EFFECT OF NUTRITION, MEDICAL TREATMENTS AND MANAGEMENT PRACTICES ON HEALTH AND PERFORMANCE OF NEWLY RECEIVED STOCKER CATTLE

By

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Bachelor of Science

Texas A&M University

College Station, Texas

1980

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
December, 1985

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ACKNOWLEDGEMENTS

I wish to express sincere appreciation to Dr. Donald Gill for his guidance and assistance during the course of this study and in the preparation of this manuscript. I would like to thank Dr. Fred Owens and Dr. Keith Lusby for serving on my guidance committee and helping in the preparation of this manuscript. I would also like to thank Dr. Robert Smith for his suggestions and guidance during the course of this study.

Grateful acknowledgement is also extended to Roy and Diane Ball, at the Pawhuska Research Station, for their time spent processing, treating, feeding, and managing the 27 truck loads of cattle used in this study.

I am also grateful to my fellow graduate students for their friendship, assistance, and helpful suggestions.

A very special thanks is extended to my parents, Bob and Linda Hicks for their love and support during the course of this study. I would also like to thank my mother-in-law, Hollis Burgess, for her love and encouragement.

Finally, I would like to extend a very special thanks to my wife, Mona, for her help, understanding, patience, and love during the course of this study.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Shipping fever is an entity of the Bovine Respiratory Disease Complex (Lillie, 1974). According to Lillie, two other major clinical entities of the Bovine Respiratory Disease Complex are enzootic pneumonia of calves and atypical interstitial pneumonia. Shipping fever includes several different syndromes which occur in cattle following shipment. The disease is characterized by mild to severe respiratory inflammation with a variable death loss due to pneumonia. It results in considerable economic loss directly (medical treatment and death loss) and indirectly (weight loss, poor feed utilization, and chronic depression of weight gains).

Symptoms of the disease range from those nearly indetectable to rapidly fatal pneumonia. Hoerlein (1964) gives the following symptoms or signs of shipping fever: 1) Affected calves exhibit considerable depression, standing alone with their heads down and ears drooping; 2) Calves often have a gaunt appearance from almost complete anorexia; 3) The nasal mucous membranes may be dry or copious nasal exudate may be present; 4) Increased respiratory rate is often present and a characteristic soft cough is common in affected groups; and 5) Diarrhea may be present in some epizootics.

At necropsy lesions are most prominent in the respiratory tract and include inflammation of the mucosa of the airways and a fibrinous

pleuritis and pneumonia with hemorrhage into the alveoli and a marked thickening of the interlobular septa (Collier, 1967). Varying amounts of the anterior and ventral portions of the lungs are affected.

Shipping fever is one of the major diseases associated with cattle production in the United States. Jensen et al. (1976) reported the results of a 1974 survey of illnesses and death in 407,000 head of yearling feedlot cattle. About 5.1% of the cattle became sick and of these, 18.9% died for a .96% death loss. Of the 3,943 fatalities, 1,988 were necropsied and about 75% of the clinical diagnoses were respiratory tract diseases. Of the cattle with respiratory tract diseases, 75% had shipping fever pneumonia which extrapolated to a .54% death loss from shipping fever. Church (1980) reported the results of a survey of 24 feedlots in Alberta, Canada conducted in 1977 and 1978. A 12.9% morbidity rate and a 1.2% death loss was reported. It was estimated that respiratory diseases accounted for approximately 60% of the sickness and death loss which equaled a .72% death loss from respiratory disease. Herrick (1979) states that on a national basis, 1 to 2% of all feeder cattle die during the first six weeks after they enter the feedlot. Losses in light 250 lb. to 350 lb calves arriving in Southwestern feedlots can rise to 2 to 5% (Addis, 1980a).

The shipping fever complex is a major economic burden on the beef cattle industry with annual losses estimated at $200 to $400 million (Cole, 1982). The estimated economic losses due to shipping fever have increased significantly ($0.5 vs. 77 million in 1940 dollars) since 1940 (Mohler et al., 1942; USDA, 1952; USDA, 1980). Much of this increase can be attributed to an increase in the number of calves transported long distances to feedlots as well as more intensive

marketing and production systems. Herrick (1969) estimated that the disease costs $10 to $20 for every calf in the feedlot. Cope (1978) estimated that it costs between $12 to $15 per head for an animal to get sick in the feedlot. Church (1980) reported that the Canadian survey estimated that the total animal health cost including veterinarian fees, drugs and vaccines, handling costs, death losses, and reduced gains averaged $12.85 per head received at the feedlot.

