Receiving Nutrition: Getting Calves Started Right[1]

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ABSTRACT: Morbidity and mortality from bovine respiratory disease (BRD) in freshly received feeder cattle continues to be the most significant health problem faced by the U.S. beef cattle industry. Medicine costs, death losses, and associated losses in animal performance and carcass quality continue to be a major economic challenge for the cattle industry. A number of different viruses and bacteria are associated with this disease complex; however, Mannheimia (formerly Pasteurella) haemolytica seems to be the major cause of the disease. In general, most healthy animals are able to defend against these organisms until a period of stress, such as marketing and transport, weakens the immune system. Although higher morbidity and mortality is normally associated with "long haul" cattle, even those transported a short distance can become susceptible to BRD. The objectives of the receiving 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 nutritional programs ranging from small supplement packages to complete diets. By following a well designed animal management / beef quality assurance plan the producer can optimize animal performance, avoid illegal drug residues, and prevent adverse effects on the safety and quality of beef from his cattle.

Introduction

Stocker or backgrounding operations are management systems designed to graze recently weaned calves or yearlings on pastures for a period of time before they are placed in the feedyard for finishing. Because so many environmental and other factors can affect the stocker or backgrounding operation, the successful management of a stocker program can be very complex. Health management can be critical because, in general, most calves entering the stocker program are recently weaned, young in age, and have been commingled with calves from many other sources. Also many have received no preweaning vaccination and have not been castrated or dehorned. After arrival at the stocker operation these calves must overcome the numerous stressors to which they were exposed, establish a new pecking order, and adjust to a new diet and new surroundings.

Bovine respiratory disease (**BRD**: shipping fever) is the major health problem encountered by calves and yearlings upon arrival at stocker or feeding operations. Proper

[1] Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.

management and nutrition during the first few weeks after arrival (i.e., the receiving period) can assist calves in getting started right, reduce the incidence and severity of BRD, and improve animal overall performance during the stocker program.

The objectives of the receiving program are to 1) reduce the stress level of the calves, 2) minimize the potential for metabolic disorders, 3) permit the calves to overcome stress and disease challenges, 4) provide nutrients in adequate amounts and 5) start the calf performing as well as possible.

Factors Causing BRD

Bovine respiratory disease is a multifaceted syndrome generally caused by a combination of stress, viral infection(s), and bacterial infection(s). The primary stressors encountered by calves or yearlings during the marketing process included feed and water deprivation, exposure to new animals and pathogens, weaning, antagonistic encounters, castrations/dehorning, and others. These stressors weaken the immune system and allow infection (routinely a virus) 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 lung defenses and allows secondary infection by bacterium. The bacteria most commonly isolated are Mannheimia (formerly Pasteurella) haemolytica, Pasteurella multocida, and Histophilus somni (formerly Haemophilus somnus).

Arrival Management

The "best" management for a load of calves will vary depending upon factors such as season, calf genetics, length of time in the marketing/transport system, previous management/vaccination, etc. Many stocker operators prefer to purchase calves with a good vaccination background but with limited access to medium- or high-concentrate preconditioning diets. Cattle purchased directly from a ranch tend to be more uniform in weight and age and to have fewer health problems. In general, the longer an animal is in the marketing chain, the more health problems will be encountered. Calves that have spent several days in the marketing channel may develop clinical disease before, or very soon after arrival at the stocker operation or feedlot; whereas, cattle with less time in the marketing chain may break later (2 to 3 weeks), simply due to the length of time it takes for the respiratory infection to develop.

In order to determine best management practices, stocker calves should be given a risk score upon arrival (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 and have moved through at least one auction barn. Low risk calves in general will come from a single source and will have gone through a value added / preconditioning program that may include vaccination, castration, dehorning, and possibly weaning and adaptation to feed bunks. However, these scenarios will not always be correct. Many groups of sale barn cattle have few health problems and some groups of preconditioned calves have a high incidence of BRD.

Therefore, the stocker operator must be willing and able to make changes in management in order to meet the needs of the individual loads of stocker cattle.

The operator should also consider a number of other management points before purchasing stocker calves. Is their sufficient forage? Do I have the labor necessary to handle the calves if I have severe health problems? Do I have facilities adequate to process, handle, and feed them?

Arrival Processing

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 are sick should not be postponed. Working facilities should be designed for easy movement of cattle. Avoid darkened areas and 90° corners. The working alley should be designed so that each calf can see the calf ahead of him and should have solid sides so that calves will not notice outside distractions. The alley should be wide enough for one calf to pass through, but narrow enough so they cannot turn around. Using "V" shaped sides greatly helps in this respect and also increases the versatility of the facility. With properly designed facilities, the use of electric prods can be greatly decreased and the safety of both cattle and workers is improved. When giving injections or conducting surgery, the animal should be adequately restrained in order to prevent injuries to the animal and to workers.

Ideally, a separate hospital area should be available to house sick calves. The purpose of a hospital area is primarily to give sick animals a greater chance to recover without having to compete with healthy animals. It is best to locate the hospital pen(s) close to the working area. For best results, at least one pen should be available for newly treated calves and another for calves that relapse.

Vaccination

In most cases the vaccination history of calves is not known. Except when the pre-arrival vaccination history is definitely known, it is generally best to assume the calf has received no vaccinations at the farm of origin. Stocker calves are routinely vaccinated with a 7- or 8- way clostridial vaccine (Blackleg, et al.) and a viral respiratory disease vaccine (IBR, BVD, PI-3, and/or BRSV). A number of vaccines are also available for Mannheimia haemolytica, Pasteurella multocida, and Histophilus somni. A number of different vaccine types are available including bacterins, toxoids, live suspensions, killed/inactivated, intranasal modified-live, injectable modified-live, and antisera/antitoxins. The best type is dependant upon calf stress level and other factors. Always remember that no vaccine is 100% effective at preventing disease. However, most vaccine failures are caused by not following the directions on the label. For example, modified live virus vaccines must be kept out of sunlight, and must be used within 1 to 2 hours of mixing. Factors such as stress, underlying illness, or depressed immune systems can also result in inadequate response to a vaccine. In keeping with beef quality assurance directives, try to select a vaccine with a low dose that is given subcutaneously. Consult your veterinarian to develop a vaccination program for your stocker calves.

Some good rules of thumb to follow with all injections are as follows:

1) Both subcutaneous (**Sub-Q**) and intramuscular (**IM**) injections should be given in front of the shoulder or in the neck and never in areas that produce the more valuable cuts of beef such as the loin, round, or rump. Use the "tent" method when giving Sub-Q injections.

2) Always use the correct size needle: normally 1 to 1.5 inch for IM injections and shorter than 1 inch for Sub-Q injections.

3) Needles should be changed after every 5 to 10 animals or whenever they become dull or bent.

4) Do not attempt to straighten a bent needle; it is more likely to break.

5) Use only one clean needle in each bottle of vaccine, etc.

6) Give all injections of a specific drug or vaccine in the same location on all animals.

