Methods to reduce morbidity in feeder calves
by Dennis James Fennewald

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Animal and Range Sciences
Montana State University

Abstract:
One thousand, eight hundred and thirty-six calves from eight ranches were individually identified to evaluate if a standardized weaning protocol following prescribed vaccinations, nutrition and 45-d of backgrounding could reduce morbidity from weaning until harvest. Freshly weaned calves were allotted to either 1) Present Ranch Management (PRM) which was defined as present weaning practices (779 calves) or 2) MSU Protocol (MSU) in which calves (1057) were fed either 1.82 kg/d of a wheat middlings-based pellet or 0.45 kg/d of liquid supplement for 28 d containing additional levels of Cu, Zn, Mn, CP, vitamins A, D and E and a coccidiostat. Ranchers chose clostridial and viral vaccines (MLV or killed) and described pre- and post-weaning management. Morbidity was 3.5% (64 of the 1836 calves) and was 2.7% for calves on the MSU protocol compared to 4.5% for calves on the PRM protocol ($P < .05$). MSU protocol may be applied to reduce morbidity in the backgrounding period. A companion study which involved calves destined for a branded beef program was conducted to more fully explain the effect of ranch management (minerals, vaccinations, backgrounding, etc.) on morbidity, ADG, hot carcass weight (HCW) and quality grade. Pen data were collected on seventy pens from four feedlots with a total of 14,140 steers and heifers from 40 ranches in 7 states bom between December 1999 and April 2000 and harvested between October 2000 and September 2001. Commingling calves increased ($P < .05$) morbidity by 6.7 percentage points. The weight of the calves entering the feedlot (In Wt) influenced ($P < .05$) the percent morbidity in a pen, death loss and HCW and indirectly influenced ADG through its relationship with the death loss. The cumulative effect of an additional 10 kg of In Wt due to a reduction in the percent morbidity ($0.14/hd), the reduction in mortality ($0.40/hd), the increase in ADG ($7.97/hd), the increase in HCW ($3.63) and the increase in the percent of carcasses that graded Choice ($0.28/hd) was $12.42/hd or $3105.00/250 hd.

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APPROVAL

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Dennis James Fennewald

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency and is ready for submission to the College of Graduate Studies.

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ABSTRACT

One thousand, eight hundred and thirty-six calves from eight ranches were individually identified to evaluate if a standardized weaning protocol following prescribed vaccinations, nutrition and 45-d of backgrounding could reduce morbidity from weaning until harvest. Freshly weaned calves were allotted to either 1) Present Ranch Management (**PRM**) which was defined as present weaning practices (779 calves) or 2) MSU Protocol (**MSU**) in which calves (1057) were fed either 1.82 kg/d of a wheat middlings-based pellet or 0.45 kg/d of liquid supplement for 28 d containing additional levels of Cu, Zn, Mn, CP, vitamins A, D and E and a coccidiostat. Ranchers chose clostridial and viral vaccines (MLV or killed) and described pre- and post-weaning management. Morbidity was 3.5% (64 of the 1836 calves) and was 2.7% for calves on the MSU protocol compared to 4.5% for calves on the PRM protocol ($P < .05$). MSU protocol may be applied to reduce morbidity in the backgrounding period. A companion study which involved calves destined for a branded beef program was conducted to more fully explain the effect of ranch management (minerals, vaccinations, backgrounding, etc.) on morbidity, ADG, hot carcass weight (HCW) and quality grade. Pen data were collected on seventy pens from four feedlots with a total of 14,140 steers and heifers from 40 ranches in 7 states born between December 1999 and April 2000 and harvested between October 2000 and September 2001. Commingling calves increased ($P < .05$) morbidity by 6.7 percentage points. The weight of the calves entering the feedlot (**In Wt**) influenced ($P < .05$) the percent morbidity in a pen, death loss and HCW and indirectly influenced ADG through its relationship with the death loss. The cumulative effect of an additional 10 kg of In Wt due to a reduction in the percent morbidity ($0.14/hd), the reduction in mortality ($0.40/hd), the increase in ADG ($7.97/hd), the increase in HCW ($3.63) and the increase in the percent of carcasses that graded Choice ($0.28/hd) was $12.42/hd or $3105.00/250 hd.

INTRODUCTION

At the 1995 National Cattlemans Beef Assoc. Strategy Workshop (NCBA, 1995), the emphasis on overcoming beefs shortcomings included the following: 1) assisting producers with use of selection and management techniques to produce cattle that fit customer expectations for marbling, red meat yield and weight; 2) develop a cattle identification system that facilitates data collection and information feedback and reduced reliance on hot-iron branding; 3) continue to develop and apply technology to enhance the quality of beef and 4) identify breeding systems that optimize production, palatability and profitability.

Source verification of individual cows and calves, feedlot performance and carcass characteristics is necessary for producers to; 1) establish a baseline for comparison of their herd to the global population, 2) effectively evaluate the potential need for adjustment of their genetics or management to more readily meet consumer demands and 3) document food safety management practices. Source verification lends itself to using a systems-approach to measure profitability as a result of having analyzed cow-calf, feedlot and carcass net returns. The first research project was aimed at individually identifying weaned calves in an attempt to track them through the production channels and to determine if a nutrition and health management protocol would reduce morbidity and mortality of weaned calves. The second, survey-study evaluated calves destined for a branded beef program and was conducted to more fully explain the effects of ranch management practices on morbidity, average daily gain, hot carcass weight and quality grade.

LITERATURE REVIEW

BQA

Deming (1986) recommended that industries "cease dependence on inspection to achieve quality" and "eliminate the need for inspection on a mass basis by building quality into the product in the first place". Lowry (1990) quoted Bob Reed from the Llano Estacado Winery, "Once the grapes hit the dock, it's too late for us to correct the fruit. You can make good or bad wine from good grapes, but you can't make good wine form bad grapes. So we try to help farmers grow premium grapes for our wines."

These statements illustrate the need to implement Total Quality Management (TQM) to ensure a "quality" product is provided to consumers. If any part of the system fails to do its part in TQM, product quality can be compromised. The beef industry uses the acronym BQA (Beef Quality Assurance) to describe the TQM process of minimizing losses of normal management practices such as vaccination and branding prior to weaning. The objectives are to ensure quality, consistency, safety and source and process verification (Montana Beef Network manual, 2001). Forty-seven states currently have BQA programs.

BQA includes proper handling of cattle to reduce stress and proper use of antibiotics, virals and feed additives. Unfortunately, the beef industry continues to have problems with inconsistency in the final product. Injection site blemishes are a problem in the beef industry that can affect tenderness three inches away from the site, even when the injection was given at birth (Beef, 2000). A 1994 Colorado State University study showed shear force values of 13.9 kg at the lesion, 5.8 kg three inches from the lesion vs. 4.0 kg in normal steaks. (Beef, 2000). Proper injection procedures can help prevent reduced tenderness in higher value cuts. Bruises also cost the beef industry $23 million/yr for fed steers and heifers and $117 million/yr for cows and bulls, according to the NCBA 2000 National Beef Quality Audit (Montana Beef Network, 2001).

According to the National Beef Quality Audit (NCBA, 1995), the top concerns of packers, purveyors, retailers and restaurateurs with regard to beef quality were: 1) low overall uniformity; 2) inadequate tenderness; 3) low palatability; 4) excessive external fat and 5) beef's price was perceived to be too high for the value received. It was estimated that excessive external fat, seam fat and beef trim fat cost the beef industry $47.76/hd marketed.. Inadequate palatability, marbling, hard-boned carcasses and bullocks added an additional $38.30 in lost income. And finally, controllable management issues (hide defects, offal condemnation, injection site blemishes, bruising, dark cutters and grubs) contributed an additional loss of $47.10/hd marketed. Management concerns which increased between 1991 and 1995 were more horned cattle, more bruising on carcasses, and more condemnation of livers, tripe and tongues. Although these defects have been documented, less effort has been aimed at developing programs that provide feedlot performance and carcass merit back to the cow/calf producer so that changes can be adapted in breeding, health and financial management.

It is important for producers to know what they are producing. Monfort Packing Co. started providing producers carcass information free of charge starting in 1998. Tim Schiefelbein, (personal communication) Monfort's value-based procurement manager, said

"We can't expect producers to make changes if we don't give them any feedback". According to Colorado State University animal scientist Tom Field, (personal communication) beef quality won't fully improve until everyone in the industry has an economic incentive to make it happen. Field also stated other beef quality components, like tenderness or yield grade, won't improve until all producers have a shared economic interest in the outcome of beef.

Proper management prior to and at weaning should reduce morbidity in the feedlot which generally reduces quality grades (Roeber et al. 2000). Tatum et al (1998) reported that the sole use of post-harvest technology is not adequate to ensure tenderness and must be used in conjunction with proper genetic inputs and management. These statements reflect the need for using BQA techniques as part of a progressive management strategy to increase consistency and consumer demand. However, this system must also reward and encourage ranchers to produce the product. Schiefelbein (personal communication) believed no system was in place to reward guaranteed tender steaks. "The present economy showed more consumers eating out and even though 1 in 4 steaks was not considered "a good eating experience", restaurant owners were enjoying the demand and not demanding a guaranteed tender steak every time."

Source Verification

According to the NCBA's 1995 National Beef Quality Audit, (NCBA, 1995) one of the strategies for overcoming beef's shortcomings was "the development of a cattle identification system that facilitates data collection and information feedback, and reduces reliance on hot-iron branding". Smith et al. (2000) indicated there are currently five major reasons why the beef industry is interested in source verification or trace-ability of cattle: 1) ascertaining ownership of the animal, 2) identifying parentage of the animal, 3) improving palatability of the product, 4) assuring food safety and 5) determining compliance in branded-beef programs and alliances.

The National Animal Health Monitoring System (NAHMS, 1994) found, however, that only 53.1% of cow-calf producers individually identify (ID) their calves. When calves were ID, the most commonly used methods were plastic ear tags (55.9%), brucellosis tags (30.4%), hot iron brand(s) (22%), ear tattoo (13.6%), freeze branding (0.9%) and microchips (0.4%). On a regional basis, 98.7% of ranchers in the western states identified beef cows compared with 89.9% for north central states, 44.2% for central states, 84.5% for south central states and 47.3% for southeast states. John Wiemers, a director for USDA's Animal and Health Plant Inspection Service, stated "the private sector will have three years to develop livestock ID systems that work...At the end of three years, livestock ID will become mandatory unless the industry has evolved to where it is already doing it as a course of business" (Smith, 2000).

Among the different identification systems currently being discussed include retinal scan (McMahon, 2000), electronic implants or electronic ear tags (Allen et al. 1994). Electronic ear tags appear to be the most successful with a lower failure rate than electronic implants (Allen et al. 1994). Ishmael (1999) indicated that EID has been discussed in the press for more than 20 yr and could be part of an overall system of producing and tracking cattle. It could simply be a closed-loop system that only operates within the boundaries of a ranch to track cattle performance or it could be used as part of a nationwide system that takes in fragmented information for each link in the entire production chain and provides performance and process verified animal histories from birth to carcass.

Three additional factors also drive the growing interest in individual animal ID: 1) the need for more effective management through information sharing, 2) consumer confidence in beef safety worldwide and 3) desire to ensure the integrity of the U.S. animal health system (Ishmael, 2000). Wiemers cited six reasons for development of individual ID: 1) disease control and eradication 2) disease surveillance and monitoring 3) emergency response to foreign animal diseases 4) global trade 5) livestock production efficiency, 6) consumer concerns over food safety and emergency management programs. Ranchers hesitate to involve the federal government because the disease problems in England led to mandatory individual identification of cattle that is costing $12 million annually with about 350 bureaucrats administrating the program (Stough, 2001). But, producers who want to compete in world markets can no longer do so anonymously (Peck, 2000).

Cross (1998) reported that both governments and customers concerns would drive individual animal identification and traceback over food safety. Traceback is viewed as a means of recapturing consumer confidence, especially among European nations who have dealt with Bovine Spongiform Encephalopathy (BSE) and Foot and Mouth Disease (FMD). Smith et al. (2000) indicated that traceback could also be used to improve beef palatability and will be used in branded-beef programs.

Source Verification Worldwide

Great Britain has actively pursued individual identification and tracking of livestock (passport system) in the aftermath of BSE. Within 15 d of tagging, a passport application must be accurately completed and sent to the British Cattle Movement Service. Italy has "smart card" technology that permits consumers to check the background of a farm animal before they buy a cut of meat. A French supermarket provides consumers the ability to access information on the animal as well as a photo of the producer. Starting Jan. 1, 2000, all livestock in the European Union must be tagged with one ID tag in each ear within 20 d after birth.

Australia has the National Livestock Identification Scheme, a voluntary program being introduced on a state-by-state basis with government funding. Argentina also has a National Task Force on Identification looking at that country's ID needs in the global marketplace and Mexico (CNG) is working with an American company that facilitates the adoption of individual animal ID (Ishmael, 2000).

Canada tested 20 types of tags in 80 herds, totaling 30,000 tags in the field. The Canadian Cattle Identification Agency, charged with developing and implementing a national system of individual ID and traceback, implemented the mandatory program Dec. 31, 2000 (Gordon, 1999).

Source Verification in the USA

Three programs including the USA Cattle Information Service (USA-CIS) from NCBA, Iowa Quality Beef Initiative and the Montana Beef Network are examples (there are several more) using EID in systems of beef cattle production. According the Ishmael

(2000), there are at least 25 feedlots, 25 alliances, six packing facilities, three auction markets and an unknown number of ranches currently utilizing some form of EID technology.

Sharing Data through the System.

