark. 1975. Energy level in starting rations for calves subjected to marketing and shipping stress. J. Anim. Sci. 41:1256-1265.

Lofgreen, G.P. 1983. Nutrition and management of stressed beef calves. Pages 87-101 in Veterinary Clinics of North America: Large Animal Practice. Vol. 5, No. 1, March 1983. W. B. Saunders, Philadelphia, PA.

Lofgreen, G.P. 1988. Nutrition and management of stressed beef calves: An update. Pages 509-522 in Veterinary Clinics of North America: Food Animal Practice. Vol. 4, No. 3, November 1988. W.B. Saunders, Philadelphia, PA.

Loneragan, G.H., D.U. Thomson, D.L. Montgomery, G.L. Mason, and R.L. Larson. 2005. Prevalence, outcome, and health consequences associated with persistent infection with bovine viral diarrhea virus in feedlot cattle. J. Amer. Vet. Med. Assoc. 226:595-601.

Massey, C., K.C. Dhuyvetter, R.V. Llewelyn, and D.A. Blasi. 2011. Castration and morbidity and their effects on performance, carcass quality, and price differentials for bulls and steers. The Professional Animal Scientist. 27:19-28.

McBeth, L.J., D.R. Gill, C.R. Krehbiel, R.L. Ball, S.S. Swaneck, W.T. Choat, and C.E. Markham. 2001. Effect of health status during the receiving period on subsequent feedlot performance and carcass characteristics. Okla. Agric. Exp. Sta. Res. Rep. P-986:30.

Martin, S.W., A.H. Meek, D.G. Davis, J.A. Johnson, and R.A. Curtis. 1982. Factors associated with mortality and treatment costs in feedlot calves: The Bruce County beef project, years 1978, 1979, 1980. Can. J. Comp. Med. 46:341-349.

McNeill, J.W. 1994. 1993-94 Texas A & M Ranch to Rail North/South Summary Report. Texas Agricultural Extension Service, Texas A & M University. College Station, TX.

McNeill, J.W. 1995. 1994-95 Texas A & M Ranch to Rail North/South Summary Report. Texas Agricultural Extension Service, Texas A & M University. College Station, TX.

McNeill, J.W. 1996. 1995-96 Texas A & M Ranch to Rail North/South Summary Report. Texas Agricultural Extension Service, Texas A & M University. College Station, TX.

McNeill, J.W., J.C. Paschal, M.S. McNeill, and W.W. Morgan. 1996. Effect of morbidity on performance and profitability of feedlot steers. J. Anim. Sci. 74(Suppl. 1):135.

McNeill, J.W. 1997. 1996-97 Texas A & M Ranch to Rail North/South Summary Report. Texas Agricultural Extension Service, Texas A & M University. College Station, TX.

McNeill, J.W. 1998. 1997-98 Texas A & M Ranch to Rail North/South Summary Report. Texas Agricultural Extension Service, Texas A & M University. College Station, TX.

Montgomery, T.H., R. Adams, M.A. Cole, D.P. Hutcheson, and J.B. McLaren. 1984. Influence of feeder calf management and bovine respiratory disease on carcass traits of beef steers. Proceedings: Western Section, J. Anim. Sci. 35:319-327.

Montgomery, S.P., J.J. Sindt, M.A. Greenquist, W.F. Miller, J.N. Pike, E.R. Loe, M.J. Sulpizio, and J.S. Drouillard. 2009. Plasma metabolites of receiving heifers and the relationship between apparent bovine respiratory disease, body weight gain, and carcass characteristics. J. Anim. Sci. 87:328-333.

NRC. 1984. Nutrient Requirements of Beef Cattle 6th Revised Ed. National Academy Press. Washington, DC.

NRC. 2000. Nutrient Requirements of Beef Cattle 7th Revised Ed. National Academy Press. Washington, DC.