7) Multiuse syringes should be cleaned between uses. However avoid using soap or disinfectant in syringes designated for modified-live vaccines. Residual antiseptic can potentially deactivate modified-live vaccines.

8) Always dispose of needles safely. Used needles should be placed in well labeled plastic containers and, before disposal, should be sterilized, filled with cement or plaster, and capped.

Castration and Dehorning

Up to 60% of the "steer" calves that arrive at sale barns are not castrated. The least stressful time to castrate calves is near birth. However, few cow-calf producers follow that practice. Most calves are not castrated, either because of the inconvenience, or because the producer is afraid of loosing performance and having a lower weaning/sale weight. Bretschneider (2005) suggested that weight gain during the month after castration was about 22 lb less in calves castrated at 8 months of age than in calves castrated at birth or 10 lb less than calves castrated at 4 months of age. Thus, the earlier the calf is castrated, the less the effect on weaning weight. A recent study (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. Thus, early castration and(or) use of estrogenic implants can counteract the negative effects of castration on weight gain.

Unfortunately, bull calves that must be castrated upon arrival at the stocker operation will have more health problems and poorer performance than steers. Daniels et al. (2000) reported that bull calves requiring castration upon arrival have as much as 92% greater incidence of BRD and average daily gains (**ADG**) as much as 1.2 lb/d less than calves received as steers.

Penchak et al. (2004) reported that sick calves returned $11 to $67 less than healthy calves stockered 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 = 475 lb) castrated upon arrival returned $37.91 less than steers of similar weight. This difference ($7.98/cwt.) is somewhat greater than typical discounts for bulls at Arkansas and Oklahoma livestock auctions ($ 4 to 5/cwt: Table 1) (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 be decrease by about 0.5% (i.e. if done 3 months before sale the weight loss will be about 2%: Cole 1992, 1996). 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.

Table 1. Factors affecting the sale price of feeder calves in Oklahoma (Ward et al., 2006)

Factor	Discount ($ / cwt)
Polled/dehorned	Base
Horned	- 1.56
Bulls	- 4.76
Steers	Base
Heifers	-8.60
Thin condition	1.36
Medium condition	Base
Fat condition	- 1.78
Large frame	1.68
Medium frame	Base
Small frame	- 3.50
Heavy muscle	0.52
Moderate muscle	Base
Thin muscle	- 6.20

Implants

Unless calves are destined for a specialty market such as a "natural" or "organic" beef program, implanting is normally a money maker. 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. Normally, because of limited performance, in a stocker program an estrogen or estrogen + testosterone implant is adequate and an estrogen + trenbolone acetate (**TBA**) combination will not give improved performance compare to an estrogen-only implant (Highfill et al., 1997).

Dewormers, etc.

Most calves that arrive at feedlots have worm burdens; even those dewormed at the farm/ranch of origin. 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. In many parts of the Southeast liver flukes are a concern. Therefore, a flukicide may also need to be included in the processing program. Consult your veterinarian for the best product(s) to use.

Although bloody diarrhea may not be evident; many calves that pass through sale barns 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. Results in 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%.

Detecting Sick calves

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 chronics. Calves should be checked early in the morning (and again later in the day if they are high risk cattle); especially before the heat of the day. Feeding a diet or supplement in feed bunks is a usefully tool to detect sick animals. Put feed bunks along fence lines rather than in the middle of pens so that calves will easily find them when walking the fence. Calves that are slow in coming to the bunk, or fail to come to the bunk, may be sick. 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 dry honking sound) and runny eyes.

One of the most useful tools in detecting and fighting BRD is a good 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 101 and 102°F, but during the heat of the day, the temperature of healthy calves can run as high as 105°F. Generally a temperature, taken in the morning before calves are warmed by solar radiation, greater than 103.5 (winter) to 104°F (summer) is considered febrile. However, a sliding scale may be required to detect sick calves. We noted that during hot weather, or as calves waited in an alley to be processed, average rectal temperatures increased about 0.5°F per hour; whereas, during cool weather with rain events rectal temperatures could decrease about 0.5°F per hour (Cole, 1992, 1996). Galyean et al. (1995) noted that during moderate weather (59 to 70°F) the average rectal temperature of calves increased from 102.8 to 104.1°F in approximately 1.5 hours. During cooler weather (46°F), temperature did not increase with time of processing. The fescue endophyte affects the calves' body temperature regulating mechanisms; therefore, calves from fescue pastures often run higher than normal temperatures. Thus, good management and observation must be combined with the rectal temperature measurements in detecting sick calves. The temperature of calves soon after arrival (< 12 hours) may be an indicator of future health problems (Figure 1) and may be useful in determining the risk category (High, Medium or Low) of a load of calves.

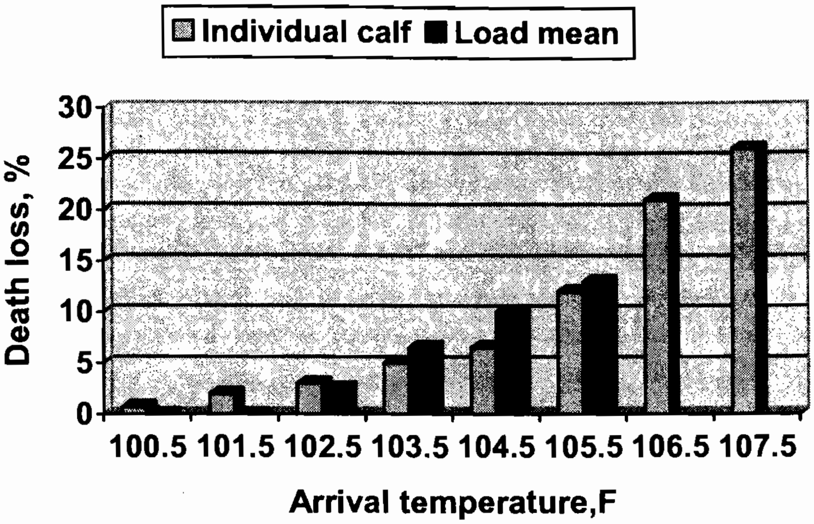

Figure 1. The relationship between arrival rectal temperature of individual calves (3,600) or truck load (33) means and subsequent death loss (Cole, 1992,1996).

Treating sick calves / Mass Medication

A number of excellent antibiotics for treatment of BRD are currently on the market. Careful use of these drugs is required to prevent tissue residues and to avoid development of antibiotic resistance. Preventative medication programs using prescription antibiotics should only be used under the supervision of a licensed veterinarian. Stocker operators should work with their veterinarian to develop a standardized treatment regimen for calves with BRD or diarrhea: the two most common health problems upon arrival. This plan should specify the antibiotics to be used, the order of their use, dosages, injection sites, and record keeping procedures. ALL calves treated with antibiotics should be individually identified to assure that proper withdrawal times are met (Table 2).