Increasing demand for beef has been a major focus in recent years. New technology such as ultrasound and expected progeny differences (EPDs) have allowed for more accurate selection of growth and carcass traits. In addition, packers have created carcass grids to give feedlot and ranchers more options to market cattle and reward production of cattle that hit specified targets. Sharing that carcass information will become critical for alliances to supply a branded, case-ready product that is source and processed verified.

Behrends et al. (2001) surveyed thirty-one feedlot managers who participated in a Certified Angus Beef Supply Development Conference to determine their current and desired levels of knowledge about several characteristics associated with the cattle they feed. Vaccination schedule and single versus multiple herd sources were known for just over one-half of the cattle currently being fed and none of the other traits analyzed were known by more than 50 percent of the feedlot owners. In general, more information was available for health and management history than for genetic origin or feedlot and carcass performance. This illustrates the lack of information currently being shared throughout the beef industry.

The top traits feedyard managers would like to have information about include yield grade (100%), quality grade (96.8%), nutritional management (96.8%), feedlot gain

(96.8%), vaccination schedule (93.5%), implant history (93.5%), breed composition (93.5%), health products used (90.3%), morbidity and mortality history (90.3%) and percent "outs" (90.0%) (Behrends et al. 2001).

When these feedyard managers were asked what traits they were willing to pay a premium for, they responded; vaccination schedule (83.3%), quality grade (80%), sire and associated performance data (79.3%), feedlot gain (76.7%), breed composition (72.4%), yield grade (70%), and implant history (66.7%). All other traits were below 55 percent in terms of the respondent's willingness to pay premiums.

Producing a Healthy Weaned Calf

Perino (1997) suggested that inadequate passive transfer of colostral immunoglobulins occurred in 10 to 25% of newborn beef calves. Skrzypek and Szetag (2000) reported that passive immunity (acquired by a newborn calf from its dam) was important in sustaining the health of the young calf. Cows were bled 7-8 wk prior to calving and calves were bled at birth and 5 d of age to measure total protein, globulins and gammaglobulins. Dams that experienced dystocia had significantly higher blood serum constituents (total protein, globulins and gammaglobulins) than dams that did not experience dystocia. Calves born to cows experiencing dystocia had significantly lower concentrations of all three blood constituents (total protein, globulins and gammaglobulins) compared to calves born to cows that did not experience dystocia.

Bernardini et al. (1996) analyzed inbred and outbred populations maintained at the Northern Agricultural Research Center near Havre, MT and found increased incidence of scours and respiratory illness in inbred calves born to 2-yr-old dams (47 and 37%, respectively). This was greater than for older cows and outbred animals. Mean incidence of scours and respiratory illness were 35 and 22%, respectively, over all years. There was a 9 and 12 kg reduction in weaning weight and final weight, respectively, for the calves which contracted scours and respiratory illness. Economic losses per calf over all years averaged $39.80 for calves which contracted respiratory illness.

The innate immune system is the first line of defense against germs and disease. It includes small hairs in the nose that help filter germs from the air and the membranes of the respiratory tract which are covered with sticky mucous. The alveolar macrophage in the lower respiratory tract engulfs any germs that make it past the defenses in the upper respiratory tract. The innate defense system may be compromised by poor husbandry practices that produce excessive stress or dehydration. The innate defense system must be overcome before the animal uses the acquired immune defense (Perino, 2001).

Acquired immunity is the immune response mediated by white blood cells called lymphocytes. Key features include 1) previous exposure to the pathogen is required, 2) the response is directed only at the pathogen stimulating it and 3) the response to a pathogen is enhanced by previous exposure to the same germ. This is why it is critical to vaccinate cattle prior to the stress so as to enable the immune system to build a defense (Perino, 2001).

Behavior of sick animals is an adaptive strategy to conserve energy as opposed to being a product of debilitation (Hart, 1987). The onset of sick behavior and fever were the first lines of defense until the immune system was activated. However, the animal's metabolism must be increased by 10 – 13% to accommodate a 1° C increase in body temperature. Thus, a sick animal's behavior is related to the high cost of producing a fever, which suppresses the growth of disease causing viruses and bacteria. Reducing feed intake and showing depression are symptoms seen in morbid animals to reduce energy requirements. Sick behavior and fever concentrated all of the animal's resources on recovering from illness (Hart, 1987). As the immune system took over, the fever subsided and the morbid animal became interested in its environment and regained its appetite.

Preconditioning

Preconditioning is the process of preparing calves for the feedlot. Preconditioning gives the producer another opportunity, after ensuring the newborn has received high quality colostrum, to improve the immune status of calves. The benefits of backgrounding and preconditioning include; 1) minimizing shipping stress, 2) giving more predictable feeding results, 3) changing delivery and marketing schedules, 4) reducing morbidity and mortality, 5) reducing risk, 6) increasing predictability, 7) expanding marketing options, and 8) improving the value of the calves (Perez, 2000). In a review of controlled studies of the effect of preconditioning on health of calves, morbidity was reduced from 26.5 to 20.4% and mortality was reduced from 1.44 to 0.74% (Perino, 2001). Unfortunately preconditioning has a different meaning to different ranchers. Some ranchers consider a vaccination program to be adequate while others combine nutrition, vaccinations and 45 d backgrounding (Stough, 1999). Other ranchers criticize preconditioning programs because it was not generally economical for the integrated operations (Peterson et al.

1989). Henderson (2000) reported preconditioned calves are becoming the industry standard due to the need to reduce sickness, death loss, poor performance and quality assurance losses. However, McNeill (Henderson, 2000) indicated preconditioning guidelines are not rigid enough. In his opinion, calves that are preconditioned and backgrounded 30 d do not have the proper immunity to remain healthy and perform as well as calves that have been backgrounded 45 d (Henderson, 2000).

Perino and Apley (1999) found that preconditioned calves were 19.5 times less likely to be sick in the feedlot than nonpreconditioned calves. Cattle shipped directly from the ranch to the feedlot were 5.7 times less likely to be sick in the feedlot than cattle that first went to an auction market and were commingled prior to arrival at the feedlot (Perino and Apley, 1999). Lofgreen (1998) reported that preconditioned calves gained better than non-preconditioned calves during a 28-d receiving period. The ADG, however, between the two groups was not different at the end of the feeding period.

Roeber et al. (2000) found that cattle from two pre-conditioning programs had fewer average number of hospital visits compared to cattle originating from an auction market. In addition, increased morbidity resulted in economic losses due to mortality, reduced performance and increased costs associated with treatment.

NAHMS (2000) data indicated that 73.8% of feedlots received pre-arrival processing information either *always* or *most of the time* or *sometimes.* This communication is important to feedlots because 86.7% considered pre-arrival processing information important and 69.5 % of feedlots at least *sometimes* altered their management or processing of cattle based on this information.

Incidence of Bovine Respiratory Disease

The most economically important disease affecting feedlot cattle throughout North America is bovine respiratory disease (BRD) complex (NAHMS, 2000) which has been reported as the most common cause of morbidity and mortality in feedlots (Perino, 1992). It has been estimated that BRD accounted for approximately 75% of feedlot morbidity and 50% of mortality (Edwards, 1996). Other reports indicate 20% of cattle in feedlots annually contract BRD with a 10-15% mortality rate due to BRD (Perino and Apley, 1999). Kelly and Janzen (1986) indicated that the average rate of morbidity was 15-45% with a range of 0-69%. They also reported the normal average in mortality was 1-5% with a range of 0-15%. NAHMS (2000) reported nineteen percent of feedlot cattle received an antibiotic injection for the prevention or treatment of disease.

Weight gain of morbid calves was 29% slower compared to healthy calves after 56 d in the feedlot (Hutcheson and Cole, 1986). Intake was a problem in newly arrived calves because after 7 d only 83% of the morbid calves had eaten compared with 95% of the healthy calves. Overall feed intake for morbid calves was 11% less than for healthy calves (Hutcheson and Cole, 1986).

Sowell et al. (1998) conducted a study in a commercial feedlot in AZ for 32 d using 108 mixed breed calves (ave weight 139 kg). Healthy steers gained 9 kg more and had 28% higher ADG than morbid steers. Morbid steers spent 30% less time at the feedbunk than healthy steers. Morbid steers were also found to spend 23.7% less time at the waterer than healthy steers (Basarab et al. 1996). Perino and Apley, (1999) found that water was the most important nutrient for an animal recovering from respiratory disease. Bud

Williams, noted animal behaviorist, found newly arrived calves are stressed to the point that they often "starve" to death (personal communication). He stated it was critical for calves to eat from day one as morbidity was greatly reduced.

The first 4 d was the critical time period because differences in time at the feed bunk and feeding bouts between healthy and morbid steers were most pronounced during this time (Sowell et al. 1999; Hutcheson and Cole, 1986). These authors found when animals were transported "long distances" it required at least 4 d before all the healthy calves were eating from the feed bunk. Morbid steers spent 30% less time at the feed bunk than healthy steers (Sowell et al. 1998) and this decrease in feeding time occurred 4 d before physical signs of sickness were observed (Basarab et al., 1996: Sowell et al., 1998). Griffin et al., (1993) stated feed consumption in cattle exposed to viral respiratory disease began to decline 48 h before a rise in body temperature could be detected and that this drop in consumption could be as much as 50% 24 h before the animal's temperature began to rise.

Evidence suggested that current methods of BRD diagnosis and treatment were of questionable value. Wittum et al. (1996) evaluated BRD morbidity in 469 crossbred steers born in three consecutive calving seasons at the USDA-MARC in Clay Center, NE. Calves were weaned at approximately 6 mo of age and fed in a feedlot for an average of 273 d. Health records were maintained from birth to harvest. Lungs were collected at harvest and evaluated for gross lesions indicative of active or resolved pneumonia. Thirty-five percent of the steers were treated for BRD but 72% had pulmonary lesions indicative of BRD at slaughter. Pulmonary lesions were evident in 78% of treated steers and 68% of steers not treated for BRD. These findings suggested current methods of treating cattle for BRD are not adequate to prevent production losses.

The Economic Impact of BRD on Performance and Carcass Value

The cost of BRD can be divided into three categories: 1) the cost of treatment, 2) the cost of lost productivity and/or salvage (chronics), and 3) the cost of death loss (Perino, 1992). BRD resulted in losses in all three categories. Perino (1992) estimated the cost of BRD for 100 hd of cattle to be $1700 or $85/sick calf or $17/calf fed.

Griffin et al. (1995) reported the cost for morbid cattle was $111.38/sick animal and that health costs accounted for 8% of the production cost in a feedlot. Morbid cattle gained 3% less and had an 18% higher total cost of gain compared with cattle that did not get sick. Also, it was determined from the Texas Ranch to Rail Summary, that 26% of the cattle incurred no medical cost but 22% of the cattle incurred a medical cost of $10/hd or more.

Gardner et al. (1996) reported that medical costs have been shown to be the most important factor affecting profitability and can be as high as $353/hd. Subsequently, in a survey of nineteen feeding companies, health was listed among the top four cattle traits important to feeders (Northcutt et al., 1996).

Gardner et al. (1998) reported that the net returns for steers without lung lesions were $20.03 more than for steers with lung lesions but non-active lymph nodes. Twenty-five percent of this reduction was medicine costs with the remaining 75% due to decreased carcass value (9.4% more U.S. Standard carcasses and 3.9% less carcass weight). Steers with lung lesions as well as active lymph nodes had a $73.78 less net return than cattle with healthy lungs.

McBeth et al (2001) reported increased performance for heifers treated for BRD once vs. heifers not treated. These authors stated this was probably due to compensatory gain for animals that had seen reduced performance in the receiving period. There were no differences in overall performance or carcass characteristics and concluded that the incidence of morbidity was low, thus had no effect on the animals in this study.

Roeber et al. (2000) reported hot carcass weight, marbling scores, and yield grades were reduced for cattle treated more than once compared to cattle not treated. The Texas Ranch to Rail 1999-2000 Summary included four factors to target a value based marketing system; 1) attainment of premiums – both quality and yield, 2) avoiding, or at least, minimizing discounts, 3) retaining performance and efficiency, and 4) having a sound health program for calves to achieve their genetic potential (McNeill, 2000). Highly profitable steers (top 10% of steers which had average net returns of $304.76) attained returns by quality grade, yield grade, both quality and yield grades, or had exceptional performance without premiums or discounts.

Gardner et al. (1999) reported lung lesions were present in 33% of all lungs and was almost equal between treated (37%) and untreated cattle (29%). Steers that were treated had lower ($P < .05$) harvest weights, ADG, hot carcass weights, less internal and external fat, and better yield grades. Gardner et al. (1999) reported steaks aged less than 7 d from steers with respiratory tract lesions were tougher ($P<0.06$) in shear force and steaks from steers without lung lesions were more tender than steaks from steers with lung lesions. Steaks aged more than 7 d did not differ in tenderness ($P > .16$).

Stovall et al (2000) reported significant effects on carcass traits, especially carcass value, for cattle requiring one or less anti-microbial treatments. Heifers treated for BRD had 37% fewer carcasses grading Choice. Heifers never treated produced a net return that was \$11.48/hd more than heifers treated once for BRD, and \$37.34/hd more than those treated two or more times.

Healthy steers had faster ADG (1.33 vs. 1.26 kg/d, respectfully) and 12% more Choice carcasses than cattle identified as sick during the finishing period (McNeill et al., 1996). However, in several studies that relied on clinical evaluation alone as opposed to diagnostic evaluation to determine health status, respiratory caused morbidity during the finishing period failed to depress ADG (Townsend et al., 1989; Griffin and Perino, 1992).