Since shipping fever continues to be a major disease in cattle and is expensive to treat, it is important to conduct research on the treatment and control of this disease. The objectives of this research project were to evaluate the effects on the health and performance of newly arrived, stressed stocker calves of the following factors: 1) Preventative medication with long-acting oxytetracycline and sustained release sulfadimethoxine, 2) Coccidiostats - decoquinate and lasalocid, 3) Recombinant leukocyte hybrid A/D interferon, 4) Respiratory syncytial virus vaccine, 5) Live Pasteurella hemolytica vaccine, 6) Vitamin E supplementation, 7) Sequence of current and new injectable antibiotics and sulfas, and 8) Anthelmintics - ivermectin.

CHAPTER II

REVIEW OF LITERATURE

Causes of Shipping Fever

During the 1950's and 1960's much research was aimed at determining the causes of shipping fever. Hoerlein and Marsh (1957) proposed the following thesis for the development of the shipping fever complex (SFC): Stress + Nonbacterial infection (viral) + Bacterial infection = shipping fever. At least six bacterial pathogens and 11 non-bacterial pathogens have been associated with the SFC (Hoerlein, 1973).

It appears that each of the three major categories (stress, nonbacterial infection, and bacterial infection) must provide at least one factor to produce the full Shipping Fever Syndrome. Hamby et al. (1963) studied the transmission of shipping fever in calves by exposing them to various infectious agents (virus and bacteria) and physical stress. It was observed that a single infectious agent alone, stress alone, or stress in combination with a single infectious agent failed to produce the disease. However, stress in combination with parainfluenza-3 and Pasteurella ssp. resulted in clinical signs closely resembling those seen in cattle with shipping fever. In additional studies, Hamby et al. (1964) reported that parainfluenza-3, infectious bovine rhinotracheitis, or psittacosis lymphogranuloma venereum virus plus Pasteurella ssp. along with

stress combined to produce shipping fever. Any of these infectious agents alone, stress alone, or any other combination of infectious agents and stress failed to produce the disease. Similar results were obtained in a study by Trapp et al. (1966).

Carter (1973) proposed the following thesis for the development of shipping fever. Collier (1968b) put forward essentially the same thesis.

1) The upper respiratory tract of cattle frequently harbors a considerable number of potentially pathogenic organisms. Different individuals and herds may harbor different organisms.

2) The bringing of cattle together from different sources results in an exchange of these organisms.

3) Mild and clinically inapparent viral infections occur continually in cattle. When cattle from different sources are brought together these infections become more frequent and severe. Mycoplasmas also might cause respiratory infections.

4) As a result of various environmental stresses, these mild infections are aggravated, with resulting dissemination of infectious agents by droplet infection and fomites. Stresses lower resistance to infectious agents. Viral pathogens are capable of destroying the "mucus escalator" of the respiratory tract by infecting the ciliated and mucus secreting cells (Hoorn and Tyrrell, 1966).

5) The damaged respiratory tract offers very favorable conditions for secondary invaders, bacteria such as P. multocida and P. hemolytica.

Viruses

During the 1960's much research was conducted looking at the relationship of parainfluenza-3 (PI-3) virus with shipping fever. It was first isolated from calves with clinical signs of SFC by Reisinger et al. (1959). Other isolations were subsequently reported by Hoerlein et al. (1959), Gale and King (1961), Bryne et al. (1961), and Sweat (1967). Brown (1979) and Wilkie (1980) suggest that PI-3 can be disregarded as a significant primary bovine pathogen. Brown (1979) reported that PI-3 is seldom found as a cause of generalized infection in High Plains feed yards. Its presence is not characterized by overt lesions, and where illness occurs and lesions are found, lesions are attributable to other more virulent micro-organisms. PI-3 is a very common cause of infection but is seldom a cause of clinically apparent respiratory disease (Brown, 1979).

There is also an abundance of research concerning infectious bovine rhinotracheitis (IBR) and its relationship with shipping fever. This virus was isolated from cattle with shipping fever in California (Madin et al., 1956) and in Maryland (Reisinger et al., 1959). More recently Jensen et al. (1976) and Brown (1979) have reported that IBR is associated with SFC in feedlot cattle. Brown (1979) reported that the virus appears to be of lessening significance as a primary viral pathogen in bovine respiratory disease in High Plains feed yards. It is suggested that this is a result of the standard practice of relatively effective IBR vaccination of both breeding animals and feeder calves.

Bovine virus diarrhea (BVD) virus is another important infectious

agent associated with shipping fever. Studies by Reggiardo (1979) and Martin et al. (1980) showed that it plays a role in SFC. Brown (1979) reported that BVD virus is the infectious agent most frequently isolated from bovine respiratory disease outbreaks in High Plains feed yards characterized by unusually high morbidity and mortality. It is suggested that clinical shipping fever, non-responsive to antibiotic medication, is the condition that the veterinarian should learn to recognize and associate with bovine virus diarrhea infection.