When the incidence of BRD is high, or expected to be high, it may be more feasible (economically or because of labor concerns) to mass-treat all calves with antibiotics to reduce subsequent disease and/or performance problems. Preshipment medication programs given at the sale barn do not appear to be more effective than arrival medication programs (Duff et al., 2000). However, the effectiveness of these programs 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) upon arrival, the incidence of BRD was decreased from 33 to 12%; however ADG was not affected. Treatment of calves based on their off-truck rectal temperature, rather than with mass-medication, reduced antibiotic costs but gave similar improvements in the incidence of BRD.

The actual point at which mass medication becomes economical is not clear. In general, today's available antibiotics cost about $12 (USDA-APHIS, 2001) per treatment (good for 2-4 days), excluding labor costs. If sick calves are worth $39 less than healthy calves (Penchak et al., 2004), then the cost of mass medicating 100 calves is similar to the dollars lost if 30% of calves become sick. This assumes mass medication completely prevents BRD, which it normally does not do. However, a rule of thumb may be that if more then 40% of calves will be ultimately treated for BRD, mass medication may be economically beneficial. Of course, other factors such as labor and facilities will affect the decision to mass medicate.

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

Table 2. Withdrawal times for a number of injectable antibiotics when used in beef cattle: Read labels for up to date information on dosages and withdrawal times.

Antibiotic	Recommended dosage, mL/100 lb body weight	Minimum required withdrawal time, days	Route of administration	Manufacturer
EXCEDE (ceftiofur)	1.5 (3 mg ceftiofur/lb)	13	SubQ in ear or base of ear	Pfizer
BAYTRIL 100 (enrofloxacin)	3.4 to 5.7 (3.4 to 5.7 mg/lb)	28	SubQ	Bayer
NUFLOR (florfenicol)	3 (IM) or 6 (Sub-Q)	28 to 38	IM or Sub-Q in neck	Schering-Plough
DRAXXIN (tulathromycin)	1.1 (2.5 mg tulathromycin /kg body weight)	18	SubQ in neck	Pfizer
A180 (danofloxacin mesylate)	1.5 (6 mg danofloxacin/kg body weight then repeat 2 days later	4	SubQ	Pfizer
Micotil 300 (tilmicosin)	1.5 (10 mg/kg body weight)	28	SubQ	Elanco
Naxcel (ceftiofur)	1-2 (0.5 to 1 mg ceftiofur/lb body weight)	4	IM	Pfizer
Tetracycline	Varies	Check label	Various	numerous
Penicillin, etc	Varies	Check label	Various	numerous
Erythromycin	Varies	21	IM	numerous
Neomycin	Varies	Check label	ORAL ONLY	several

Withdrawal times / Individual ID

In order to avoid antibiotic or other drug residues, proper withdrawal times for drugs, feed additives, and vaccines must be observed (Table 2). Therefore, it is critically necessary to individually identify every animal that is treated with antibiotics. If drugs are given in excess of the manufacturer's recommended dose (i.e. extra label use; which can only legally be done on the advice of your veterinarian) necessary withdrawal times will increase. Also animals that are sick or stressed (i.e. chronics, etc.) may have slower metabolism of injected drugs, and thus, may require a longer withdrawal period before the drug is removed from the system. Check labels carefully, because most parasiticides and vaccines, as well as fed antibiotics, also have withdrawal times.

All operators should keep good records of injections given, including individual animal ID, product name, site and quantity of injection, etc. In order to diagnose possible problems later, injections for each product/vaccine should be given in the same designated site on every animal. Then, if a problem occurs later (abscesses, etc.), the product given can be determined. In that way, the producer can use real data, rather than speculation, to make future management decisions. Animals that have not reached their appropriate withdrawal times should not be sold because of the chance they could end up in the food chain.

Temperament

Recent research suggests animal temperament may affect animal performance (Voisinet et al., 1997) and response to vaccination (Oliphint, 2006; Oliphint et al., 2006). Select calves (and cows) with good temperament. This is also good for animal and worker safety and for equipment as well.

Non-antibiotic treatments

Although research results have been quite variable, direct-fed microbials may improve animal performance and health (McDonald et al., 2005). The response may be greater in calves that have been treated for BRD (McDonald et al., 2005) than in healthy calves. However, as with any feed additive, if the calf does not eat because of stress or disease; the nutrient/pharmaceutical will not be consumed in adequate quantities to provide a benefit.

PI-BVD

A small number of calves are apparently exposed to BVD *in utero* and become persistently infected with BVD (**PI**). Although the number is small (0.3 to 0.4%), these calves have a very high morbidity and mortality rate when moved to the feedlot. Although the effect of a PI on the health and performance of calves within the same pen is not clear (Loneragan et al., 2005; O'Connor et al., 2005; Elam, 2006a); it seems that calves grouped with a PI calf will have higher morbidity and mortality rates. Some feedyards now test cattle upon arrival so that PI calves can be removed from the pen. In large commercial feedyards the number of PIs may be sufficient to assign one or more pens just to PIs. However, due to the low prevalence, that is difficult for smaller operations; thus the problem becomes what to do with PIs. Obviously, it is probably unethical to put known PI calves back into the marketing chain. Consult your veterinarian concerning testing for and managing PI calves.

Monitoring shrink.

It is generally believed that as shrink increases, the incidence of BRD will increase. This is not always true. In general animal shrink is a combination of gut fill and tissue loss, even in calves transported very short distances (Cole 1992, 1996). Calves can obviously shrink too much but they can also shrink too little (Figure 2). Calves that were initially shrunk before arriving at the sale barn, because of poor management or diet will have less shrink than normal, but may be highly susceptible to disease. When using shrink to evaluate potential health problems, shrink should be compared to a normal or expected shrink for cattle from that source. If shrink is more, or less, than the expected shrink, then the incidence of BRD may increase. For example, we noted that calves transported 24 hours from eastern Tennessee to the Texas Panhandle routinely shrink 6 to 9%. However, some individual calves shrank less than 1% and some shrank more than 15%. Morbidity and mortality increased whenever shrink was outside the 6 to 9% range (Figure 2). Bartle and Preston (1989) calculated that calves shrink about 3.3% during loading and unloading, and shrink an additional 0.46% for each 100 miles transported; which is very similar to the values we saw. Factors such as weighing times and conditions will affect the calculated shrink.

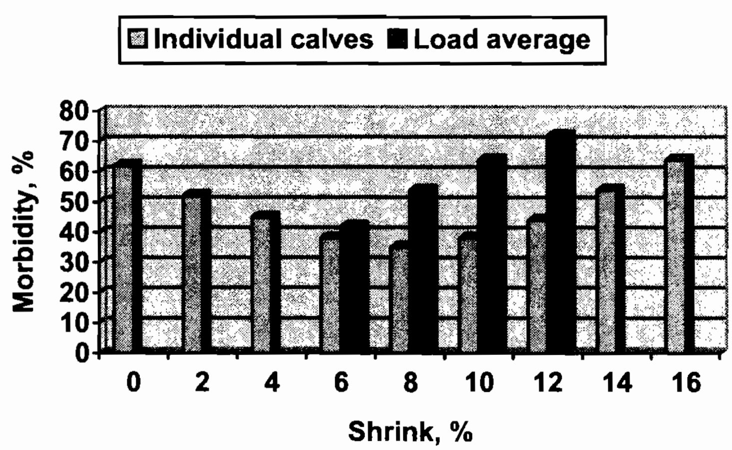

Figure 2. Relationship of shrink to morbidity of feeder calves (3,600 head, 33 loads) shipped from eastern Tennessee to Texas with an average time of 24 hours.