Faber et al. (1999) analyzed data from 2,146 feedlot cattle in 17 feedlot tests from 1988 to 1997 to determine the impact of bovine respiratory disease (BRD) on veterinary treatment costs, average daily gain, carcass traits, mortality, and net profit. Morbidity caused by BRD was 20.6% and the average cost to treat each case was \$12.39. Mortality of calves diagnosed and treated for BRD was 5.9% vs. 0.35% for those not diagnosed with BRD. Average daily gain differed between treated and non-treated calves from day 1 to d 28 but were not different from 28 d to harvest. Net profit was \$57.48 lower for treated steers with 82% of this value due to mortality and treatment costs. Eighteen percent of the net profit difference was due to improved performance and carcass value of the non-treated steers.

In summary, BRD has been identified as the most economically important disease affecting feedlot cattle (NAHMS, 2000). It has been estimated that BRD accounted for approximately 75% of feedlot morbidity and 50% of mortality (Edwards, 1996). However, only half of the calves that have pulmonary lesions indicative of BRD at slaughter may be treated during their lifetime (Wittum et al., 1996). The cost of BRD may range from $85/sick calf (Perino, 1992) to $111.38/sick calf (Griffin et al., 1995) and includes losses in the cost of the treatment, the cost of lost productivity and the cost of death loss (Perino, 1992). Cattle treated in the feedlot may also have reduced carcass weight and quality grades (McNeill et al., 1996; Roeber et al., 2000; Stovall et al., 2000) and the reduction in quality grades may result in substantial discounts as carcasses move from the Choice grade to the Select grade (Stovall et al., 2000; McNeill et al., 1996) and from the Select grade to the Standard grade (Gardner et al., 1999; McNeill, 2000). Additionally, steaks aged less than 7 d from calves with respiratory tract lesions were tougher in shear force (Gardner et al., 1999). Resuming normal feed consumption in the first 4 d at the feedlot was critical to remaining healthy (Hutcheson and Cole, 1986). Depression and reduced feed intake were symptoms of morbid animals (Hart, 1987) and feed intake began to decline 48 h prior to a detectable rise in body temperature (Griffin et al., 1993).

Pasteurella

Pasteurella is a common but normally noninvasive bacterium. When certain tissues or functions become damaged or stressed, usually by IBR, PI-3, or BRSV, *pasteurella* invades (Richey, 1996). *Pasteurella* is common in the upper respiratory tract and *Pasteurella* infections are easily spread by inhalation of aerosol droplets, by direct nose-to-nose contact, or by ingestion of feed and water contaminated by nasal and oral discharges from infected cattle.

If *Pasteurella* infections go unnoticed, the lungs may become irreversibly damaged, the body temperature drops to below normal and the animal usually dies. If the animal survives, the result is a calf that will never be able to adequately perform to expectations. These calves are referred to as chronics in the stocker and feedyard industries.

When *Pasteurella* alone causes pneumonia, it is commonly referred to as shipping fever. Shipping fever is not the main concern as true shipping fever losses are minimal compared to the larger problem called Bovine Respiratory Disease (BRD), which is the respiratory illness caused by the association of *Pasteurella* and other diseases. *Pasteurella* pneumonia is present in nearly 75% of all diagnosed cases of BRD.

Perino and Apley (1999) listed the primary sign of BRD as depression with other symptoms including a decreased flight zone, glazed look, and respiratory character (outstretched head or labored breathing). In their opinion, nasal and ocular discharge along with increased respiratory rate were unreliable signs of BRD when there was the absence of depression. Genetics of the individual animal may also affect the degree which they show clinical signs of BRD.

Pasteurella bacteria can easily develop resistance to antibiotics and because the bacteria are geographically widespread, antibacterial resistance among *Pasteurella* bacteria is very common throughout the United States. While it is easy to find an antibacterial drug against pasteurellosis on the ranch where the calf was raised, it is very difficult to find a drug that will work against pasteurellosis in commingled calves. *Pasteurella* bacteria are easily spread from calf to calf resulting in the harboring of many drug-resistant strains. *Pasteurella* has developed resistance against most of the common over-the–counter antibacterial drugs (Richey, 1990).

BRSV

The feedlot industry identified a respiratory problem in cattle in which a virus was suspected. This virus caused a lung lesion called a syncytium and became known as bovine respiratory syncytial virus or BRSV. BRSV infections are common in the United States and nationwide studies show BRSV is present in 38% to 76% of the beef and dairy herds (Richey, 1990).

BRSV disease occurs in cattle of all ages but most adult animals show little if any signs of the disease. It has been identified as an important disease in both nursing and weaned calves. BRSV can effect February to April born calves in the summer while still nursing their mothers. The number affected is usually low in this early syndrome. Calves that are susceptible can also show respiratory disease a few days after weaning.

The late syndrome typically occurs from three weeks to three months after fall weaning. The disease progresses to a frothy saliva around the mouth and breathing becomes very labored. When the tongue is extended and the neck is stretched as breathing becomes more difficult, preventing death is doubtful. This same late syndrome occurs in feedyard calves but because of the high incidence of secondary infections, many calves may die before the advanced stages of the disease are observed.

BRSV infected cattle appear to be the principal reservoirs of the disease and transmission from one animal to another is thought to be via aerosol droplets from the nose and throat. In confinement situations, the disease can spread rapidly through the cattle in 3-10 days. In pastured cattle it may take several weeks or months to get through the entire herd. Once exposed, it requires 2-4 days for a susceptible animal to begin showing clinical signs. In susceptible herds undergoing a BRSV outbreak, 100% of the animals could become infected with the virus, 20-50% show clinical signs, and less than 5% could die.

Treatment of the virus with antibiotics has no affect on BRSV but can be used to control the secondary bacterial infections. Vaccination of the cowherd provides a barrier by slowing the spread of the virus to other cows and calves in the herd. Unfortunately, maternal antibodies against BRSV passed to the calf via colostrum from vaccinated or infected cows will not protect the calf from BRSV infection. General recommendations are to vaccinate calves over four months of age twice with a minimum of 21 days between the vaccinations and a booster each year.

PI-3

The parainfluenza-3 (PI-3) virus is common in cattle and is found worldwide. By itself, PI-3 is a relatively mild infection but usually works in concert with IBR, BVD, BRSV and pasteurella pneumonia to be a damaging and dangerous disease. Vaccinating the cows to provide maternal antibodies to the newborn and vaccinating before weaning and/or shipping can enhance immunity in calves (Richey, 1990).

IBR

Infectious bovine rhinotracheitis (IBR) results from bovine herpesvirus 1 infection (NAHMS, 2000) and is capable of attacking many different tissues in the body and producing a variety of clinical disease forms according to those tissues (Richey, 1994). These infections can be grouped as 1) respiratory tract infections, 2) eye infections, 3) abortions, 4) genital infections, 5) brain infections and 6) a generalized infection of newborn calves.

The IBR infections are usually confined to the upper respiratory tract (nose, throat, and wind-pipe). If the infection becomes severe, the nostrils become encrusted. If the crusts on the nostrils are rubbed off, the nose looks very red and inflamed, a condition known as “red nose”.

Concentrating susceptible cattle provides an ideal situation for the rapid spread of the shedding IBR virus. Most feedyards (97.5%) vaccinate cattle against IBR with either an intranasal or injectable vaccine (NAHMS, 2000). It requires about one week following infection for the initial signs of the disease to appear and will last 10-14 days. In general, the respiratory form of IBR does not cause death but may reduce the resistance to other infections, which can cause death.

Proper vaccination of the herd to raise the resistance to IBR is the best way to control IBR. Once clinical signs of IBR are exhibited, antibiotic treatment must be administered to reduce the challenge of other infections.

Haemophilus somnus

Haemophilus somnus is a common disease-causing bacterium that usually creates a major problem before the disease is detected (Richey, 1990). In most cases, the minute blood vessels (capillaries) are blocked and blood flow is interrupted to the organs or parts of the organ. This results in tissue death and clinical symptoms of the disease. *Haemophilus somnus* can attack both the upper and lower respiratory tract. The result of attacking the upper respiratory tract in calves is calf diphtheria. The calf exhibits difficulty in swallowing, bawling and breathing. If the *H. somnus* organism reaches and attacks the lungs, severe pneumonia can result. This pneumonia can result in rapid death before any clinical signs have been detected. Although *H. somnus* is the primary cause of the pneumonia, Pasteurella quickly becomes the main problem.

In case of an outbreak of *H. somnus*, chlortetracycline and /or sulfamethazine is supplied in the feed for an extended period (30 d). However, relapse will usually occur without a simultaneous vaccination and booster given 14-21 d apart.

The Importance of Initial Vaccinations and Booster Vaccinations

Maternal antibodies passed to the calf via colostrurm are expected to be present in effective amounts as long as four to five months after birth (Richey, 1996). Perino (2001) found that achieving an immune response requires time. The first vaccination will produce an appreciable level of protection in seven to ten days but is not considered a strong immune response. The booster vaccination will produce a faster and more intense immune response and is required to reach an acceptable level of resistance. Perino (2001) recommended prebreeding vaccinations against BVD to protect the fetus from infection. Vaccinations 30 d before calving would help cows make high-quality colostrum, which is a one-time event just before calving. Calves that do not consume adequate colostrum are 3.2 to 9.5 times more likely to get sick and 5.4 times more likely to die than calves that do consume adequate amounts of colostrum.

Wankel et al. (2001) reported the effect of vaccinating cows and heifers precalving and calves preweaning for *Pasteurella haemolytica* to determine if serum antibody titers in dams could be elevated and the health and performance of the calves was improved. Vaccinations increased serum antibody titers in multiparous cows but not first-calf heifers. Precalving vaccination had no effect on mortality and morbidity of calves before or after weaning, which could be attributed to the low level of illness observed throughout the study.

Killed vs. Modified Live Vaccines

Faber et al. (1999) analyzed data from 496 steers and heifers in nine feedlot tests to determine the effects of age, weaning, and use of MLV or killed vaccines before the feeding period to predict BRD. Younger calves, non-weaned calves, and calves vaccinated with killed vaccines before the feeding period had higher BRD morbidity than those that were older, weaned, or vaccinated with MVL vaccines, respectively. Non-weaned calves were 3.4 times more likely to experience BRD than weaned calves. Calves vaccinated with killed vaccines were 2.2 times more likely to experience BRD than calves vaccinated with MLV vaccines. Calves vaccinated with killed vaccines had a 32% treatment rate for

BRD and 10% were treated 3 or more times vs. 18% treatment rate for calves vaccinated with MLV and 3% were treated 3 or more times. This treatment rate resulted in calves that were treated three or more times earning $174 less net profits than those that were not treated. However, these data do not agree with results by Kreikemeier et al. (1997) who compared Kentucky ranch calves (252 kg) assigned to one of three treatments. In the first treatment, calves were vaccinated with a killed viral vaccine 2 to 4 wk before weaning and revaccination with a killed vaccine at the time of commingling at a sale barn. The second treatment, calves were vaccinated with a MLV at the sale barn before shipment to a feedlot in western Kansas and boostered with MLV 21 d after arrival. For the third treatment, calves were vaccinated with MLV on d 1 and d 21 in the feedlot. Morbidity rates decreased for those vaccinated before weaning compared to calves vaccinated on arrival at the feedlot or vaccinated at the sale barn (27% vs. 37% and 33%, respectively). Treatments per morbid calf decreased for calves vaccinated before weaning (1 treatment) compared to calves vaccinated on arrival at the feedlot (1.14 treatments) and for those vaccinated at the sale barn (1.36 treatments).

Nutritional Stressors affecting Weaned Calves

Publications by the National Research Council (NRC) and Agricultural Research Council (ARC) provide the nutrient requirements for beef cattle. However, recommendations typically represent the minimum dietary levels for disease free animals, serving low production roles (Graham, 1991) and do not reflect requirements due to growth, pregnancy, sickness, etc.

Feedlot calves undergo numerous nutritional stressors that result in 1) transient endocrine responses, 2) altered products of energy and protein metabolism, 3) changes in appetite and growth rate, 4) possible limited compromise of digestive and rumen function, and 5) a challenged immune system. Cortisol and epinephrine levels change in response to marketing, transportation and feedlot adaptation (Loerch and Fluharty, 1999). Cortisol was not affected when weaning was the only stressor (Lefcourt and Elsasser 1995). Others (Locatelli et al. 1989; Agnes et al. 1990) reported increased cortisol associated with transport but Galyean et al. (1981) did not see a change in cortisol levels associated with transport.

Cole (1993) suggested that actual mineral requirements of stressed calves were not greater than those of unstressed calves, except for potassium. However, because of reduced dry matter consumption, concentrations of most minerals need to be increased in receiving diets to compensate for reduced appetite. Blood levels of Ca, P, K, Mg, Cu, Zn and Na have not been seen to change due to marketing stressors (Cole and Hutcheson, 1979; Galyean et al., 1981; Cole and Hutcheson, 1985b, 1987).

Most cattle have been without feed for 24 to 48 h when they arrive at the feedlot. Calves are susceptible to digestive upsets due to a reduction and shift in rumen bacterial population. California studies indicated that after 48 h of food deprivation, rumen bacterial numbers were reduced to 10 to 15 percent of normal (Moseley and Sewell, 1993). Similarly, Galyean et al, (1981) reported steers deprived of feed for 32 h and transported had reduced total counts of ruminal bacteria, which returned to pre-experiment levels by 72 h after feeding resumed. Newly arrived feeder calves typically consume 0.5 to 1.5% of their BW during the 1st wk and 1.5 to 2.5% of the their BW the 2nd wk (Hutcheson and Cole, 1986). Normal intakes were achieved between 2 and 4 wk after arrival.