Rosenquist (1983) reported on several "less well-recognized" viruses that are associated with bovine respiratory disease. These viruses include "Type 4" bovine herpesviruses, adenoviruses, respiratory syncytial virus, reoviruses, rhinoviruses, and enteroviruses. The most widespread of these other viruses is respiratory syncytial virus (RSV). Rosenquist (1983) reported that where testing for RSV has been done in the United States, the number of seropositive cattle ranges from 38 to 100 percent. It is reported that approximately 88 percent of Missouri beef and diary calves less than one year of age are seropositive. The virus has been detected in respiratory infections of cattle with severe clinical and pathological features (Rosenquist, 1974) and recent work has suggested that it may be associated with the Acute Respiratory Distress Syndrome of calves (Frey, 1983).

Bacteria

Several review articles address the subject of bacteria in SFC (Collier, 1968a, 1968b; Carter, 1973; Lillie, 1974). The clinical signs of SFC are largely caused by bacterial components since treatment

with antibiotics and sulfonamides generally provide dramatic results (Hoerlein, 1973). Pasteurella multocida was known to be associated with SFC several years before the importance of Pasteurella hemolytica was discovered (Farley, 1932). During the 1950's and early 1960's P. hemolytica was isolated from calves with SFC (Carter, 1954; Gale and King, 1961; Hoerlein et al., 1961; Collier et al., 1962). More recently, P. hemolytica and less frequently, P. multocida, have been isolated from the pneumonic lungs of feedlot cattle (Jensen et al., 1976; Hjerpe and Routen, 1976; Reggiardo, 1979; Martin et al., 1980). P. hemolytica Type I is the most commonly isolated bacterial pathogen from the acutely affected bovine lung (Brown, 1979; Frank and Smith, 1983).

Corynebacterium pyogenes has been isolated from pneumonic lungs as well as from healthy tissues from the upper respiratory tract (Hjerpe and Routen, 1976; Brown, 1979; Frank, 1983). It is a known pathogen often found in abscesses of cattle, swine, sheep and goats, but its involvement in bovine respiratory disease is unknown (Frank, 1983).

Haemophilus somnus has been isolated from cattle with bronchopneumonia and fibrinous pneumonia. Its involvement in typical bovine respiratory disease is unclear (Brown, 1979; Stephens et al., 1981).

Mycoplasmas are isolated with great frequency from cattle with bovine respiratory disease (Hjerpe and Routen, 1976; Jensen et al., 1976). They are isolated both from pneumonic lungs and from the respiratory tracts of healthy calves, but their role in bovine respiratory disease has not been determined (Stalheim, 1983).

Stress

Brown (1959) defined stress as a harmful condition resulting from the inability of the organism to maintain an adequate internal environment. Wilson (1971) defined stress as the load on the animal system and the resulting strain of that load is the physiological response. The magnitude of the stress will dictate the amplitude of the response by the organism if it can respond. Phillips (1982) divided the types of stress imposed on beef cattle into five major areas: physical, nutritional, physiological, environmental, and productive. Since mature cattle are not confronted with as many new and different situations as immature cattle, they are subject to fewer kinds of stress than calves. To the calf, all experiences are new and most are perceived as stressful. The inability to respond or to maintain the response to stress lowers the resistance of the calf to viral and bacterial agents and can result in SFC.

Physical stress includes such factors as restraint, dehorning, castration, identification, transportation, and assembly. Martin et al. (1980) reported that there was a lower death loss among cattle not having to be dehorned in Canadian feedlots. Addis et al (1980b) reported that castration of newly received calves decreased daily gains by 26%, feed intake by 12%, and feed efficiency by 22%. Davis (1978) reported that dehorning, castration, or a combination of both resulted in lowered daily gains and increased morbidity and mortality in stressed calves. Castration with a burdizzo tended to decrease gains and increased death loss more than surgical castration. Zinn et al. (1985a) noted that dehorning of newly arrived feedlot calves did not

influence animal health or performance, whereas castration reduced weight gains ($P<.05$). Zweiacher et al. (1979) reported that castration by emasculation tended to decrease gains and increase sickness more than castration by elastrator-ligation.

One of the major factors affecting the performance and health of stocker calves is the farm of origin. McLaren et al. (1978) reported that the farm of origin was a significant factor in weight gain and loss during assembly, transportation, and after arrival at the feedlot. Farm of origin explained 9.4 to 26.9% of the variation in weight changes and 7.3 to 56.4% of the variation in rectal temperature at various points from farm to feedlot. The amount of variation explained by farm of origin was less at each assembly site (auction, barn, order buyer barn, transportation, and feedlot). Feedlot morbidity was significantly affected by farm of origin and varied from 15 to 90% across farms. Phillips and Leining (1981) noted that transit of yearling steers resulted in elevated rectal temperatures. Camp et al. (1981) reported significant differences in weight gains and morbidity due to differences in shipping dates. Camp et al. (1983) observed a high positive correlation between market-transit weight loss (shrink) and subsequent incidence of bovine respiratory disease. Apparently the incidence of shipping fever is effected by time in transit and environmental conditions before, during, and immediately after transit. Griffin (1983) speculated that 25% of the problems in receiving cattle at Oklahoma Panhandle feedlots can be attributed to shrink involved in animal transport and another 25% of the problems can be associated with either the order buyer or geographical origin of the calves.