Receiving Nutrition

The vast majority of studies on proper nutrition of marketing-transport stressed calves have been conducted with feeder calves arriving at feedyards: little data is actually available with stocker calves. However, with the possible exception of energy requirements, it appears that nutritional factors that apply to feeder calves also apply to stocker calves. During the first 2 to 3 weeks after arrival it is best to feed stocker calves in confinement; providing at least 10 inches of bunk space per head. This makes it much easier to detect sick calves and pull them for treatment. In general, calves will adapt more rapidly if fed a diet that is familiar to them. In all situations, the diet should be made as palatable as possible.

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 3) the concentrations of nutrients in the diet need to be increased to meet the nutrient requirements of the animals (Table 4).

Table 3. Dry matter intake of newly arrived calves transported from Tennessee to Texas (% of body weight: Hutcheson and Cole, 1986)

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

Table 4. Recommended nutrient concentrations in receiving diets for stocker calves (DM basis: Cole, 1992, 1996; NRC, 2000)

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

Protein concentration and source

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. Our individual studies suggest a CP concentration of approximately 14.5% is probably optimal for freshly received feeder calves (Cole 1992, 1996). Similarly, stocker receiving studies in Oklahoma suggested that the optimal protein supplementation program for 400 + lb stocker calves was approximately 2 lb (= 0.5% of body weight) of a 40% CP, soybean meal-based supplement daily along with good quality grass hay. Whitney et al (2006) fed bermudagrass hay (6.7% CP) alone, or with 0.175% or 0.35% of body weight as supplemental soybean meal for an 84-day backgrounding period. When supplemental protein was provided, ADG and dry matter intake (**DMI**) increased; but performance was not different for the 0.175 and 0.35% groups.

Young calves appear to prefer soybean meal over cottonseed meal. A recent 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 milling byproducts in heavily stressed calves is not know. Van Koevering et al (1992) 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. Our studies suggest urea should be limited to less than 30g/head 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, for optimal benefit these ingredients need to have high protein quality as well: a trait many of the corn milling byproducts do not have. Most feed ingredients with both high protein quality and high UIP, such as meat and bone meal or blood meal, can not be fed to ruminants due to feed restrictions related to bovine spongiform encephalopathy (**BSE**). The high cost of high UIP ingredients such as fish meal often make it more economical to feed higher levels of moderately degradable protein sources such as soybean meal. It appears that UIP concentrations of 5.4% of dietary DM are adequate for stressed calves.

Energy intake / supplementation

Feedlot studies suggest that the incidence of BRD in market-transport stressed calves is increased when the diet contains more than 60% concentrate. In a stocker operation, it is unlikely that the energy concentration of the diet will be excessive. However, 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 poor early performance later in the feeding period, and thus were sold at significantly lighter weights.

When forage quality is poor or there is insufficient forage, stocker calves should be supplemented; especially during the receiving period. The type and quantity of supplementation will be determined by the quantity and quality of forage available. For example, if adequate forage is available, but it is of low quality, protein should be supplemented. In contrast, if the quantity of forage is limited, additional energy will need to be provided. This can be provided as grain, a low protein supplement, or via highly digestible fiber by-products (see later discussion).

Minerals

Because of low feed intakes, the concentrations of most minerals need to be increased in receiving diets (Table 4). With the possible exception of K, the actual mineral requirements (i.e. grams/day) of stressed calves do not appear to be increased.

Copper, zinc, and selenium have been shown to be essential for optimal immune function. Although a number of studies reported a beneficial effect of supplemental Cu, Se, and Zn on some indicators of immune function, the 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. Although the fescue endophyte has been shown to affect copper status, supplementation with Cu in excess of requirements does not appear to overcome this deficiency. In general, beneficial effects of supplementing these trace minerals on immunity or the incidence of respiratory disease 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 usually 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 (Table 5). However, feeding excessive quantities of the trace minerals may not be helpful and is potentially harmful. A summary of the Texas A&M Ranch-to-Rail project reported that calves from ranches that did not provide a complete mineral supplement tended to have higher sickness rates (% pulls) than calves from ranches that provided a complete mineral supplement to cows and calves. Studies with rats indicate that feeding trace mineral deficient diets to females during gestation can result in impaired immune response in their pups that lasts for 2 generations or more. It is not known if a similar response may occur in beef cattle; nonetheless proper amounts of these minerals should be provided during the receiving period; especially in areas with know mineral deficiencies. A good rule of thumb is to provide 50% or more of mineral requirements in the daily supplement.

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 noted no effect (Galyean et al., 1999; Duff and Galyean, 2007).

Vitamins

Vitamin A plays an important role in immune function and a deficiency can result in an increased severity of infection. In the absence of a vitamin A deficiency it is unlikely that supplement vitamin A will improve animal performance or health. Calves coming off good green pastures will normally not be deficient in vitamin A. However, because the vitamin A status of received calves and of forage is usually not known, sufficient vitamin A should be provided in the receiving diet / supplement to meet animal requirements.

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 (Table 6: 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/day, BRD decreased 0.35% for every 100 IU increase in vitamin E intake.

Results with supplementation of B vitamins have been inconsistent (Cole, 1996).

Table 5. Mineral status of forages from 18 states (Corah & Dargatz, 1996)

Forage & season	Cu	Mn	Zn	Co	Se
Considered deficient, ppm	<4	< 20	< 20	< 0.1	< 0.1
Considered marginal, ppm	4 – 7	20 - 40	20 - 40	--	0.1 – 0.15
Alfalfa					
Mean ± SE	7.4 ± 0.28	51.0 ± 3.4	19.1 ± 0.8	0.26 ± 0.02	0.32 ± 0.05
% Marginal	48	30	38	19	24
% Deficient	6	7	62	49	17
Bermudagrass					
Mean	8.5 ± 0.6	125 ± 16	22.4 ± 1.6	0.22	0.20 ± 0.07
% Marginal	39	3	47	14	18
% Deficient	6	6	50	42	64
Fescue					
Mean	6.2 ± 0.4	122.3 ± 17	17.8 ± 1.5	0.22 ± 0.01	0.06 ± 0.01
% Marginal	50	0	19	8	4
% Deficient	15	0	81	46	96
Sudan grass					
Mean	7.5 ± 1.3	57.1 ± 6	24.4 ± 4.4	0.33 ± 0.03	0.22 ± 0.02
% Marginal	63	26	37	7	7
% Deficient	15	0	56	63	22