Strategies to Increase Nutrient Intake and Balance Nutrient Antagonists

Strategies have been suggested to achieve greater intakes by calves upon arrival at the feedlot. Preconditioning calves before marketing will result in increased intakes during the receiving period (Loerch and Fluharty, 1999). Increasing nutrient intake by increasing nutrient density of the receiving diet would help offset low feed intake (Cole, 1993). Increased CP concentrations are needed to meet a calf's protein requirement early in the receiving period when DMI is low (Loerch and Fluharty, 1999). Increased feed intake before sending calves to the feedlot resulted in greater reserves of energy, water, and electrolytes and shortened the realimentation adaptation period (Cole and Hutcheson, 1985a). This may be more critical for small calves although not all studies show a difference in initial weights for morbid and healthy calves (Gardner et al., 1999).

It has been hypothesized that newly weaned calves penned with older animals would adapt to the new surroundings faster. Newly weaned calves penned with trainer cows may have greater ADG than calves penned without trainer cows for the first week but no differences in ADG were evident at 28 d (Fluharty et al., 1996c). Morbidity was 16.7, 28.3, and 8.3% for control calves, calves with trainer steers and calves with trainer cows, respectively. From a health standpoint, trainer steers may not be advisable. Hays et al. (1988) reported use of feedlot-adapted lead steers did not enhance performance of stressed calves and resulted in increased morbidity. Loerch and Fluharty (1999) conducted a second trial with 12 pens of control calves and 12 pens of calves each with a trainer cow. Morbidity was 78% for control calves and 54% for calves penned with a trainer cow. Calves with a trainer cow had ADG of 1.42 and 1.33 kg/d for wk 1 and 2, respectively. Control calves had ADG of 1.26 and 1.06 kg/d for wk 1 and 2, respectively.

Nutrients Suspected of impacting Calf Health

Copper (Cu)

The primary role of the trace mineral Cu is as an enzymatic cofactor, activator and constituent (McDowell, 1992a). A Cu deficiency in ruminants results in decreases in enzymatic activity, which result in less than optimal productivity and metabolic health (Bailey et al. 2001). Copper deficiency among grazing ruminants is widespread and supplementation is usually provided. However, as is common in the western USA, high levels of molybdenum (> 7ppm) may cause Cu deficiencies (Church, 1988). Spears (2000) reported that Cu deficiency could also result from the presence of high levels of other minerals (S, Mo or Fe; Suttle, 1991) in the forage that interfered with Cu utilization rather than just a simple deficiency of Cu in the diet.

The earliest visual sign of Cu deficiency is depigmentation or bleaching of hair. This is manifested as a russet or pale color in black-haired cattle and a dull, dead-like appearance in red cattle (Spears, 2000). Neutrophils isolated from Cu-deficient cattle had a reduced ability to kill yeast organisms (Boyne and Arthur, 1981). Copper functions in the immune system through energy production, neutrophil activity and antioxidant enzyme production. Copper also aids in the development of antibodies and lymphocyte replication

(Nockels, 1994). Molybdenum (5 ppm) or Fe (500 ppm) fed to induce Cu deficiency in feeder cattle also impaired neutrophil function (Boyne and Arthur, 1986).

Copper requirements tend to vary more than other trace minerals. High concentrations of Mo and S in forage greatly increase Cu requirements. High levels of S increased the negative action of Mo on Cu utilization. Copper deficiency or Mo toxicity can be prevented by maintaining a Cu to Mo ratio of 3:1 (Spears, 2000). Sulfur levels well within the normal range (0.2 to 0.4%) found in forages could reduce Cu absorption, even when Mo concentrations were low. In addition, growing cattle consuming Fe at levels as low as 500 ppm (typical of those often found in forages) could have reduced Cu levels (Spears, 2000).

Bailey et al. (1999) suggested supplementing trace minerals to incoming feedlot cattle which previously consumed dietary mineral antagonists, replenished lost mineral stores more effectively than cattle with no previous supplementation. In addition, a combination of inorganic and complexed Cu and Zn may be used strategically to limit hepatic accumulation on Mo while conserving hepatic Cu. Swenson et al. (1996a) reported consumption of the complexed form of Cu (copper lysine) increased liver Cu levels in the presence of antagonists and maintained a higher Cu level approximately 150 d after supplementation had ceased.

Breed may also affect copper levels. Simmental and Charolais cows and their calves had lower plasma Cu concentrations than Angus cattle when fed similar diets (Ward et al., 1995) and based on liver Cu, one-half of the Simmental cattle were classified as deficient (Underwood, 1981; Puls, 1994) whereas none of the Angus cattle were classified as deficient. Angus calves had fewer apparent clinical signs of copper deficiency than Simmental calves. Liver copper concentrations were twice as high in Angus steers compared to Simmental steers managed and fed together since birth (Spears, 2000).

Zinc (Zn)

Baker and Ammerman (1995b) found that chelating agents and ionic interactions were the most important dietary factors affecting the bioavailability of Zn. Zinc has been associated with synthesis of DNA, RNA and protein, i.e. expression of genetic potential, growth and tissue repair. Zinc also plays a role in the function of enzymes and hormones. Toxicities of Zn can be reduced with the addition of Cu and vise versa (McDowell, 1992b). Age, physiological state, environmental stress and health can affect the requirement for Zn (McDowell, 1992b).

A severe Zn deficiency results in reduced feed intake and growth, loss of hair, skin lesions, excessive salivation, and impaired reproduction. Severe Zn deficiency is rare but has been observed in ruminants grazing forages. Marginal or subclinical zinc deficiency is widespread (Spears, 2000). A genetic disorder of Zn metabolism has been reported in Holstein and Shorthorn calves. This disorder results in a deficiency due to the impaired ability to absorb Zn resulting in suppressed cell-mediated immune response (Spears, 2000).

Immune function in laboratory animals, such as the rat, is severely impaired by zinc deficiencies (Spears, 2000). Zinc supplementation enhanced recovery rate in IBR-virus-stressed cattle (Chirase et al., 1991) and zinc methionine has been shown to increase antibody titer against bovine herpesvirus-1 (Spears, 1991).

Swenson et al (1996) studied 60 first-calf gestating beef heifers to determine the effect of feeding zinc as an amino acid complexed mineral or inorganic sulfate compared to a control of no additional minerals. Heifers were injected with phytohemagglutinin (PHA-P) to illicit an immune response. The peak response to the swelling for the complex and inorganic minerals was 3 h while the control peaked at 6 h, suggesting Cu and Zn supplemented heifers were able to respond more rapidly. Zinc methionine appeared to be more bioavailable because of increased retention compared to supplementation with zinc sulfate. Heifers fed complexed Zn (zinc methionine) had increased liver Zn levels within 30 d of supplementation (Swenson et al, 1996a).

Molybdenum (Mo)

Abnormalities normally attributed to Cu deficiencies may actually be due to Mo toxicity. Molybdenum toxicity occurs when Mo intake is excessively high (20 ppm or higher) and toxicity can be overcome by providing additional dietary Cu. The addition of Mo (5 ppm) to a diet low in Mo reduced growth and feed efficiency and caused infertility in heifers (Phillippo et al., 1987). Supplementing Cu will generally prevent or correct adverse effects due to Mo (Spears, 2000).

Selenium (Se)

Selenium deficiency is a major problem in many areas of the U.S. despite the relatively small (0.1 to 0.3 ppm) amount required by cattle. Deficient animals may show lameness, stiffness or in extreme cases, cardiac failure. Other signs include unthriftiness, anemia, and increased incidence of retained placenta.

Selenium deficiency can affect the ability of neutrophils to kill microorganisms as well as antibody production following a disease challenge (Spears, 2000). Spears (2000) reported reduced calf losses (4.2 vs. 15.3%) from birth to weaning by giving selenium-vitamin E injections bimonthly to beef cows and calves receiving pasture and corn silage marginally deficient in selenium (0.3 to 0.5 ppm)

Organic vs. Inorganic forms of trace minerals

Strategic supplementation of organic trace minerals upon arrival at the feedyard may have pharmacological benefits for stressed feeder calves (Greene, 1995). Organic trace minerals may help replenish reduced mineral stores due to dietary antagonists (Spears, 1995). The additive role of organic trace minerals has its greatest potential in strategically incorporating both inorganic and organic forms of trace elements into one supplementation tool (Greene, 1995).

Stressed steers fed Cu proteinate had higher antibody titers to IBR compared to those fed copper sulfate after vaccination against IBR (Nockels, 1991). The effect of level and source of Zn was studied by Spears et al. (1991) on the immune response to IBR and PI-3 vaccination of newly weaned and shipped calves. Three treatments evaluated were; 1) a control diet that contained 26 ppm zinc, 2) the control diet supplemented with an additional 25 ppm zinc oxide or 3) the control diet supplemented with an additional 25 ppm zinc methionine. Steers supplemented with zinc methionine had 47 and 31% higher antibody titers against IBR on day 14 following vaccination compared to control and zinc oxide fed steers, respectively.

Hill, et al. (2000) tested organic vs. inorganic minerals (Co, Cu, Mn, and Zn) in feedlot steers and found no differences in performance. However, in the last 114 d, ADG was greater for steers receiving trace minerals and feed:gain was somewhat better for organic than inorganic or control steers. The observations from this experiment were that the liver stores of all the steers were adequate upon arrival and for several months into the feeding period and may explain a lack of response. Steers fed organic minerals had a 7% efficiency advantage and may reflect a metabolic advantage over inorganic minerals.

Stanton et al. (2000) fed four different trace mineral combinations to cow-calf pairs; 1) low organic, 2) high organic, 3) low inorganic and 4) high inorganic after weaning. Calves, which previously consumed the low organic and the high inorganic supplements, had higher ADG ($P < 0.05$) during the first 28 d than calves fed the high organic or low inorganic trace minerals. However, trace mineral type or level did not influence overall feedlot ADG, feed efficiency, off test weight, dressing percent or hot carcass weight. As the level of inorganic trace minerals increased in the diet, rib eye area (REA) also increased while as the level of organic trace minerals increased in the diet, the REA decreased. Stanton et al. (2000) reported all calves treated for respiratory condition the first 28 d were from one pen fed the low inorganic treatment and recovered rapidly after treatment.

Vitamin A

The rumen microbes do not synthesize vitamin A. Vitamin A is rapidly turned over in growing feedlot cattle due to their high production rate. A deficiency of vitamin A may cause a degeneration of the mucosa of many organs and may lead to damage of the respiratory and urogenital tracts, the kidneys, the salivary and buccal glands and eyes, making them much less resistant to infections. The result is greater susceptibility to pneumonia and other diseases of the respiratory tract. Toxicity is usually not a concern in ruminants (Church, 1988).

Vitamin D

Vitamin D's primary function is to stimulate formation of Ca-binding protein in the mucosa of the small intestine. The action of the Ca- binding protein is necessary for absorption of Ca into the bloodstream. It has been difficult to induce a vitamin D deficiency in cattle because exposure to sunlight activates D_3 in the skin and it has been generally accepted this prevents deficiency problems. However, this exposure to sun irradiation may be inadequate for activation for vitamin D at certain times of the year (cloud cover). Supplemental vitamin D becomes cheap insurance during those times (Church, 1988).

Vitamin E

Vitamin E is an essential nutrient that is not stored in the body in appreciable amounts and is not synthesized by microbes of the rumen. The predominant metabolic function of vitamin E is to serve as an antioxidant. Vitamin E prevents peroxidative degradation of fats in animal cells and the consequent formation of free-radical peroxides that inhibit action of certain enzymes that damage cellular membranes (Church, 1988).

Carter et al (2000) fed 2000 I.U. of supplemental vitamin E to six hundred ninety-four stressed calves from southern Oklahoma and northern Texas auction barns for 0, 7, 14, or 28 d. Regardless of dietary Vitamin E treatment, ADG and feed conversion were not improved. Average morbidity was 64.5% and anti-microbial treatment costs were reduced by 22.4% when cattle were fed 2000 I.U. of vitamin E for 28 d compared to controls.

Galyean et al. (1999) reported that when vitamin E was added to receiving diets to supply ≥ 400 IU/animal, it seemed beneficial for increasing gain and decreasing BRD morbidity. Carter et al. (2000) reported on two experiments involving Tasco™, a seaweed supplement. The first experiment compared vitamin E vs. Tasco™. Heifers fed supplemental vitamin E had less morbidity but similar ADG to heifers fed Tasco™. The second experiment reported only a control vs. Tasco™. The control treatment had less morbidity, higher ADG and better feed conversions than the Tasco™ treatment. In these experiments, Tasco™ did not reduce morbidity compared to vitamin E or controls.

Daniels et al. (2000) reported serum IgG titers were not different ($P > 0.15$) between ewes and their lambs that did not receive supplemental vitamin E compared to ewes and their lambs that received 400 IU of vitamin E and also exposed to parainfluenza type 3 (PI_3) vaccination. Colostral IgG titers and serum anti-PI_3 titers did not differ ($P > 0.20$) between ewes that did not receive vitamin E and ewes that received 400 IU of vitamin E supplementation.

Perry et al. (1968; Rivera et al., 2000) demonstrated that feeding or injecting vitamin E had no effect on weight gains. Rivera et al. (2000) reported no difference in ADG, DMI, or gain:feed for the 28 d feeding period for steers fed 285, 570, or 1,140 IU/d of vitamin E (assuming a DM intake of 1.5% of BW). Gill et al., (2000) reported that vitamin E (800 IU/lb supplement) improved feed efficiency by 26% (0.063 vs. 0.049 kg gain/kg feed for control and vitamin E treatment, respectfully).