Nutritional stresses include dietary changes, feed deprivation,

water deprivation, irregular feeding, protein deficiency, and mineral imbalance. Nutrition-health interactions will be discussed later in this review.

Psychological stresses include weaning, change in location, change in social order, transit, feeding pattern, and space allowance. Weaning is one of the more severe stresses of feeder calves (Wieringa et al., 1974, 1976). Martin et al. (1982) in a survey of Canadian feedlots, observed that mixing of cattle after arrival was consistently associated with increased mortality and health cost. It is suggested that this is most likely due to the introduction of larger numbers and/or new strains of respiratory pathogens. However, the stress involved with the change could also play an important role.

Environmental stresses include heat, cold, winds, humidity, solar intensity, and day-light. Young (1981) summarized feedlot performance of beef calves at different geographic locations and during different seasons. The locations varied from the northern climate of Canada to the warmer southern climate of the Texas Panhandle. Only small differences were noted in daily gains, but feed efficiency was lower at colder locations and within each location seasonal variations in gains were noted. Schake et al. (1971) in summarizing the performance of 150,000 West Texas calves noted seasonal variations for daily gain and mortality.

Productive stresses include conception, gestation, parturition, lactation, and growth. These stressors are primarily associated with mature beef cows and not feeder calves.

Vaccines

Much research has been conducted over the past 25 years with parainfluenza-3 (PI-3), infectious bovine rhinotracheitis (IBR), and bovine virus diarrhea (BVD) virus vaccines. Most feedlots now routinely vaccinate for PI-3 and IBR viruses. These vaccines, though useful, will not prevent SFC because of the large number of infectious agents and stressors involved in the development of the disease. Martin (1983) in a review of laboratory experiments and field trials conducted to determine the efficacy of vaccination reported that there was little published data to support the use of virus vaccines (PI-3, IBR, IBR/PI-3, and BVD) against respiratory diseases under feedlot conditions.

Over the past 50 years much research has been conducted with Pasteurella bacterins in an effort to control SFC. Wilkie (1980) reviewed studies on the biological control of SFC and concluded that Pasteurella bacterins do not have obvious usefulness in control of the disease. Farley (1932) reported that vaccination of 5,661 cattle with Pasteurella bacterins was associated with a death loss of 3.58% compared with 1.02% for 4,119 nonvaccinated controls. Similarly, more recent field trials have indicated that vaccinated calves had higher morbidity, higher mortality, and reduced weight gains when compared to nonvaccinated calves (Hamby et al., 1965; Woods et al., 1976; Amstutz et al., 1981). Martin et al. (1980) observed higher mortality in calves vaccinated at the time of arrival in Canadian feedlots with viral (PI-3, IBR, and BVD) and bacterial agents.

Recent research with live Pasteurella hemolytica vaccine has

shown more promising results. Hutcheson et al. (1983) reported the results of a study with 93 calves in which approximately one-half of the calves were vaccinated with experimental live P. hemolytica intradermal vaccine and the other half served as controls. No significant differences in morbidity, mortality, or performance of the two groups was seen. However, the geometric mean antibody titer to P. hemolytica was statistically greater in vaccinates than controls 14 days after vaccination. Purdy et al. (1983) vaccinated 41 calves (51 control calves) with modified live P. hemolytica. The vaccine had no significant effect on average daily gains or morbidity, but both morbidity and mortality were slightly decreased by vaccination.

Smith (1983) reported the results of field tests in which a live P. hemolytica vaccine (PRECON-PH) was tested. In field tests of commercial cattle comparing 225 vaccinated calves with 1,225 nonvaccinated calves, morbidity and mortality were reduced by vaccination. The incidence of bovine respiratory disease among the nonvaccinated calves was 17.4% with 2.3% mortality while the incidence among co-mingled vaccinated calves was 2% with no mortality. In field trials in which the vaccine was used with a preconditioning program, the incidence of BRD was 55.2% among the non-preconditioned calves and 12.7% among the preconditioned calves. In a feedlot trial, the vaccine was used to vaccinate feeder calves upon arrival. The incidence of BRD among the co-mingled vaccinated calves was reduced 44% as compared to the nonvaccinated cattle and the number of treatments per case was reduced by 40%.