Table 6. Influence of vitamin supplementation on feeder calf health and performance (summarized by Cole, 1992, 1996)

Vitamin(s)	Method of administration	Change with supplementation		
		% BRD	ADG	Gain/Feed
A & D	Inject	-3.0	+ 4.1	-1.1
A, D, & B12	Inject	+ 3.0	+1.6	+2.4
Thiamine (1g/hd)	Fed	-17.0	+2.0	--
B complex	Fed	-3.0	+4.2	+5.2
E (400 IU/d)	Fed	-2.6	+5.2	+5.0
E +B complex	Fed	-0.5	+10.9	+10.9
E (1600 IU/d)	Fed	-11.7	+22.2	+28.5
E, 2000 IU	Injected	0	0	+7.6

Water

The dietary cation-anion balance (**DCAB**) is a measure of dietary acidity based on the ratio of positively charged cations (Na, K, Mg, Ca) to negatively charged anions (Cl, sulfate, phosphate). Diets with low or negative DCAB can have adverse effects on animal performance. In many locations forages/diets may appear adequate; however, water sources may contain high concentration of Na, Cl, and/or S that affect overall cation-anion balance. Tentative data at our location (Wayne Greene, unpublished data) suggests this can have a negative carry-over effect in the feedlot, especially if calves are switched to a relatively high-concentrate diet. Thus, water sources should be checked to be sure they are not high in sulfates, phosphates, nitrates, or other minerals.

Table 7. Nutrient requirements of medium frame steer calves gaining 0.5 to 2.0 lb / day

Weight, lb	Daily gain, lb	Crude protein, lbs	TDN, lbs
300	0.5	0.75	4.2
	1.0	0.95	4.9
	1.5	1.14	5.5
	2.0	1.32	6.0
400	0.5	0.87	5.2
	1.0	1.06	6.1
	1.5	1.24	6.8
	2.0	1.41	7.4
500	0.5	0.98	6.2
	1.0	1.20	7.2
	1.5	1.30	8.1
	2.0	1.50	8.8
600	0.5	1.10	7.2
	1.0	1.30	8.2
	1.5	1.40	9.3
	2.0	1.60	10.1

Feeding Programs for Receiving Stocker Calves

The type and quantity of supplement provided to stocker calves during the receiving period can vary depending upon the quantity and quality of forage available, weight and genetics of the cattle, expected performance (Table 7) and other factors. In general, for stocker calves to make economical gains, good quality forage is required. It normally is 2 to 3 weeks after arrival before healthy calves are consuming enough feed to gain appreciable weight (except for replacement of gut fill), unless the feed has a relatively high concentration of nutrients. Therefore, well fortified mixed diets or supplements are most appropriate early in the receiving/weaning period. The nutritional program should also consider the management experience of the operator, labor availability, and facility limitations. Based on these parameters, many operations will have limited options and compromises may have to be made between ideal nutritional /management programs and feasibility. Fortunately, there are no "magic bullets," therefore, a number of options are available. These range from small supplement packages formulated to be fed with hay or pasture, to complete rations designed for high rates of gain.

The diet and management of very young calves (< 300 lb) should differ from older calves or yearlings that arrive at the stocker operation. In very young calves the protein and energy requirements, as a percent of diet dry matter, are relatively high and the rumen may not yet function at optimal capacity. Because of these factors, roughage alone will not meet nutrient requirements or allow for adequate weight gain. Therefore, a complete ration should be fed during the first 2 weeks or until cattle are "straightened out." Two example diets for light-weight calves, proposed by the Univ. of Arkansas and Texas Cooperative Extension Service (TCE), are presented in Table 8. These diets have been shown to be very palatable to young calves that are not familiar with dry feed. To avoid the loss of dietary "scratch factor" it is best to only pellet that portion of the diet that contains the soybean meal, minerals, and additives; then mix that with the remaining ingredients. If the entire diet is pelleted, the animal should have access to 2 to 3 lbs of long stem good quality hay each day. Young calves seem to prefer soybean meal over cottonseed meal; this also decreases the risk of gossypol toxicity. This is less a problem for heavier calves (> 400 lbs) and yearlings. Soybean hulls, good quality coarsely-chopped grass hay or other roughages can be substituted for portions of the alfalfa and cottonseed hulls after adjustments are made for differences in protein content and form. With light-weight calves, consumption of this diet should be 3 to 3.5% of body weight within 4 or 5 days and calves should gain 2 pounds per day. To avoid acidosis, this diet should not be fed to heavy calves or yearlings without a step-up program.

Typical stocker calves and yearlings weighting 400 to 600 lbs will normally recognize and consume hay. However, hay alone will usually not meet all nutrient requirements or allow for optimal weight gain. Therefore, especially during the receiving period, a well designed supplement should be provided along with clean, good quality hay. Normally the supplement should provide both energy and protein and well as needed minerals, vitamins and additives. However, starch levels should be kept relatively low in the supplement to prevent negative associative effects that result in decreased forage intake and(or) digestion, and to avoid acidosis. The University of Arkansas recommended that the supplement contain 25% all natural protein and be fed at a rate of 2 to 4 lbs/day (Table 9). Such a supplement should be pelleted to a diameter of less than ½ inch or less.

Oklahoma State University recommends feeding a 40% CP, soybean meal-based pellet at 0.5% of body weight along with good quality hay (Table 8) during the first 2 to 3 weeks after arrival. However, a low- protein high-energy supplement may be fed with lush winter annuals such as wheat pasture (Table 8).

Table 8. One possible ration for receiving very light-weight calves (Arkansas) and possible supplements for receiving heavier calves and yearlings or for early weaning (% in ration, as fed).

Ingredient/ nutrient	Light weight (< 300 lb) calves only (U Ark.)	High protein supplement (OSU)	Low protein supplement (OSU) [a]	Low protein (TCE)
Cottonseed hulls	14.7	1.75	0	29.5
Alfalfa pellets	15.1	0	0	0
Rolled corn	46.0	0	85.0	46.6
Molasses	4.7	0	0	4.1
Soybean meal	17.7	90.8	13	17.8
Limestone	1.0	1.5	0	1.2
Dicalcium phosphate	0.5	2.75	1.0	0.5
Salt	0.3	3.0	1.0	0.3
Vitamin A, IU/lb	2,500	3,300	1,080	2,000
Vitamin E,IU/lb	30 to 50	150-300	50	50
Trace minerals	As needed to meet requirements below			
Coccidiostat	As per nutritionists or veterinarians preference			
Nutrient (DM basis, except DM)				
Dry matter, %	88	92	89	89
NEm, Mcal/100lb	82	75	97	74.5
NEg, Mcal/100 lb	50	49	67	46.5
TDN, %	74	70	86	71
CP, %	13.7	41.0	14.5	14.2
DIP,%	8.6	23.4	7.0	7.2
Potassium, %	1.2	1.54	0.80	0.85
Calcium, %	0.95	1.28	0.41	0.73
Phosphorus, %	0.45	1.63	0.65	0.50
Copper, ppm	10-15	50 % of requirement		10-15
Selenium, ppm	0.1-0.2	50 % of requirement		0.1+
Zinc, ppm	75-100	50 % of requirement		50-60
Feeding level	Ad libitum, but only to light weight calves	0.5 % of body weight	1.5% of body weight	Ad libitum

[a] Lasalocid included at 50 mg/lb of supplement

Table 9. Specifications for a 25% protein supplement for receiving heavy weight calves or yearlings recommended by Univ. of Arkansas.