Feeding Agrado®, a product containing ethoxyquin, an antioxidant, reduced the incidence of morbidity by 12% in lightweight heifers obtained from sale barns in Arkansas during December (Kegley et al., 1999). However, bulls and steers purchased in March and castrated at the start of the experiment showed no significant effect of dietary treatment on morbidity. Kegley et al (1999) indicated this might be a result of the time of year the experiment was conducted. Mean incidence of morbidity was greater in heifers (78%) vs. bulls and steers (58%).

Carcass

Owens and Gardner (2000) reviewed the impact of feedlot management and nutrition on carcass measurements of feedlot cattle. Published research trials (n=552) on carcass quality and yield information as well as weights, age and diet were compiled. A longer feeding period and an increased slaughter age were associated with greater longisismus muscle area, marbling score, external fat thickness and yield grade. Heavier initial weight was associated with greater longisismus muscle area, dressing percent, and quality grade. The heavier initial weight was also associated with lower subcutaneous fat, kidney, pelvic, and heart fat, and marbling score. Steers gained 9% faster and were 1.3% more efficient than heifers. When carcass weight was ignored, heifers had superior ($P < .05$) yield grades compared to steers. This was due to larger longissimus muscle area per 100 kg compared to steers. Actual longissimus muscle area was smaller for heifers compared to steers. Cattle with greater initial weight were less efficient in converting feed to live weight gain. High protein diets and cattle with heavier initial weights made faster gains. The longissimus muscle area, as a percentage of carcass weight, decreased by about 7% as carcass weight increased across the 293-351 kg weight range. Longissimus muscle shear force tended to decline as carcass weight increased.

Owens and Gardner (2000) also found dressing percentage was higher for cattle with greater initial weights, those fed more days and those fed higher-protein diets. Maximum dressing percentage occurred when cattle were fed a 90% concentrate diet. Maximum dressing percentage and maximum longissimus muscle area occurred when fat supplementation was 2% of the diet or 4% total dietary fat. However, maximum longissimus muscle area, like muscle mass, was not reached at typical slaughter age but continued to increase with time on feed. Marbling score strongly increased with slaughter age and slightly with days fed and decreased as initial weight increased. Quality grade was most positively affected by added protein and heavier initial weights.

BQA includes proper handling of cattle to reduce stress and proper use of antibiotics, virals and feed additives while source and process verification may be helpful in identifying strengths and weaknesses from ranch to rail. Reducing morbidity continues to be an important challenge to the beef industry as morbidity has direct medicine and labor costs and may reduce ADG, HCW and quality grade. Building a strong immune system includes reducing stress, proper vaccinations and a sound nutritional program which may include organic and inorganic supplemental minerals. Thus, a simple protocol that combines the best science of nutrition, vaccinations and time, may assist producers in preparing calves for entry into a feedlot, reducing morbidity and maintaining quality.

A SYSTEMS APPROACH TO REDUCING MORBIDITY IN FEEDER CALVES

Summary

One thousand, eight hundred and thirty-six calves from eight ranches were individually identified to determine if a standardized weaning protocol which included vaccinations, nutrition and 45-d of backgrounding could reduce morbidity from weaning until harvest. Freshly weaned calves were randomly allocated to two treatments: 1) Present Ranch Management (**PRM**) which was defined as present weaning practices or 2) MSU Protocol (**MSU**) in which calves were fed either 1.82 kg/d of a weaning pellet or 0.45 kg/d of liquid supplement for 28 d. The supplement contained additional levels of Cu, Zn, Mn, CP, vitamins A, D and E and a coccidiostat. All ranches divided calves into PRM and MSU groups (779 and 1057, respectfully) and group size ranged from 26 to 188 animals. Overall morbidity was 2.7% for calves on the MSU protocol compared to 4.5% for calves on the PRM protocol ($P < .05$). The range in morbidity was 0 – 9.8% for calves on MSU vs. 0-24.7% for calves on PRM. During the first 28 d after weaning, ADG was not different ($P = .14$) between treatments (avg. 0.84 kg/d). However, ADG was greater ($P < .05$) for MSU from 0-45 d compared with PRM (1.12 vs. 1.04 kg/d). Calves exhibiting morbidity had 19% slower ($P < .05$) ADG compared to healthy calves (0.89 vs. 1.10 kg/d). Gain in the feedlot was faster for calves previously on the MSU protocol (1.39 vs. 1.29, respectfully) but morbidities were similar (avg 4.1%). These data suggest that calves which followed a protocol of defined vaccinations, nutrition and backgrounding performed better than control calves.

Introduction

The benefits of preconditioning and backgrounding calves include; 1) minimizing shipping stress, 2) giving more predictable feeding results, 3) changing delivery and marketing schedules, 4) reducing morbidity and mortality, 5) reducing risk, 6) increasing predictability, 7) expanding marketing options, and 8) improving the value of the calves (Perez, 2000). Henderson (2000) reported that preconditioned calves are becoming the industry standard due to the need to reduce sickness, death loss, poor performance and meat quality losses. In a review of controlled studies on the effects of preconditioning on health of calves, morbidity was reduced from 26.5 to 20.4% and mortality was reduced from 1.44 to 0.74% compared to calves which were not preconditioned (Perino, 2001). Unfortunately the concept of preconditioning has various meanings to different ranchers. Some ranchers consider a vaccination program only to be preconditioning while others combine nutrition, vaccinations and 45 d backgrounding (Stough, 1999). It has been suggested that preconditioning guidelines are not rigid enough, because calves that were preconditioned and backgrounded for 30 d did not have adequate immunity to remain healthy and perform as well as calves that were backgrounded at least 45 d (Henderson, 2000).

The objectives of this study were to: 1) develop and implement a structured protocol for preconditioning and backgrounding calves using nutrition, vaccinations and time, 2) evaluate the effects of the protocol on morbidity and ADG during a 45 d backgrounding period.

Materials and Methods

One thousand, eight hundred and thirty-six calves from eight ranches were individually identified to determine if a standardized weaning protocol which included vaccinations, nutrition and 45-d of backgrounding could reduce morbidity from weaning to harvest. Ranches were chosen with input from county extension agents and industry beef nutritionists. Only ranches that were able to provide two pens (one for each treatment), had facilities to properly process calves, and had previously backgrounded calves were accepted. Freshly weaned calves were randomly allocated to two treatments: 1) Present Ranch Management (PRM) which was defined as practices in which calves were backgrounded but had not received pre-weaning vaccinations and generally did not retain calves for 45 d after weaning prior to sale or 2) MSU Protocol (MSU) which was defined as a standardized weaning protocol which included vaccinations, nutrition and 45 d of backgrounding. Calves were divided into PRM and MSU groups (779 and 1057, respectfully) and group sizes ranged from 26 to 188 animals.

All (PRM and MSU) calves were individually identified with Alflex electronic ear tags for source and process verification. All calves were dehorned and males were castrated. Ranchers chose viral (MLV or killed) and clostridial vaccines and described pre- and post-weaning management in a written survey filled out at time of weaning.

The MSU protocol followed these requirements: 1) MSU calves were vaccinated at least 3 wk pre-weaning with IBR, BVD, PI-3, BRSV, 7 or 8 way Clostridial, Pasturella and Hemophilus somnus and boostered at weaning with IBR, PI-3, BVD, BRSV and

Pasturella (preferred), 2) MSU calves were fed either 1.82 kg/d of a weaning pellet or 0.45 kg/d of liquid supplement for 28 d and held a minimum of 45 d (Table 1).

Table 1. Nutrient Specifications for the MSU Weaning Pellet[a]

Nutrient	Concentration of pellet	Amount supplied/d
Crude protein	16%	288 g
Crude fat	3%	
Crude fiber	9%	
Calcium	.8%	
Phosphorus	.8%	14 g
Salt	1.25%	
Potassium	1.00%	18 g
Vitamin A	10000 IU/lb	40,000 IU/d
Vitamin D	1000 IU/lb	4,000 IU/d
Vitamin E	50 IU/lb	200 IU/d
Copper		
2/3 inorganic:1/3 organic	80 ppm	150 mg/d
Zinc		
2/3 inorganic:1/3 organic	250 ppm	450 mg/d
Maganese		
2/3 inorganic:1/3 organic	225 ppm	400 mg/d
Selenium	1.65 ppm	3 mg/d
DECOQUINAT	31 mg/lb (62 g/ton)	125 mg/d

[a] The nutritional program was a 1.82 kg/d weaning pellet or liquid supplement (0.45 kg/day) fed for 28 d after weaning with the following minimum specifications.

The supplement contained 100-150% of NRC requirements of Cu, Zn, Mn, CP, vitamins A, D and E and a coccidiostat. Water and forage samples were collected to determine sulfate and nitrate levels of diet and water to better determine if antagonistic levels were present in the diet.

After the 45 d of backgrounding, ranchers reported where and when the calves were sold. Calves were fed in six states and Canada where feedlot personnel collected morbidity data. Calves were determined morbid if removed from the pen and treated.

Calves were also tracked into the packing plant where carcass data were collected. Only carcass data from actual measurements were reported due to the increased accuracy over the USDA subjective report provide by graders.

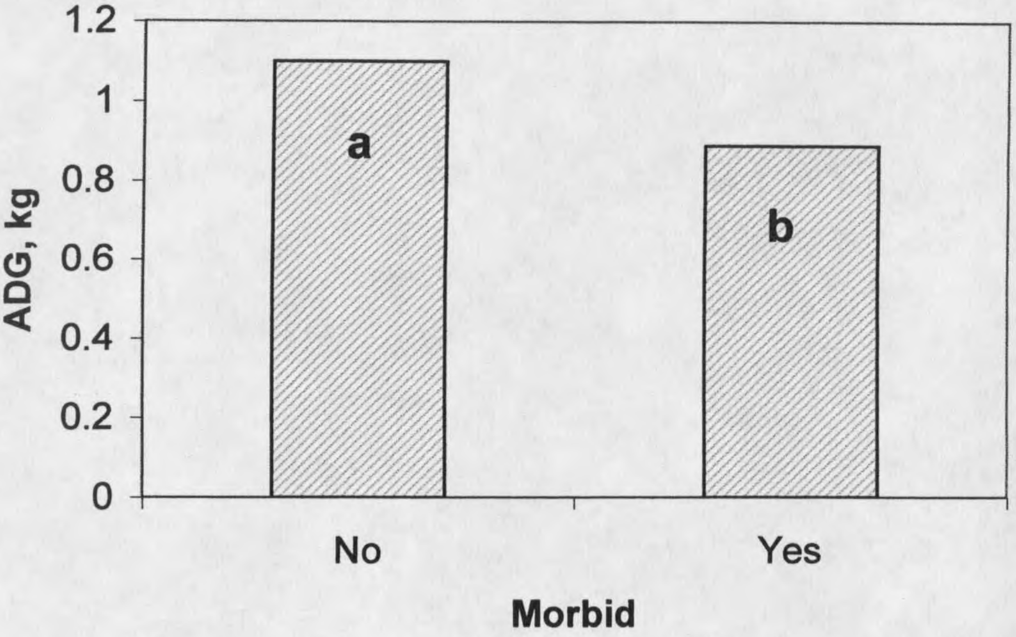
Statistical Analysis

Data were analyzed as a completely randomized design with a one-way ANOVA. Initial weight, ADG from 0-28 d, from 0-45 d for the background period, and feedlot gain were analyzed using the General Linear Model (GLM) procedure of SAS (2001). Because calves on the MSU protocol had higher ($P < .05$) initial weights (230 vs. 216 kg, respectfully) compared to calves on the PRM protocol, initial weight was used as a covariate for analysis of ADG and final weight. Data were also analyzed using the CORR procedures of SAS to determine the relationship between initial weight, and ADG. Categorical data (i.e. sick in the background period) were analyzed using the CATMOD, LOGISTIC and FREQ procedures of SAS (2001).

Results and Discussion

Calves that were morbid had 19% slower ($P < .05$) ADG 0-45 d compared to healthy calves (0.89 vs. 1.10 kg, respectfully, Figure 1). These results are similar to those reported by Hutcheson and Cole (1986), Griffin et al. (1995), McNeil et al. (1996), Sowell et al. (1998) and Faber et al. (1999). In contrast, where clinical evaluation alone compared to diagnostic evaluation was used to determine health status, morbidity did not depress ADG (Townsend et al., 1989; Griffin and Perino, 1992).

Figure 1. Effect of Morbidity on ADG of Calves during the first 45 d after Weaning.



[ab] ($P < .05$)

The effects of the MSU protocol on ADG and morbidity are presented in Table 2. During the first 28 d, ADG were not different ($P = .14$) between calves on the MSU protocol vs. calves on the PRM protocol (0.87 vs. 0.80 kg, respectfully). However, after 45 d, calves on the MSU protocol had faster ($P < .05$) ADG vs. calves on the PRM protocol (1.12 vs. 1.04 kg, respectfully). In addition, the MSU protocol resulted in reduced ($P < .05$) morbidity compared to calves on the PRM protocol (2.7 vs. 4.5%, respectfully). Calves that were morbid did not have lower ($P = .69$) final weights compared to healthy calves (266 vs. 268 kg, respectfully).

Table 2. Effect of Treatment Protocol on Backgrounding Performance and Morbidity of MT Weaned Calves.

Item	MSU[a]	PRM[b]	MSE	P-Value
No. calves	1078	758		
Initial wt, kg	230	216	4.6	.05
Final wt, kg	270	267	2.9	.05
ADG 0-28 d, kg/d	0.87	0.80	0.5	.14
ADG 0-45 d, kg/d	1.12	1.04	0.4	.05
Morbidity, %[b]	2.7	4.5		.05

[a] MSU weaning protocol.
[b] PRM was present ranch management practices.