Interferon

Interferon is a small protein which is produced or released by animal cells in response to invasion by viral or certain nonviral stimuli and which indirectly protects other cells against viral damage by stimulating the production of new antiviral polypeptide or protein (Rosenquist, 1973). It is believed to have an important role in the recovery of host animals from viral infections (Isaacs, 1963; Baron et al., 1966). Baron (1970) pointed out that interferon is an important part of the body's non-immune defenses and is probably the major cause of recovery from already established viral infections. Interferon appears early in infection, in contrast to circulating antibody, and is present before lesions occur. It can intracellularly inhibit the multiplication of viruses in animal tissues. Thus, it seems to provide a mechanism for the recovery of animals from viral infections and is independent of the specific immune mechanisms (Rosenquist and Loan, 1969).

Rosenquist (1973) noted that viruses of almost every major viral group have been shown to induce and be affected by interferon though some are more efficient stimulators of interferon production or are more sensitive to its actions than others. Those viruses most commonly associated with SFC that have been shown to induce interferon production are PI-3 (Rosenquist and Loan, 1967; Trueblood and Manjara, 1972) and IBR (Rosenquist and Loan, 1969; Todd et al., 1972; Cummins and Rosenquist, 1980, 1982a, 1982b). Interferon has been shown to protect against heterologous respiratory tract viral infections (Todd et al., 1972; Cummins and Rosenquist, 1980, 1982a, 1982b). Fulton and

Cummins (1983) noted that IBR virus is sensitive to the antiviral effects of bovine and human alpha interferon in vitro. Cummins and Hutcheson (1982) tested the hypothesis that interferon induced by an intranasal IBR/PI-3 vaccination would protect feedlot calves against natural viral challenge during a shipping fever outbreak. In this experiment, the attempt to enhance interferon production by vaccination was not beneficial. More morbidity and mortality were observed in the vaccinated calves than the controls, though this difference was not significant.

Cummins and Hutcheson (1983) conducted a study to determine the efficacy of human leukocyte interferon in calves infected with IBR virus. Twenty-eight head of 36 virus infected calves were given interferon once daily on the day of, and for two days subsequent, to virus inoculation by three different routes (intravenously, orally, and intranasally) at three different dosage concentrations. Calves given interferon intravenously performed the poorest (30% death loss) and calves given interferon orally at the lowest dosage out-gained all other groups.

Preventative Medication

A high incidence of sickness due to SFC is only a problem during the first month for calves received at feedlots. It is important that an effective animal health program be used the moment a shipment of calves arrives at a feedlot. The cattle must be started correctly if they are to be profitable. Compared with sick cattle, cattle that remain healthy should consume more feed, gain faster, and require fewer dollars in medication and feed costs. One approach to prevent

excessive death loss and decreased performance of newly received stocker cattle is to mass medicate all animals on arrival with antibiotics. This approach is based on the premise that most of the cattle will get sick shortly after arrival and that sickness is not easily identified on arrival. The primary considerations in mass medication are (1) effectiveness and (2) economics. Cost is justified only if most of the calves get sick shortly after arrival.

Schipper and Kelling (1974) reported the results of a study in which 1167 calves in five feedlots were given a subcutaneous injection of procaine penicillin G and benzathine penicillin G with or without dihydrostreptomycin sulfate (Longicil-F or Longicil-S) or dihydrostreptomycin alone. All three of the preventive medication treatments significantly reduced morbidity as compared to the controls, though no significant difference was observed between preventive treatments. The combination of the two penicillins without dihydrostreptomycin was most effective in preventing SFC in calves during their first 14 days in the feedlot.

Addis et al. (1976) reported the results of three 28-day trials in which the intramuscular (IM) administration of oxytetracycline for the first three days after arrival of stressed calves in the feedlot (10 cc/100 lbs body weight) was compared to the oral administration of oxytetracycline at the rate of 1 gram per head per day in the feed plus 1 gram per head per day in the water until the animals were consuming 2% of their body weight in feed. It was observed that the intramuscular injection of oxytetracycline reduced morbidity by 43% and 30% as compared to the controls in two trials. The oral administration of oxytetracycline reduced morbidity by 48% in one trial but showed no

effect on sickness in the other two trials. The number of medical treatments per sick animals was reduced an average of 10% by the IM administration of oxytetracycline (3.7 versus 4.1). The percent of treated cattle requiring re-treatment (returns or repulls) was decreased by IM oxytetracycline in all three trials and oral administration in two trials. Though no significant difference in weight gains were observed in the three trials, IM oxytetracycline tended to slightly improve gains and both oxytetracycline treatments tended to improve efficiency of feed use. Oral oxytetracycline tended to decrease feed intake. But the total cost per pound of gain over the 28 day receiving period was increased by preventive medication in all three trials.