Item	Recommendation
Crude protein	Minimum 25% all natural
Phosphorus	0.7% minimum
Calcium	1.0% minimum
Vitamin A	Up to 20,000 IU per day when needed
Vitamin E	Up to 400 IU per day when needed
Coccidiostat, antibiotic or ionophore	At label recommendations
Feeding Level	2 to 4 lbs per day
Good Ingredients	
Soybean meal	
Cottonseed meal	
Molasses	
Feed grains	Maximum of 33% of diet
Soybean hulls	
Wheat middlings	

Supplementation Programs after the Receiving Period

The type and quantity of supplementation provided to stocker calves after the receiving period is determined by a number of factors: most notably the quantity and quality of forage available (Figures 3 and 4), expected results of the producer, and future plans. About 2 to 3 weeks after arrival, or when calves are "straightened out," they can be removed from the receiving program and moved to a program to obtain optimal performance and optimal utilization of the forage resource. Supplementation should be designed to optimize the utilization of the available forage without adversely affect the environment. Usually, supplementation with milled feeds must be accompanied by higher daily gains and(or) increased carrying capacity to be economically feasible.

In some studies the efficiency of utilization of a supplement (or creep feed) has been evaluated based on actual animal performance divided by the quantity of supplement (or creep) fed. This calculation method greatly overestimates the benefit of the supplement (or creep). Rather, the improvement in weight gain (compared to an unsupplement control) must be divided by the actual supplement (or creep) intake to get a true measure of the value of supplementation (or creep feeding).

Forage and protein nutrition

Microbial fermentation of feeds in the rumen supplies most of the energy and protein utilized by the animal. The microbes in the rumen require a balance of nitrogen and energy, as well as other nutrient such as minerals, to function efficiently. Under adequate conditions the microbes can synthesize 11 to 13 grams of microbial protein for each kg of organic matter digested (1 kg digested OM is approximately equal to 1 kg of total digestible nutrients: **TDN**). An imbalance of energy and nitrogen (i.e. CP) in the rumen leads to decreased microbial protein production, decreased rate and/or extent of forage digestion, decreased forage intake, and ultimately to decreased performance.

Energy intake is the primary factor limiting animal performance on high forage diets. In general, as forages mature the CP concentration decreases; and in many forages CP may become deficient. As noted in Figure 3 (Moore and Kunkle, 1995: McCollum , 1997); when forage CP concentration decreases to less than 7 to 8% of forage DM, forage intake decreases. For example, forage intake of a 5% CP grass is about 1.6% of body weight; whereas at 8% CP forage intake is approximately 2.3% of body eight - a 44% increase. However, in some forages this "breakpoint" value is as low as 5% CP and, in some, is as high as 10% CP.

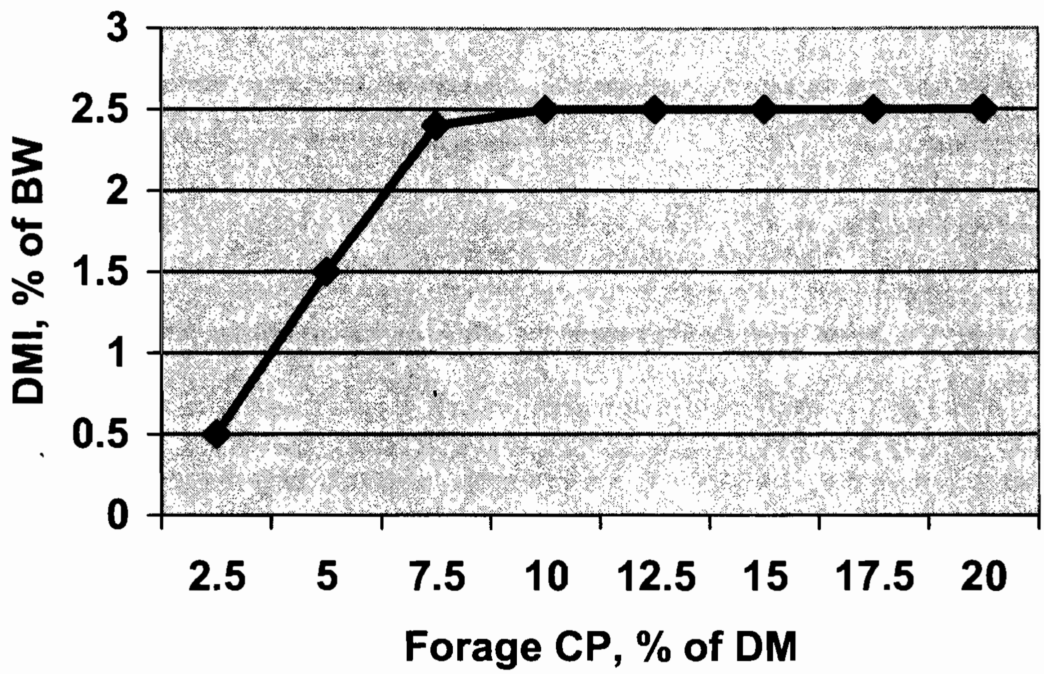

Figure 3. Forage intake (% of body weight) of stocker calves in relation to forage crude protein concentration (on dry matter basis). (Moore and Kunkle, 1995: McCollum, 1997).

As noted in Figure 4, forage intake increases as the TDN:CP ratio of the forage decreases. Low TDN:CP ratios are typically seen in forages such as fresh annual pastures (i.e. wheat pasture); whereas, high TDN:CP ratios are noted in mature forages. Theoretically, ruminal microbes need a TDN:CP ratio of approximately 4:1. As the TDN:CP ratio increases, the amount of energy available to microbes exceeds the amount of available nitrogen and the breakdown of energy sources (starch, cellulose) to available energy (volatile fatty acids) by microbial activity is decreased. Thanks to N recycling and other nitrogen conservation mechanisms, the actual optimal dietary TDN:CP ratio appears to be between 6:1 and 8:1. If forage has a higher value, supplemental protein is needed to bring the dietary ratio back to the 6 to 8 range; whereas, if the ratio is lower, a low protein supplemental energy source may be provided to balance the ratio (Table 10).