The correlation of initial weight to the overall ADG was small and negative (n =1291; -0.25; $P < .05$) while the correlation of ADG in the first 28 d to the overall ADG was moderately positive (n =190; 0.64; $P < .05$).

Few recent studies are available investigating methods for improving the health of backgrounded calves. Most studies have compared freshly weaned calves to preconditioned calves on subsequent health and efficiency of gain in the feedlot. Perino (2001) reported that preconditioned calves had reduced morbidity (20.4% vs. 26.5%) and reduced mortality (0.74% vs. 1.44%) compared to nonpreconditioned calves. Perino and Apley (1999), in a review of controlled studies, reported feedlot morbidity usually averaged 10-15% which is similar to the present study but lower than the 15-45% morbidity reported by Kelly and Janzen (1986) in their survey of feedlots in the Central Plains.

A summary of the effect of treatment on feedlot health was presented in Table 3. Morbidity in the feedlot was 4.1% (33 of 803 calves) and was not different ($P = .19$) between calves (n=502) previously on the MSU protocol vs. calves (n=301) on the PRM protocol (3.4 vs. 5.3%, respectfully). However, mortality in the feedlot was lower (P < .05) for calves previously on the MSU protocol vs. calves on the PRM protocol (0.16 vs. 1.53%, respectfully). Daily gain in the feedlot averaged 1.34 kg and was faster (P = .05) for calves on the MSU protocol vs. calves on the PRM protocol (1.39 vs. 1.29 kg, respectfully, Table 4). However, ADG in the feedlot was not affected by morbidity in the feedlot (P = .62). This result disagrees with the summaries by Griffin et al. (1995), Gardner et al. (1999) and McNeill et al., (1996) who found that morbid steers had slower ADG in the feedlot compared to healthy steers. Faber et al. (1999) reported that morbid calves had slower ADG in the first 28 d in the feedlot compensated by the end of the feeding period. These findings agree with several studies that have relied on clinical evaluation alone as opposed to diagnostic evaluation to determine health status in which respiratory caused morbidity during the finishing period failed to depress ADG (Townsend et al., 1989; Griffin and Perino, 1992).

Table 3. Effect of Treatment on Health in the Feedlot.

Item	MSU	PRM	Chi Sq Value	P value
No. calves	502	301		
Morbidity, %	3.4	5.3	1.75	.19
Mortality, %	0.16	1.53	4.38	.05

Table 4. Effect of the Treatment on Performance in the Feedlot.

Item	MSU	PRM	SE	P value
No. calves	137	111		
ADG, kg	1.39	1.29	0.36	.05

Implications

Methods that reduce morbidity consistently and economically are needed to capture value and reward producers for their extra efforts at time of weaning. The overall goal of this study was to compare a systems approach to improve the calf's immune system and potentially reduce losses due to morbidity, mortality and realizers. This study implemented a protocol that combined the best available science on nutrition, vaccinations and time with a range of backgrounding regimes that may or may not differ from the MSU protocol. The MSU protocol reduced morbidity compared to the PRM protocol and should be applied with success.

THE EFFECTS OF RANCH AND BACKGROUNDING MANAGEMENT ON FEEDYARD PERFORMANCE OF CALVES: A SURVEY FROM COLORADO

Summary

Seventy pens of feedlot cattle (avg 202 hd/group) from seven states were analyzed to determine the effects of various management practices used at the ranch on the performance, health and carcass traits in the feedlot. Age at weaning averaged 220 d and ranged from 148 to 290 d. After weaning, calves were backgrounded an average of 69 d with a range from 0 to 135 d. The weight of the calves entering the feedlot (In Wt) averaged 326 kg and ranged from 207 to 404 kg. As In WT increased, percent morbidity and mortality decreased and ADG and the hot carcass weight increased. The groups were fed an average of 167 d in the feedlot and had an ADG of 1.34 kg; steers gained 0.14 kg/d more ($P < .05$) than heifers. Calves that had heavier In Wt and calves with faster ADG had heavier ($P < .05$) hot carcass weights. Heavier hot carcass weights contributed to more ($P < .05$) carcasses receiving the USDA Choice grade. Morbidity averaged 11% and ranged from 0 to 39%. Of the calves removed from pens for medical treatment, 36.6% were pulled in the first 30 d and 40.2% were pulled from d 30-60. Morbidity was increased ($P < .05$) by 6.7% when the calves were commingled in the feedlot. The percent that died in the feedlot averaged 1.29% and ranged from 0-5.1%. In comparing MT calves to surrounding states, MT calves were not different ($P > .05$) for morbidity or mortality but were faster ($P < .05$) gaining, had heavier ($P < .05$) hot carcass weights and more ($P < .05$) Choice carcasses. Commingling calves in the feedlot resulted in more ($P < .05$) morbidity and calves that entered the feedlot at heavier weights had less mortality, higher ADG and

HCW, and more Choice carcasses. These data indicate In Wt and commingling was critical to health, performance and carcass quality.

Introduction

At the 1995 National Cattlemans Beef Assoc. Strategy Workshop (NCBA, 1995), the emphasis on overcoming beef's shortcomings included the following: 1) assisting producers with use of selection and management techniques to produce cattle that fit customer expectations for marbling, red meat yield and weight; 2) develop a cattle identification system that facilitates data collection and information feedback and reduced reliance on hot-iron branding; 3) continue to develop and apply technology to enhance the quality of beef and 4) identify breeding systems that optimize production, palatability and profitability.

Taking a systems approach encourages producers, feeders, and packers to work together to produce a product and share the risk and rewards of that product. Only recently has the beef industry attempted to work together to regain market share lost to more integrated protein sources, namely pork and poultry. However, few large studies exist that have documented the impact of ranch management practices on feedlot health, performance and subsequent carcass value. This survey-study evaluated calves destined for a branded beef program and was conducted to more fully characterize the effects of ranch management practices on morbidity, average daily gain, hot carcass weight and quality grade.

Materials and Methods

Pen data were collected on seventy-five pens from four feedlots with a total of 14,643 steers and heifers from 41 ranches in seven states (MT, WY, CO, NE, TX, UT and ID) born between December 1999 and April 2000 and harvested between October 2000 and September 2001. One ranch was deleted from the analysis due to unusually high (> 2 SD) morbidity and mortality. Two additional pens were also deleted due to unusually high morbidity.

A survey (Table 5) was sent to each rancher to determine the management practices experienced by each group of calves before weaning. Data compiled included minerals usage, breeding programs and type of vaccines used. Another survey (Table 6) was also sent to backgrounders but due to the low return, conclusions could not be made. Fifty-four of the groups were classified according to the breeding program. Straightbred British (SB), British crossed with British (BB) and British crossed with Continental (BC) were 31.5, 3.7, and 64.8% of the pens, respectively. Fifty-two of the groups were classified according to type of vaccines used for BRSV. Modified live vaccines were used on 82.7% of the groups and 17.3% of the groups received killed vaccines. Selected data are presented in Table 7.

Table 5. Sample Survey sent to Ranchers.

Ranch Name__________________________________ Date Called____________________

Feedlot # ____________________________________ Time Called____________________

Breeds______________________________________ No. of calves___________________

Average birth date___________________________ Date shipped____________________

Vaccines for Cows (MLV or Killed)____

Mineral Offered	365 days__________	Drought in prior year (Y,N)________
(loose vs. none)	(prior to calving)____	Green grass at calving (Y, N)_______
	(prior to weaning)___	Green grass at weaning (Y,N)_______

Brand of mineral___________________________

Vaccines for calves (MLV, Killed)______________________

Vaccines at Calving___________________________________

Vaccines at Branding___________________________________

Vaccines PreWeaning___________________________________

No. Days Pre Weaning___________________________________

Vaccines at Weaning___________________________________

Weaning Date_______________________________________

Vaccines Post Weaning_________________________________

No. Days Post Weaning_________________________________

Weaning Weight_______________ Days of Backgrounding on ranch_________________

Backgrounded on grass or lot__________ Destination (BG lot or Feedlot)____________

Table 6. Sample Survey sent to Backgrounders.

Backgrounder's Name____

Receiving Ration____

____

No. of Days of Receiving Ration_________________ % DM____________

% Protein_____________ Neg______________ Ca:P_________________

Minerals	**Organic/Chelated/Inorganic/Blend/None**	**Free Choice or TMR**
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		
Receiving		

Vaccinations___________________________________MLV/Killed

Initial implant for _________lb. calves._______________
Initial implant for _________lb calves._______________
How many days after arrival do you vaccinate?___________
Booster Vaccinations_________________________________MLV/Killed

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How many days after initial vaccinations?_______________
Booster Implant_______________________________

Statistical Analysis

Data were analyzed with General Linear Model of SAS (SAS Inst, Inc., Cary, NC). Categorical data were analyzed with CATMOD and LOGISTIC procedures of SAS (SAS Inst, Inc., Cary, NC).

Main effects of Sex and Biological Type influence and a Sex x Biological Type interaction were tested for significance of selected feedlot performance and carcass traits. The Sex x Biological Type interaction was not significant ($P > .05$) and was removed from the analysis.

The marginal effect of changing ADG by 0.045 kg/d was calculated by dividing the cost/d ($1.40) by an ADG of 1.36 and then multiplied by a constant gain of 273 kg. Then the cost/d ($1.40) was divided by 1.41 kg/d and multiplied by 273 kg. The difference was the marginal effect of an additional 0.045 kg/d gain.

Results and Discussions

Seventy pens of feedlot cattle (avg 202 hd/group) were analyzed to determine the effects of various management practices used at the ranch on the performance, health and carcass traits in the feedlot. Age at weaning averaged 220 d and ranged from 148 to 290 d (Table 7). The calves were backgrounded an average of 69 d with a range from 0 to 135 d. Unfortunately, the health and performance of calves in the background period could not be determined due to the low response from the owners/managers of the background yards.

Table 7. Summary of Selected Data collected in the Feedlot on Calves Targeted for a Branded Program.

Item	No. Pens	Mean	SD	Min	Max	SEM
Group size	69	202	119.7	22	485	14.4
Wean Age	53	220	30.7	148	290	4.2
Days of BG	56	69	30.2	0	135	4.0
In wt. kg	68	326	40.3	207	404	4.9
DOF[a]	70	167	27.7	98	221	3.3
ADG[e], kg	59	1.34	0.13	0.99	1.6	0.017
HCW[f], kg	70	356	23.6	285	398	2.8
Dressing Percent[g], %	70	64.0	0.91	61.6	65.7	0.11
Ch & Pr[h], %	70	65.2	20.5	22.0	97.3	2.45
YG 1 & 2[i], %	70	39.4	23.2	0.97	93.6	2.77
Ave YG	70	3.06	0.31	2.18	3.52	0.037

[a] Days on feed in the feedlot.
[e] Average daily gain in the feedlot.
[f] Hot carcass weight.
[g] Dressing percent = Hot carcass weight/Harvest weight.
[h] Percent of carcasses that quality graded USDA Choice or better.
[I] Percent of carcasses that were yield graded 1 and 2.

The weight of the calves entering the feedlot (In Wt) averaged 326 kg and ranged from 207 to 404 kg. As the weight of the calves entering the feedlot (In WT) increased, the morbidity and mortality decreased ($P < .05$). As the In Wt increased, the ADG and the hot carcass weight also increased.

The groups were fed an average of 167 d in the feedlot and had an average ADG of 1.34 kg. Steers gained 0.14 kg/d more ($P < .05$) than heifers. Calves that had heavier In Wt and calves with higher ADG had heavier ($P < .05$) hot carcass weights which contributed to more ($P < .05$) carcasses receiving the USDA Choice grade.

Morbidity averaged 11% and ranged from 0 to 39%. Of the calves pulled for treatment, 36.6% were pulled in the first 30 d and 40.2% were pulled from d 30-60 (Table 8). Morbidity increased ($P < .05$) by 6.7% when the calves were commingled in the feedlot. The percent of calves sold as a realizer averaged 0.8% and ranged from 0-3.45%. The percent that died in the feedlot averaged 1.29% and ranged from 0-5.1%.

Table 8. Summary of Morbidity, Mortality, and Realizers in the Feedlot.

Item	No. Pens	Mean	SD	Min	Max	SEM
Morbid[a], %	57	10.99	9.67	0	39.1	1.34
Mortality[b], %	58	1.29	1.24	0	5.1	0.16
Realizers[c], %	54	0.80	0.95	0	3.4	0.13
Morbidity, %						
0-30 d, %	51	4.02	4.7	0	23.9	0.66
31-60 d, %	51	4.42	6.6	0	31.3	0.92
>61 d, %	51	2.91	2.6	0	13.9	0.36

[a] Percent of the group that was morbid in the feedlot.
[b] Percent of the group that died in the feedlot.
[c] Percent of calves that are sold prior to achieving their harvest weight, usually due to respiratory illness.

Commingling of calves in the feedlot resulted in more ($P < .05$) calves being pulled for treatment compared to calves that were not commingled (15.39 vs. 9.37%, respectfully). However, commingling did not affect ($P > .05$) the percent realizers, mortality or ADG of the calves in the pen (Table 9).

Table 9. Effect of Commingling in the Feedlot on Health and ADG.