Lofgreen (1978) and Lofgreen et al. (1980) reported the results of a study with 514 stocker calves in which one-half of the calves received intramuscular oxytetracycline (11 mg/kg body weight) for the first three days after arrival. Mass medication significantly reduced the death loss, morbidity, and returns by 46%, 35%, and 75%, respectively. However, calves in need of further medication after three days of oxytetracycline treatment were sick two days longer than calves requiring treatment from the control group. Daily weight gains and feed efficiency were improved by 29% and 23% ($P<.05$), respectively, by preventive medication. The total medication cost per calf was increased by mass medication, but due to the improved gain and feed efficiency, the total cost per pound of gain over the 28 day trial was decreased by mass medication. This contrasts with the study by Addis et al. (1976).

Lofgreen (1983) reported the results of a study with 353 stocker

calves comparing three treatments: control (receiving no preventive medication), three successive days of intramuscular oxytetracycline (11 mg/kg body weight) beginning on the arrival date, or the oral administration of sustained release sulfadimethoxine (150 mg/kg body weight) in bolus form. Both of the preventive medication treatments reduced morbidity by approximately 14% and significantly reduced the number of treatment days per calf purchased (21%). The sulfadimethoxine treatment did not affect weight gains or feed efficiency. Whereas, the oxytetracycline treatment increased daily feed intake, daily weight gain, and feed efficiency by 4%, 12%, and 8%, respectively, over the 28 day trial.

The results of a similar study with 263 heifer calves were reported by Lofgreen (1982, 1983). The same preventative treatments were compared with the addition of a fourth treatment which was three days of oxytetracycline treatment with sustained release sulfadimethoxine administered at the time of the third oxytetracycline injection. Morbidity and the number of treatment days per calf purchased were reduced by 17% and 31%, 44% and 54%, and 77% and 81% by oxytetracycline treatment, sulfadimethoxine treatment, and the combination treatment, respectively. None of the mass medication procedures affected feed intake or weight gains during the 28 day test. Lofgreen (1983) observed in another experiment that the combination treatment of three successive days of oxytetracycline treatment followed by sustained released sulfadimethoxine reduced morbidity and treatment days per calf purchased by 77% and 85%, respectively. An additional preventive treatment was studied in this experiment which was the combination of oxytetracycline and sulfadimethoxine followed by

feeding 700 mg of chlortetracycline plus 700 mg of sulfamethazine per head per day for one week. Providing feed medication during the second week did not improve performance beyond that achieved with the oxytetracycline followed by sulfadimethoxine.

Janzen and McManus (1980) reported the results of a study in a Canadian feedlot with a long-acting oxytetracycline used in preventative medication. This product eliminates the necessity of rehandling calves to administer successive doses following processing. In this study, all cattle were processed upon arrival and treated for shipping fever if rectal temperature exceeded 104°F. When the incidence of SFC in a pen reached 6 to 10%, the animals in that pen were alternately treated with long-acting oxytetracycline (20 mg/kg body weight) or a control placebo. The long-acting oxytetracycline reduced morbidity by 78% and improved daily gains by 13%.

Davis and Caley (1981) conducted a study comparing a long-acting IM oxytetracycline administered at two levels (5.3 mg and 8.0 mg/lb body weight). Also the typical processing procedure (calves with temperatures above 103°F were given intramuscular injection of oxytetracycline during processing) was compared with preventative medication (each calf given an intramuscular injection of oxytetracycline during processing). Both levels of long-acting oxytetracycline given as preventative medication tended to increase rate of gain and feed intake and reduce the times sick calves were treated and the number of deaths (2% vs 12% mortality) as compared to calves receiving oxytetracycline only if their temperature was above 103°F. The lower level of oxytetracycline given as preventative medication significantly improved weight gains as compared to the same

level given only to calves with elevated temperatures. Performance tended to be highest in calves receiving the lower level of oxytetracycline as preventative medication.

Swafford et al. (1983) investigated the use of long-acting IM oxytetracycline (18 mg/lb body weight) as preventive medication. Preventative medication reduced mortality by 50%, decreased morbidity by 15%, and improved daily gains by 17%.

Gill and Richey (1982) summarized a study using long-acting oxytetracycline plus sustained release sulfadimethoxine as preventative medication administered at the time of arrival of 163 newly received stocker cattle. Mass medication decreased morbidity by 21% as compared to those calves not receiving medication at processing. However, it was observed that mass medication caused a greater number of calves to become sick during the second week and returns increased from 20 to 31%.

Lofgreen (1983) in a similar investigation with 244 head of feeder calves compared the injection of long-acting oxytetracycline (20 mg/kg body weight) at arrival plus oral administration of sustained release sulfadimethoxine (150 mg/kg body weight) at arrival or on day three. Control calves received no preventative medication. Mass medication with oxytetracycline, followed by sulfadimethoxine on day three, reduced morbidity and treatment days per calf purchased, by 90% and 93% ($P<.05$), respectively. Very similar results were observed with both drugs administered at processing (89% reduction in both morbidity and treatment days per calf purchased). Both mass medication treatments improved weight gains by approximately 27% and feed efficiency by

approximately 16%. The total cost per pound of gain was reduced by preventive medication.