The quantity of supplemental protein needed will vary based on the protein deficiency in the forage and the CP concentration of the supplement (Table 11)

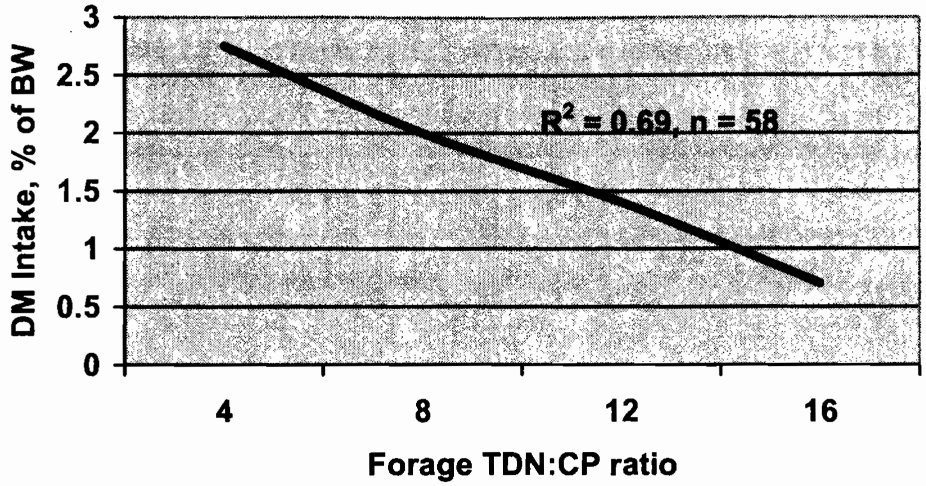

Figure 4. Forage intake in relation to the ratio of TDN (or digestible organic matter) to crude protein in the forage (Moore and Kunkle, 1995: McCollum 1997)

Table 10. An example of using the TDN:CP ratio to selecting a supplement program

Item	Dormant forage		Wheat pasture	
	CSM	Corn	CSM	Corn
Forage CP, %	5	5	25	25
Forage TDN, %	45	45	75	75
Forage TDN:CP	9	9	3	3
Supplement CP,%	45	9	45	9
Supplement TDN, %	76	88	76	88
Forage TDN:CP	9	9	3	3
Supplement TDN:CP	1.7	9.8	1.7	9.8
TDN:CP target	4-8	4-8	4-8	4-8
Best choice	x			x

Table 11. Supplemental protein intake required to correct a protein deficiency in the forage

% CP in supplement	Protein deficiency, lbs/day		
	0.20	0.40	0.80
16	1.25	2.5	5.0
20	1.0	2.0	4.0
24	0.83	1.67	3.33
28	0.71	1.43	2.86
32	0.63	1.25	2.50
38	0.53	1.05	2.10

Should the supplemental protein be high in DIP or high in UIP? The answer to that question will depend upon forage availability and protein concentration and degradability in the forage. If forage is low in CP then the supplement should contain some DIP that will be utilized in the rumen to stimulate fermentation. However, a protein source with a high UIP value may not stimulate ruminal activity. On average, 60 to 70% of supplemental protein probably needs to be DIP and the total diet should contain 0.1 to 0.12 lbs of DIP per lb of TDN. If supplying DIP does not improve production, then supplemental UIP may be useful. This has been mostly demonstrated in cattle grazing cool season forages high (15 to 20%) in CP that is also highly degradable. In general, the DIP should not be rapidly degradable (i.e. urea, etc.) in the rumen to optimize ruminal fermentation. The utilization of urea N in supplements is normally less than 50%.

If performance is limited by energy intake (i.e. forage availability) then supplementation of energy may be needed and/or economical. In some cases feeding supplemental energy will cause a decrease in forage intake and/or digestion. As a general rule, 1 lb of an energy-dense supplement reduces forage intake by 0.5 to 1 lb. Supplementing hay also results in decreased forage intake.

Feeding low-protein high energy supplements at rates of 0.3% of body weight per day probably has little impact on forage intake. As feeding rate increases forage intake will decrease and performance may not be improved (Table 12). Feeding frequency (daily vs. 3 x per week) may also affect animal performance, because feeding smaller quantities every day decreases the probability of negative impacts on forage intake. Using high-fiber energy feeds (bran, wheat midds, gluten feed, soybean hulls) will have less effect on forage consumption than starchy feeds (feed grains). With wheat pasture, Horn et al. (1995) noted that feeding a corn-based supplement at 0.7 to 1.0% of body weight resulted in a 1:1 substitution rate of corn for forage. However stocking rate could be increased by 33% without sacrificing animal performance.

Table 12. Effects of feeding corn-based supplement to stocker cattle on winter annual pasture (Rouquette, 1995)

Supplement rate, lb/day	Added gain, lb/day	Lb. supplement:lb. added gain
0.74 (0.18% BW)	0.38	1.9:1
1.43 (0.36% BW)	0.77	1.9:1
2.44 (0.61 % of BW)	0.45	5.4:1
4.06 (1.0% of BW)	0.45	9:1

Obviously the cost of supplements is a concern to the operator. When pricing supplements always remember that price per lb or bag is rarely a good indicator of the true value of a supplement. In some cases, byproduct feeds high in moisture may be available at, what appears to be, an excellent price. However, when corrected to a constant 100% dry matter basis, the price per unit of DM can be very high (Table 13).

Table 13. Effects of dry matter content of the supplement and its as-fed price on the price per ton of dry matter

% moisture	As-fed price, $/ton				
	30	60	90	140	170
10	33	67	100	156	189
20	38	75	113	175	213
30	43	86	129	200	243
50	60	120	180	280	340
70	100	200	300	467	567

However, supplements should be priced on more than just DM content. They should be priced based on their protein and energy content (Figures 5 and 6). If a supplement contains 20% CP and 75% TDN, each ton of supplement will contain 400 lb of CP and 1,500 lb of TDN. A 32% CP, 60% TDN supplement will contain 640 lb of CP and 1,200 lb of TDN per ton. Using such values and the as-fed cost of the supplement, the cost per unit of CP and(or) TDN can be determined. If urea is included in the supplement, the CP value of the urea portion of the supplemental nitrogen should be divided by two to correct for the low (50%) availability of urea nitrogen in high forage diets. Similarly, be wary of supplements that contain low quality ingredients such as rice hulls (12% TDN) or peanut hulls (22% TDN). Also avoid feeding supplements that contain illegal ingredients such as ruminant proteins and poultry litter.