Item	No. Pens	Commingled	Not commingled	SE	P value
Pulled, %	52	9.37	15.39	2.51	.05
Realizers, %	54	0.79	0.83	0.30	.90
Dead, %	58	1.37	1.04	0.33	.39
ADG, kg	59	1.36	1.31	0.075	.26

Heifers were lighter (P < .05) than steers upon entry into the feedlot (303.3 vs. 331.2 kg, respectfully). Heifers were slower growing (1.24 vs. 1.40 kg/d respectfully) and had lighter HCW (335.5 vs. 363.5 kg, respectfully) compared to steers. However, heifers were not fed longer (P = .43) than steers. Carcasses from heifers had a higher percent that graded Choice or better compared to steers (77.6 vs. 62.2 %, respectfully). The average yield grade was significantly different (P < .05) between heifers and steers (3.20 vs. 3.04, respectfully). A summary of the effects of sex of the calves in the pen is presented in Table 10.

Table 10. Effect of Sex of Calves in the Feedlot on Performance and Carcass Traits.

Sex	Heifers	Steers	SE	P value
No. Pens	23	47		
In Wt, kg	303	331	8.91	.05
ADG, kg	1.24	1.40	0.03	.05
DOF, d	172	166	6.4	.43
HCW, kg	336	364	4.98	.05
Choice, %	77.6	62.2	3.9	.05
Ave YG	3.20	3.04	0.06	.05

Significant differences existed between calves that were straightbred British (SB) and calves that were British x Continental (BC) for In Wt, DOF, quality and yield grade. BC calves were heavier (P < .05) entering the feedlot (333 vs. 301 kg, respectfully) and were fed fewer ($P < .05$) d compared to SB (159 vs. 179, respectfully). SB and BC calves had similar ($P > .05$) ADG and HCW. Carcasses from SB calves had a higher ($P < .05$) percent that graded Choice or better (82.0 vs. 57.8%, respectfully) but had poorer ($P < .05$) yield grades (3.30 vs. 2.94, respectfully) compared to carcasses from BC calves. A summary of the effects of biological type is presented in Table 11.

Table 11. Effect of Biological Type on Feedlot Performance and Carcass Traits.

Item	British	Continental	SE	P value
No. Pens	22	36		
In Wt, kg	301	333	8.35	.05
ADG, kg	1.31	1.33	0.03	.50
DOF, d	179	159	5.8	.05
HCW, kg	348	351	4.55	.60
Choice, %	82.0	57.8	3.6	.05
Ave YG	3.30	2.94	0.06	.05

We had three questions that we wanted to answer from this data. First, what factors affected health, performance and quality grade. Second, what was the marginal cost or change in gross income per hd due to changes in health, performance and quality grade. Third, were calves from MT different vs. calves from the other states in measures of health, ADG, HCW or quality grade in this study. Initially, we felt level of heterosis, nutrition (minerals, green grass at weaning), vaccinations (schedule and type) and backgrounding at the ranch would have an affect on health in the feedlot. In addition, the In Wt, commingling and age of the calves when they entered the feedlot would contribute to overall health. However, the results of the regression only found In Wt and commingling to be significant ($P < .05$) in changing morbidity and only explained 12% of the variation in the percent morbid. Calves from MT were not different ($P > .05$) for measures of health relative to calves from other states in this study. Furthermore, the type of vaccine (modified live vaccine vs. killed), vaccine schedule or use of minerals was not important in explaining the variation in health. Thus, ranch management practices prior to weaning were not effective in this study in reducing variation in morbidity or mortality.

The percent morbidity averaged 11% and ranged from 0-39%. Of the calves that were morbid, 70% were treated once, 20% were treated twice and 10% were treated three times. The chute charge was $1 and the medicine and veterinary (med/vet) charge was $15/treatment. As In Wt increased, the percent morbid decreased ($P < .05$). An additional 10 kg In Wt (318 vs. 328 kg, respectively) resulted in a 0.63 percentage point reduction in the percent of morbid calves. This resulted in a $0.14/hd difference due to a decrease in morbidity. In a pen of 250 hd, the advantage of 10 kg heavier In Wt was $35.00.

Mortality averaged 1.3%. Only In Wt was significant ($P < .05$) but explained a small (Adj R- Sq = 0.12) portion of the variation in the percent mortality. For every 10 kg increase in In Wt, the percent dead decreased by 0.11 percentage points. A conservative assumption was made that feeder calves that varied by 10 kg (318 vs. 328 kg, respectfully) and purchased at $1.87/kg resulted in a marginal change of $0.40/hd or $100.00/250 hd pen due to mortality. These calves may or may not have been morbid and treated before death, thus additional health costs may have occurred but have not been included in this example for this demonstration.

We analyzed factors for their affect on ADG in the feedlot. These included morbidity, mortality, breed type (British vs. Continental), heterosis (straightbred vs.

crossbred), sex of the calves, the number of days the calves were backgrounded, and weight and age of the calves entering the feedlot. In addition, we wanted to know if the state the calves originated from would explain variation in ADG.

Daily gain in the feedlot averaged 1.34 kg/d. Factors that were important to explaining ADG were the state the calves originated, sex of the calves and the percent mortality in the pen. The regression analysis explained 45% of the variation in ADG. Calves from MT gained 0.087 kg/d faster ($P < .05$) relative to other states and steers gained 0.14 kg/d faster ($P < .05$) than heifers. A 10 kg change in In Wt (318 vs. 328 kg, respectfully) resulted in a 0.11 percentage point change in the percent that died in the pen which changed the ADG by 0.004 kg/d.

Factors that were analyzed for their effect on HCW were morbidity, mortality, breed type (British vs. Continental), heterosis (straightbred vs. crossbred), sex of the calves, and weight and/or age of the calves entering the feedlot. In addition, we wanted to know if the state the calves originated from would explain variation in HCW. We also wanted to know which measurement was more accurate in explaining variation in HCW: the number of days the calves were fed in the feedlot, the weight gained in the feedlot or the ADG in the feedlot.

The In Wt and ADG were significant ($P < .05$) in explaining variation in HCW and ADG was better than weight gain or the number of days the calves were fed in explaining variation in HCW. A 10 kg change in In Wt affected health and ADG which impacted HCW by 1.57 kg. The carcass was valued at \$2.31/kg and resulted in a marginal change of \$3.63/hd.

The change in HCW was used with the change in ADG to determine the change in the cost of gain. The cost of gain was calculated by dividing the cost per day ($1.40) by the ADG and multiplying the result by the respective weight gain of each option. The difference in cost of gain was the marginal value change for ADG. For this example, the In Wt was 318 vs. 328 kg, the ADG was 1.432 vs. 1.445 kg and the weight gain was 261 vs. 253 kg for Option 1 and Option 2, respectively. The marginal value change due to faster ADG was $7.97/hd.

The percent of the pen that graded USDA Choice or better averaged 64.8% and 45% of the variation was explained by sex of the calves (steers had a lower percentage of Choice carcasses compared to heifers) in the pen, breed (Continental cross calves had a lower percentage of Choice carcasses compared to calves with no Continental influence) and hot carcass weight (calves that had heavier carcasses graded better than calves with lighter carcasses).

The increase in HCW (1.57 kg) increased the percentage of carcasses that graded Choice by 0.38 percentage points. Conservatively, Choice carcasses were priced at $2.42/kg and Select carcasses were priced at $2.31/kg. Selling the carcass on this "grid" would result in an additional $0.28/hd or $70.00/250 hd. The cumulative effect of an additional 10 kg of In Wt due to a reduction in the percent morbidity ($0.14/hd), the reduction in mortality ($0.40/hd), the increase in ADG ($7.97/hd), the increase in HCW ($3.63) and the increase in the percent of carcasses that graded Choice ($0.28/hd) was $12.42/hd or $3105.00/250 hd. The regression analysis for an additional 10 kg In Wt was presented in Table 12.

Table 12. The Cumulative Value Change of an Additional 10 kg In Wt per hd.

Item	Regression	Option 1	Option 2	Marginal Change	Value Change
Intercept	29.53367				
Commingled[a]	6.701105	1	1		
In Wt, kg[b]	*-0.06289*	*318*	*328*		
Morbidity, %		16.24	15.61	-0.63	$0.14
					A
Intercept	4.71974				
In Wt, kg	-0.01059	318	328		
Mortality, %		1.35	1.25	-0.11	$0.40
					B
Intercept	1.2497				
State[c]	0.0868	1	1		
Sex[d]	0.14183	1	1		
Mortality, %	-0.03453	1.35	1.25		
ADG, kg		1.432	1.435	0.004	$7.97
					C
Intercept	131.37332				
ADG, kg	139.36434	1.4323	1.435		
In Wt, kg	0.10618	318	328		
HCW, kg		364.7	366.2	1.57	$3.63
					D
Intercept	6.42163				
Sex	-22.58475	1	1		
SB[e]	7.2228	0	0		
BC[f]	-22.73093	0	0		
HCW, kg	0.24396	364.7	366.2		
Choice, %		72.80	73.18	0.38	$0.28
					E
Value advantage if sold in the meat of Option 2 per hd					**$12.14**
(A + B + C + D)					
Value advantage if sold on a grid of Option 2 per hd					**$12.42**
(A + B + C + D + E)					

[a] Commingled (0=No, 1=Yes)

[b] In Wt was the weight of the calves entering the feedlot.

[c] State (Other=0, MT=1).

[d] Sex (Heifer=0, Steer=1).

[e] SB was Straight British calves.

[f] BC was British x Continental calves.

Commingling calves in the feedlot negatively influenced ($P < .05$) the percent morbidity in the pen by 6.7 percentage points. The value change in the percent morbidity due to commingling resulted in a difference of $1.50/hd or $375.00/250 hd pen. However, commingling and morbidity did not affect mortality, ADG, HCW, or quality grade and thus, the total value change for these options was due to commingling and the subsequent morbidity. The summary of the cumulative value change of commingling was presented in Table 13.

The summary of the cumulative value change of MT calves vs. calves from other states was presented in Table 14. MT calves were not different from calves from other states for morbidity or mortality and thus, were not different in value change for health. However, calves from MT had faster gains (0.087kg/d) in the feedlot compared to calves from other states and resulted in a $3.53 difference over the feeding period. This increase in ADG also increased HCW by 12.1 kg which was worth $27.94/hd and increased the percent of carcasses that graded Choice by 2.95 percentage points and $2.11/hd. Thus, the cumulative value change of feeding MT calves was $31.47 if the calves were sold in the meat and $33.58 if the calves were sold on the grid used in this study. If the Choice-Select spread were raised to $0.22/kg, the cumulative value would be $35.70.

Table 13. The Cumulative Value Change of Commingling per hd.

Item	Regression	Option 1	Option 2	Marginal Change	Value Change
Intercept	29.53367				
Commingled[a]	*6.701105*	*0*	*1*		
In Wt, kg[b]	-0.06289	318	318		
Morbidity, %		9.53	16.24	6.7	-$1.50
					A
Intercept	4.71974				
In Wt, kg	-0.01059	318	318		
Mortality, %		1.35	1.35	0	$0.00
					B
Intercept	1.2497				
State[c]	0.0868	1	1		
Sex[d]	0.14183	1	1		
Mortality, %	-0.03453	1.35	1.35		
ADG, kg		1.432	1.432	0	$0.00
					C
Intercept	131.37332				
ADG, kg	139.36434	1.432	1.432		
In Wt, kg	0.10618	318	318		
HCW, kg		364.7	364.7	0	$0.00
					D
Intercept	6.42163				
Sex	-22.58475	1	1		
SB[e]	7.2228	0	0		
BC[f]	-22.73093	0	0		
HCW, kg	0.24396	364.7	364.7		
Choice, %		72.80	72.80	0	$0.00
					E
Value advantage if sold in the meat of Option 2 per hd					**-$1.50**
(A + B + C + D)					
Value advantage if sold on a grid of Option 2 per hd					**-$1.50**
(A + B + C + D + E)					

[a] Commingled (0=No, 1=Yes)
[b] In Wt was the weight of the calves entering the feedlot.
[c] State (Other=0, MT=1).
[d] Sex (Heifer=0, Steer=1).
[e] SB was Straight British calves.
[f] BC was British x Continental calves.

Table 14. The Cumulative Value Change of MT Calves vs. Calves from Other States In Wt per hd.

Item	Regression	Option 1	Option 2	Marginal Change	Value Change
Intercept	29.53367				
Commingled[a]	6.701105	1	1		
In Wt, kg[b]	-0.06289	318	318		
Morbidity, %		16.24	16.24	0	$0.00
					A
Intercept	4.71974				
In Wt, kg	-0.01059	318	318		
Mortality, %		1.35	1.35	0	$0.00
					B
Intercept	1.2497				
State[c]	***0.0868***	***0***	***1***		
Sex[d]	0.14183	1	1		
Mortality, %	-0.03453	1.35	1.35		
ADG, kg		1.345	1.432	0.087	$3.53
					C
Intercept	131.37332				
ADG, kg	139.36434	1.345	1.432		
In Wt, kg	0.10618	318	318		
HCW, kg		352.6	364.7	12.10	$27.94
					D
Intercept	6.42163				
Sex	-22.58475	1	1		
SB[e]	7.2228	0	0		
BC[f]	-22.73093	0	0		
HCW, kg	0.24396	352.6	364.7		
Choice, %		69.85	72.80	2.95	$2.11
					E
Value advantage if sold in the meat of Option 2 per hd					**$31.47**
(A + B + C + D)					
Value advantage if sold on a grid of Option 2 per hd					**$33.58**
(A + B + C + D + E)					

[a] Commingled (0=No, 1=Yes)

[b] In Wt was the weight of the calves entering the feedlot.

[c] State (Other=0, MT=1).

[d] Sex (Heifer=0, Steer=1).

[e] SB was Straight British calves.

[f] BC was British x Continental calves.