Lofgreen et al. (1984b) investigated the effects of preventative medication of feeder calves with long-acting oxytetracycline and sustained release sulfadimethoxine at arrival versus preventative medication on day eight after arrival. These long acting drugs supposedly do not maintain adequate drug levels past four days. Even though symptoms of SFC were not observed until five days after arrival, medication on day one reduced both morbidity and treatment days per calf purchased by 93%. In the group receiving mass medication on day eight, no new calves were pulled for SFC treatment after day seven. Only a 24% reduction in morbidity was reported in the day eight medicated calves since the majority of the sick pulls occurred on days five through seven. However, day eight medication reduced treatment days per calf purchased by 61%. In contrast to the previous studies, mass medication in this study did not improve weight gains or feed conversion.

These data indicate that administering long-acting oxytetracycline plus sustained release sulfadimethoxine at processing will improve weight gains and reduce morbidity in newly received calves. Giving only long-acting oxytetracycline also increases gains and reduces morbidity but to a lesser degree than a combination of the two drugs. The economics of mass-medicating cattle depends on the cost and success of conventional treatment (treatment of sick calves only), availability of labor, ability to detect sick cattle early, and on the health status of received cattle. If mass medication procedures are to be used, their cost must be offset by savings in labor, treatment medication, or

improved animal performance. Mass medication should be most economical in cattle experiencing high morbidity.

Time of Processing

Knight et al. (1972) compared the performance of feeder calves vaccinated three weeks before weaning, at weaning, or upon arrival at the feedlot. Those calves vaccinated three weeks prior to weaning had lower morbidity and mortality rates and gained weight faster than the other two groups. Results of this study suggested that vaccination three weeks before weaning is efficacious. In contrast, Greathouse et al. (1968) and Coleman (1973) observed no performance difference between feeder calves vaccinated two weeks before shipment or upon arrival. Sweat (1968) suggested that the optimum time to vaccinate would be three to four weeks before weaning. Hoerlein (1973) recommended vaccination at least three weeks before shipment.

Calves moving into feedlots come from many sources and usually pass through several sale barns or assembly points before they reach their final destination. Hence, it is difficult to establish a program to uniformly vaccinate or precondition calves three to four weeks before shipment. Also, vaccination does not benefit the seller so the seller must be compensated by the buyer for the the expense of vaccination. Though possible and justified, such compensation is seldom provided.

Lofgreen et al. (1978) used 358 calves to study the effects of processing (branding, castrating, deworming, and vaccinating) at the point of origin immediately prior to shipping, immediately upon arrival at the final destination, or two to three weeks after arrival at the

feedlot. Delayed processing increased morbidity and mortality and increased the number of repulls. Although processing at origin or on arrival did not increase morbidity, it did increase the proportion of calves requiring earlier treatment. Delayed processing delayed the onset of sickness in some calves. Delayed processed calves had significantly lower feed intakes, weight gains, and feed efficiencies over the four week receiving period despite the fact that they had higher daily gains and a more efficient feed conversion during the first week after arrival. Hence, delaying processing for two to three weeks allowed the calves to recover faster from the stresses of marketing and shipping but the stress of processing later depressed performance more than processing either at the farm of origin or on arrival. The differences persisted throughout an entire feeding period of 342 days, although time of processing had no effect upon performance during the post-receiving period.

Similar results were reported by Zinn et al. (1985b) in which calves processed at arrival gained 9% faster and 5% more efficiently over a 42 day receiving period than calves processed two weeks after arrival. Delayed processed calves gained 18% faster than calves processed at arrival during the first two weeks but gained 60% less than calves processed at arrival during the second two-week period.

Lofgreen et al. (1984a) reported the results of a study with 324 newly received calves comparing processing on days one, three, six, or 12 following arrival. The gains of calves processed on day three never dropped below the gains of day one calves, indicating no detrimental effect of delaying processing until the third day following arrival. The gain of calves processed on day six dropped slightly below the gain

of calves processed on day one but these calves recovered by 42 days on feed. But calves processed on day 12 had consistently lower weight gains and feed efficiencies over 42 days. Although calves processed on days six and 12 appeared to be stressed more than those processed earlier, they compensated for this stress by the end of the full 238 day feeding trial. Very little sickness and no death loss were reported in this study. In the case of calves experiencing high morbidity during the early phase of receiving, the additional stress of processing on days six and 12 may prove to be more detrimental than observed in this trial.

These data indicate that newly arrived calves processed at arrival experience fewer health problems and gain faster than calves processed one to two weeks after arrival. If added stress will increase mortality, delayed processing could be useful, but unless extreme, intensity may be less important economically than duration of the stress.