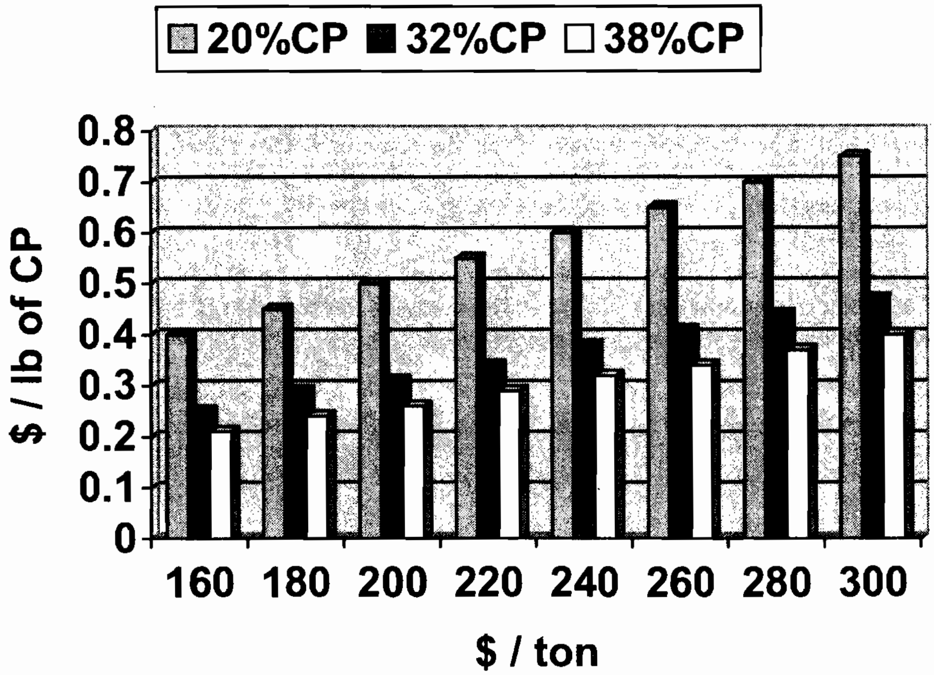

Figure 5. Effects of the crude protein concentration in a 75% TDN supplement on the cost per lb of crude protein in the supplement

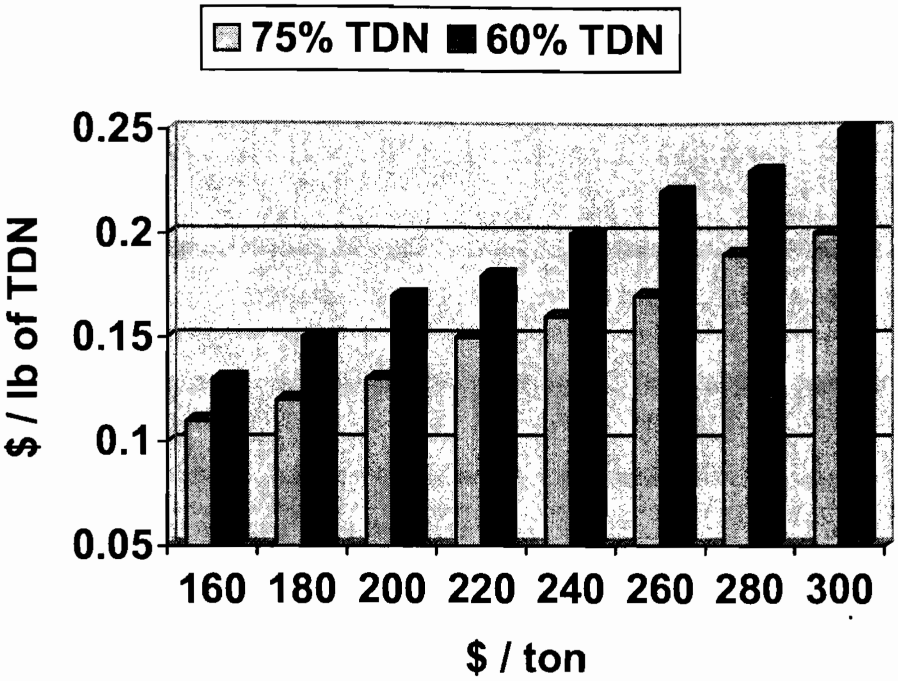

Figure 6. Effect of supplement as-fed cost and supplement TDN content in a 32% CP supplement on price per lb. of TDN

Supplementation Scenarios

McCollum (1997) noted that supplementation strategies required for stocker cattle normally develop around one of the following three scenarios.

Scenario 1:

Ample forage is available (i.e. it does not limit forage intake) but it is of low quality (i.e. low in CP). Animal performance is limited by low forage intake and/or poor forage digestibility.

The objective of supplementation in this scenario is to improve performance by increasing utilization of standing forage. This is best done by feeding a small quantity (0.1 to 0.3% of BW/day) of a high protein (> 30% CP; 50-60% DIP) supplement. This will stimulate ruminal fermentation leading to increased rate and extent of forage digestion which will lead to increased forage intake and animal weight gain. On average, for each lb of supplement fed, weight gains will normally increase 1.5 to 3 lbs.

Scenario 2

Forage availability and quality may or may not be limiting forage intake but production goals are greater than can be obtained from the forage alone. Thus, a supplement is needed that will sustain forage intake and forage digestibility at the present level but provide additional nutrients required to increase performance to the desired level.

In this scenario the goal is to improve performance by supplying additional nutrients without reducing the utilization of the standing forage. This can be done by feeding a 20-30% CP (minimum 50% DIP) high-fiber energy supplement at 0.3 to 0.5% of body weight. Normally for each 5 to 10 lb of supplement, weigh gain will be increased about 1 lb.

Scenario 3

Forage quality is sufficient so those forage and energy intakes are currently adequate to meet performance goals. However, due to climate (i.e. drought) or management (bought too many stocker calves) factors, future forage supplies will probably be limited. In this scenario, a supplementation program is needed that will decrease forage intake but maintain total energy intake.

In this scenario the goal is to maintain the current level of production but extend the forage supply into the future. Thus, we should feed a supplement that will depress forage intake but maintain total energy intake. This is routinely done with a low protein (10 to 18%) grain-based supplement fed at 0.7 to 1.0 % of BW. Weigh gain will be increased about 1 lb for each 10 lb of supplement. Although the ratio is not excellent, because stocking rate is increased, the efficiency per acre will range from 5 to 10 added lbs per lb of supplement.

Beef Quality Assurance & Biosecurity

With increased concern about the quality and safety of beef and introduction of foreign animal diseases it is imperative that all cattle producers adhere to beef quality assurance and biosecurity guidelines. By following your state and(or) a national beef cattle Quality Assurance Plan you will be assured of meeting animal welfare requirements, avoiding drug/vaccine residues in the carcass, and avoiding unnecessary negative effects on carcass quality and safety of the cattle you maintain. In addition, a reasonable biosecurity plan for the operation should be developed to decrease the risk of transferring undesired diseases to the operation. A number of publications and web sites are available that provide information on Beef Quality Assurance Guidelines and Biosecurity including the following:

1) (http://animalscience.ag.utk.edu/beef/BiosecurityPractices.htm;

2) Kentucky Beef Quality Assurance Program at http://www.ca.uky.edu/age/pubs/id/id140;

3) Alabama Beef Quality Assurance manual at http://www.aces.edu/pubs/docs/indexes/anranisci.tmp/;

4) Ohio Beef Quality Manual at http://beef.osu.edu/~obqa;

5) Nebraska Beef Quality Assurance Manual at www.ianrpubs.unl.edu/epublic/pages;

6) Texas Beef Quality Assurance resources at www.beefquality.com/resources/cdresources.html;

7) Kirkpatrick and Selk, 2004 (see references);

8) Thedford, 2004 (see references).

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