Implications

It is difficult to collect complete information from the producer, backgrounder, feeder and packer. The reasons include: 1) lack of records, 2) lack of standardization of those records, 3) multiple owners, 4) lack of communication between owners 5) distrust between the industry segments and 5) a mismatch of pen size to herd size which necessitates commingling..

The size and complexity of modern feedyards requires a complicated computer record keeping system. Clarifying which records are valuable for making production and financial decisions may alleviate these problems. In addition, it is apparent that ranchers would like to take advantage of heterosis, as evident of the percentage of pens that had crossbred calves. However, in personal communication with the ranchers that participated in this study, confusion exists concerning the proper breed types that should be used to achieve targets at the ranch, feedlot and packing plant. Some of these pens contained two British and three Continental breed types. Ranchers were dissatisfied with seedstock supplier claims and experimented with other breeds. Multiple breed types also created additional management problems for feedlot managers and packing plants.

Commingling calves in the feedlot increased morbidity. In addition, the weight of the calves entering the feedlot influenced mortality, ADG, HCW and the percent of carcasses that graded Choice. In these examples, increasing ADG and HCW was more important to the gross income compared to reducing health cost and quality grade.

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APPENDIX A:

INDIVIDUAL ANIMAL MEASUREMENTS FROM RANCHES

Table 15. Preconditioning Program Protocol for Calves on the MSU Protocol.

Cattle must be individually identified with electronic ear tags.
Cattle must be source verified.
Cattle must be dehorned and males castrated.
Cattle must be vaccinated a minimum of 21 d prior to weaning with IBR, BVD, PI-3, BRSV, 7 or 8 Way Clostridial, Pasturella and Hemophilus Somnus.

Table 16. Vaccination and Backgrounding Program for Calves on the MSU Protocol.

Administer booster immunizations 14-28 d after weaning/preweaning immunizations and a minimum of 30 d prior to shipment if necessary.
Cattle **MUST** be held a minimum of 45 d after weaning, prior to shipping.
Cattle must be bunk broke.

Table 17. Suggested Types of Vaccines for Preconditioning Calves on the MSU protocol.

IBR (chemically altered modified live)
PI-3 (chemically altered modified live)
BVD (killed)
BRSV (modified live or killed)
7- way blackleg
H. somnus

Table 18. Suggested Types of Booster Vaccines for Preconditioning Calves on the MSU protocol.

IBR (modified live or chemically altered)
PI-3 (modified live or chemically altered)
BVD (killed)
BRSV (modified live or killed)
Pasturella

It is recommended that the producer seek the advice of his/her veterinarian to select the type of respiratory vaccine that best fits their ranch health management program. It is up to the discretion of the ranch if the animals are to be de-wormed at weaning or the second month.

Table 19. Survey of Ranch Management

	No		Viral		Vaccination Schedule	Mineral
Ranch	**MSU**	**PRM**	**MSU**	**PRM**		
1	147	138	MLV	MLV	W[a]	Yes[e]
2	177	163	MLV	MLV	WPO[b]	Yes
3	188	183	MLV	MLV	PRW[c]	Yes
4	98	93	MLV	MLV		Yes
5	109	26	MLV	MLV	PR[d]	Yes
6	158	47	MLV	MLV	PR	Yes
7	88	90	MLV	MLV	PRW	Yes
8	92	39	MLV	MLV	WPO	Yes
	1078	**758**				

[a] Weaning.
[b] Weaning and postweaning.
[c] Preweaning and weaning.
[d] Preweaning.
[e] Mineral provided prior to weaning to calves and cows.

Table 20. Results of Water and Forage Tests

Ranch	Water		Forage	
	Nitrates, ppm	Sulfates, ppm	Nitrates, ppm	Sulfates, ppm
1	n.d.	229		
4	3.7	2536		
6			1.6	38.3

Table 21. Summary of Ranch Location and Feedlot Location.

Ranch	Ranch Location	Feedlot	
		MSU	PRM
1	Central	MT	MT
2	Southeast	MN	MN
3	East Central	SD	SD
4	East Central	Ontario	Ontario
5	North Central	KS	MT
6	North Central	NE	MT
7	North West	CO	CO
8	South West	CO	CO

Table 22. Summary of Morbidity by Ranch.

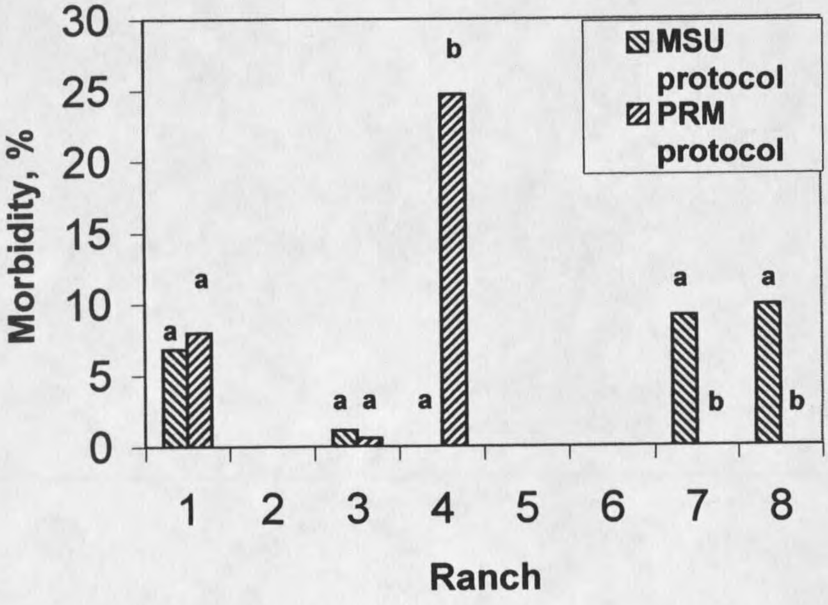
Ranch	No of calves		Mean, %
	MSU	PRM	
1	147	138	7.4^{bc}
2	177	163	0^{a}
3	188	183	0.8^{a}
4	98	93	12.0^{c}
5	109	26	0^{a}
6	158	47	0^{a}
7	88	90	4.5^{b}
8	92	39	6.9^{bc}
Mean	**1078**	**758**	**3.5**

^{abc} Different superscripts in the same row are different ($P < .05$).

Table 23. Summary of Morbidity by Ranch x Treatment.

	No.		Morbidity, %[b]			
Ranch	**MSU**	**PRM**	**MSU**	**PRM**	**Chi Sq Value**	**P value**
1	147	138	6.8	8.0	0.1423	NS
2	177	163	0	0	0	NS
3	188	183	1.1	0.6	0.3095	NS
4	98	93	0	24.7	27.55	.0001
5	109	26	0	0	0	NS
6	158	47	0	0	0	NS
7	88	90	9.1	0	8.57	.0034
8	92	39	9.8	0	4.1	.0430
Mean	**1057**	**779**	**2.7**	**4.5**		

Figure 2. Morbidity by Ranch x Treatment.



[ab] Unlike superscripts within ranch are different (P < .05).

Table 24. Summary of Initial Weight by Ranch x Treatment[a].

	Initial Wt, kg			
Ranch	**MSU**	**PRM**	**SE**	**P-value**
1	239	237	2.4	NS
2	205	199	2.2	NS
3	173	163	2.1	.05
4	233	211	2.9	.05
5	249	307	5.4	.05
6	270	257	4.1	.05
7	248	239	3.0	.05
8	274	301	4.4	.05
Mean	**230**	**216**	**4.6**	**.05**

[a] The initial weight was the weaning weight and was also the weight at the start of the 45 d study.

Table 25. Summary of ADG 0-28 D by Ranch x Treatment.

Ranch	**MSU**	**PRM**	**SE**	**P-value**
2	0.62	0.13	0.04	.05
4	1.09	1.37	0.05	.05
6	1.15	1.53	0.05	.05
Mean	**0.87**	**0.80**	**0.5**	**.14**

Table 26. Summary of Overall ADG by Ranch x Treatment.

	ADG, kg			
Ranch	**MSU**	**PRM**	**SE**	**P-value**
1	0.80	0.78	0.03	NS
2	-	-	-	-
3	1.39	1.04	0.03	.05
4	1.19	1.35	0.03	.05
5	1.07	0.91	0.07	.05
6	-	-	-	-
7	1.20	1.12	0.04	NS
8	0.90	1.28	0.06	.05
Mean	**1.12**	**1.04**	**0.4**	**.05**

Table 27. Summary of Final Weight by Ranch x Treatment[a].

Ranch	Final Wt, kg		SE	P-value
	MSU	PRM		
1	251	250	1.3	NS
2	-	-	-	-
3	287	273	1.4	.05
4	272	278	1.5	.05
5	264	259	3.1	NS
6	-	-	-	-
7	269	266	1.6	NS
8	264	280	2.6	.05
Mean	**270**	**267**	**2.9**	**.05**

[a] The final weight was the weight at the end of the 45 d study.

Table 28. Summary of Morbidity and Initial Weight.

Trt		**MSU**		**SE**	**P-value**		**PRM**		**SE**	**P-value**
Morbid	Percent	No	Yes			Percent	No	Yes		
Ranch										
1	8.0	239	233	8.8	**NS**	6.8	237	242	8.4	**NS**
2	0	205	-	2.1	-	0	199	-	2.2	-
3	1.1	173	185	19.6	**NS**	0.6	163	216	27.7	**.05**
4	0	233	-	2.8	-	24.7	210	213	5.8	**NS**
5	0	249	-	2.7	-	0	307	-	5.4	-
6	0	270	-	2.2	-	0	257	-	4.0	-
7	9.1	248	249	9.8	**NS**	0	239	-	2.9	-
8	9.8	276	254	9.2	**.05**	0	301	-	4.4	-
Mean	**2.7**	**215**	**222**	**8.3**	**.42**	**4.5**	**230**	**241**	**8.1**	**.20**

Table 29. Effect of Morbidity on Overall ADG.

Trt		MSU		SE	P-value		PRM		SE	P-value
Morbid	Percent	No	Yes			Percent	No	Yes		
Ranch										
1	8.0	0.81	0.66	0.10	**NS**	6.8	0.82	0.33	0.10	**.05**
2	0	-	-	-	-	0	-	-	-	-
3	1.1	1.40	1.16	0.23	**NS**	0.6	1.05	0.47	0.32	**NS**
4	0	1.19	-	0.03	-	24.7	1.39	1.22	0.07	**.05**
5	0	1.06	-	0.03	-	0	0.91	-	0.07	-
6	0	-	-	-	-	0	-	-	-	-
7	9.1	1.20	1.26	0.12	**NS**	0	1.12	-	0.04	-
8	9.8	0.93	0.67	0.11	**.05**	0	1.28	-	0.06	-
Mean	**2.7**	**1.12**	**0.90**	**0.07**	**.05**	**4.5**	**1.06**	**0.92**	**0.06**	**.05**

Table 30. Summary of Morbidity on Final Weight.

Trt		MSU		SE	P-value		PRM		SE	P-value
Morbid	Percent	No	Yes			Percent	No	Yes		
Ranch										
1	8.0	252	246	4.6	**NS**	6.8	252	235	4.4	**.05**
2	0	-	-	-	-	0	-	-	-	-
3	1.1	287	276	10.3	**NS**	0.6	274	245	14.6	**.05**
4	0	272	-	1.5	-	24.7	280	273	3.0	**.05**
5	0	264	-	1.4	-	0	259	-	3.1	-
6	0	-	-	-	-	0	-	-	-	-
7	9.1	269	271	5.2	**NS**	0	266	-	1.6	-
8	9.8	265	254	4.9	**.05**	0	280	-	2.6	-
Mean	**2.7**	**274**	**265**	**3.2**	**.05**	**4.5**	**262**	**254**	**3.1**	**.05**

[a] Only animals with complete information from weaning to harvest and with carcasses with calculated quality and yield grades were reported.

[b] P-values not calculated.

Table 31. Summary of Feedlot Performance and Carcass Characteristics[a] by Ranch and Treatment[b].

Ranch	Trt	No	ADG, kg	DOF	HCW, kg	REA, cm^2	QG, % > Ch	YG	YG 1 & 2, %
1	MSU	90	1.34	175	315.5	28.14	67.8	3.13	36.7
1	PRM	84	1.29	177	310.5	27.99	53.6	3.17	33.3
5	MSU	46	1.50	124	317.7	34.54	47.8	3.17	30.4
5	PRM	23	1.36	117	321.5	28.78	52.2	3.21	30.4
	Summary	**243**	**1.35**	**161**	**314.7**	**29.36**	**57.6**	**3.16**	**33.7**

Table 32. Effect of Sex of Calf x Biological Type interaction on Performance and Carcass Traits.

	British		Continental				
	Heifers	**Steers**	**Heifers**	**Steers**	**SE**	**P value**	**R-Sq**
No. Pens	6	24	12	18			
In Wt, kg	272^{a}	320^{bd}	325^{b}	343^{cd}	16.6	.21	0.23
ADG, kg	1.23^{a}	1.39^{b}	1.25^{a}	1.4^{b}	0.05	.94	0.33
DOF, d	188^{a}	174^{ab}	160^{bc}	157^{c}	12.0	.50	0.13
HCW, kg	328^{a}	364^{b}	339^{a}	364^{b}	9.38	.39	0.29
Choice, %	89.0^{a}	74.4^{ab}	65.8^{b}	49.9^{c}	7.3	.89	0.38
Ave YG	3.38^{a}	3.23^{b}	3.03^{a}	2.86^{b}	0.11	.92	0.34

Unlike superscripts within a row are different ($P < .05$).