O'Conner, A.M., S.D. Sorden, and M.D. Apley. 2005. Association between the existence of calves persistently infected with bovine viral diarrhea virus and commingling on pen morbidity in feedlot cattle. Am. J. Vet. Res. 66:2130-2134.

Penchak, W.E., D.R. Tolleson, M. McCloy, L.J. Hunt, R.J. Gill, R.J. Ansley, and S.J. Bevers. 2004. Morbidity effects on productivity and profitability of stocker cattle grazing in the Southern Plains. J. Anim. Sci. 82:2773-2779.

Perino, L.J. 1992. Overview of the bovine respiratory disease complex. Compend. Cont. Educ. Pract. Vet. 14(Suppl.):3.

Pritchard, R. H., and D. L. Boggs. 2006. Use of DDGS as the primary source of supplemental crude protein in calf receiving diets. 2006 South Dakota Beef Report. pg 6-9.

Pritchard, R.H. and J.K. Mendez. 1990. Effects of preconditioning on pre- and post-shipment performance of feeder calves. J. Anim. Sci. 68:28-34.

Snowder, G.D., L.D. Van Vleck, L.V. Cundiff, and G.L. Bennett. 2006. Bovine respiratory disease in feedlot cat tle: Environmental, genetic, and economic factors. J. Anim Sci. 84: 1999-2008.

Sowell, B.F., M.E. Branine, J.G.P. Bowman, M.E. Hubbert, H.E. Sherwood, and W. Quimby. 1999. Feeding and watering behavior of healthy and morbid steers in a commercial feedlot. J. Anim. Sci. 77:1105-1112.

Step, D.L., C.R. Krehbiel, H.A. DePra, J.J. Cranston, R.W. Fulton, J.G. Kirkpatrick, D.R. Gill, M.E. Payton, M.A. Montelongo, and A.W. Confer. 2008. Effects of commingling beef calves from different sources and weaning protocols during a forty-two-day receiving period on performance and bovine respiratory disease. J. Anim. Sci. 86:3146-3158.

Troxel, T.R., B.L. Barham, S. Cline, J. Foley, D. Hardgrave, R. Wiedower, and W. Wiedower. 2006. Management factors affecting selling prices of Arkansas beef calves. J. Anim. Sci. 84 (Suppl. 1): 12-13 (Abstr.).

U.S. National Animal Health Monitoring System: Beef Cow-Calf production management and disease control. Available at: http://www.aphis.usda.gov/vs/ceah/ncahs/nahms/beefcowcalf/beef97/bf97wean.pdf. Accessed on February 21, 2006.

USDA-APHIS. 2001. National Animal Health Monitoring System. Info Sheet - Veterinary Services. Treatment of respiratory disease in U.S. feedlots. Available: http://www.aphis.usda.gov/vs/ceah/nahms/feedlot/feedlot99/FD99treatresp.pdf. Accessed December 5, 2006.

Van Koevering, M.T., D.R. Gill, and F.N. Owens. 1991. The effects of escape protein on health and performance of shipping stressed calves. Oklahoma State Univ. Anim. Sci. Res. Rept. MP-134:156-162.

Ward, C.E., C.D. Ratcliff, and D.L. Lalman. 2006. Buyer preferences for feeder calf traits. Oklahoma Cooperative Extension Service Fact Sheet F-602 (Accessable at http://www.osuextra.com).

Whitney, T.R., G.C. Duff, J.K. Collins, D.W. Schafer, and D.M. Hallford. 2006. Effects of diet for early-weaned crossbred beef steers on metabolic profiles and febrile response to an infectious bovine herpesvirus-1 challenge. Livestock Sci. 101:1-9.

Wittum, T.E., N.E. Woollen, L.J. Perino, and E.T. Littledike. 1996. Relationships among treatment for respiratory tract disease, pulmonary lesions evident at slaughter, and rate of weight gain in feedlot cattle. J. Am. Vet. Med. Assoc. 209(4):814-818.

# Notes