Treatment of Shipping Fever

Detection of Sickness

One common method to detect sickness in newly received calves is by rectal temperature. Normally cattle permit their temperature to fluctuate rather than expend energy to hold it constant. Temperatures of normal cattle can range from 100°F to 108°F and follow a diurnal pattern. The magnitude of the fluctuation is affected by environmental temperatures and the adaptation of the animals. Gill and Richey (1982) observed that movement or excitement of cattle will raise normal body

temperature. Lofgreen (1979) reported that the mean temperature of newly received calves increased 1.5°F during a four hour processing period while a temperature increase of 1°F during a five hour processing period was reported by Axe et al. (1984). The probability that a newly received calf will be treated for sickness at a later date increases as processing temperatures increase (Lofgreen et al., 1973; Dunbar et al., 1980; Axe et al., 1984).

When normal body temperatures are at the diurnal low point and are not elevated by the stresses of movement, animals with elevated temperatures due to infection may be separated from healthy cattle based on temperature (Gill and Richey, 1982). To detect sickness based on temperature, newly received cattle should be rested over night before processing, calves should be processed in small groups early in the morning before outside temperatures rise, no calf should be out of its pen for over 30 minutes, and extra care should be exercised to process the cattle with a minimum of stress. Under such conditions, Gill and Richey (1982) reported that calves with rectal temperatures of a 104°F or greater can be designated as sick. Other workers have also used 104°F as the break point between healthy and sick calves (Dunbar et al. 1980; Janzen and McManus, 1980; Axe et al., 1984). While Lofgreen et al. (1975) used 103°F to detect sickness in receiving calves. Lofgreen et al. (1981) has also used a sliding break point. At the start of processing, each calf with a rectal temperature of 103°F was considered to be sick but this was increased by .2°F every 15 minutes during processing.

Use of Antibiotics

Fales et al. (1982) performed susceptibility tests to 15 antimicrobial agents on isolates of Pasteurella ssp. recovered from 386 beef cattle with bovine respiratory disease. From the data collected, they recommended that the first drug choices for treating bovine respiratory disease should be erythromycin and sulfachlorpyridazine with tetracycline as an alternate drug. Hjerpe and Routen (1976) also measured the antimicrobial sensitivity of Pasteurella isolated from nasal secretions of cattle with feedlot pneumonia and determined the following sensitivities: tetracycline- 63 to 97%, erythromycin - 22 to 35%, sulfamethazine - 82%, and ampicillin - 83%. In contrast, Amstutz et al. (1982) reported that 90% of P. Hemolytica strains recovered from calves with bovine respiratory disease complex were resistant to streptomycin and tetracyclines, 24% were resistant to sulfonamides, and 41% were resistant to ampicillin.

Breeze and Magonigle (1979) and Breeze et al. (1980) stressed Holstein steer calves by wetting them alternately with hot and cold water four times and infecting them with P. multocida. The following treatments were initiated two hours after infection: no medical treatment, oxytetracycline given at 5 milligrams per pound of body weight twice at daily intervals, or long-acting oxytetracycline given once at 9 milligrams per pound of body weight. In both studies, the overall response to both drugs was essentially equal but the long-acting formulation reduced labor, handling, and stress in pneumonic calves.

Nash (1983) examined the response of 212 sick feedlot calves to

the following treatments: long-acting oxytetracycline (15 to 19 mg/lb body weight) plus 2 sustained-release sulfadimethazine (SRS) boluses, 2,500 milligrams of oxytetracycline IV for three days plus two SRS boluses, or 2,000 milligrams of both oxytetracycline and tylosin IV for three days plus two SRS boluses. No response differences were observed between the three treatment groups, but the use of long-acting oxytetracycline reduced the handling of the calves since they were treated only once rather than on three successive days.

The efficacy of long-acting oxytetracycline for single-day treatment of bovine respiratory disease was evaluated at levels of 10, 15, and 20 milligrams per pound of body weight in morbid feedlot cattle as compared to a four-day treatment sequence of oxytetracycline (5 mg/lb body weight) by Bennett and Rupp (1983). All treatments were administered with an initial dose of sustained-released oral sulfadimethoxine. Duration of treatment favored the 15 milligram per pound long-acting oxytetracycline plus sulfadimethoxine. Cattle administered the oxytetracycline on four consecutive days had considerably higher treatment relapse rates and much higher labor costs. Results by Edwards (1983) also favored long-acting oxytetracycline over a three-day sequence of antibiotics.

Nutrition and Health

Recent studies have shown that nutrition can have a significant effect on the incidence of SFC in stressed calves. Williams and Mahoney (1984) in a review of nutrition-health interactions observed that under-nutrition predisposes animals to disease and increases disease severity and mortality. This is presumably due to altered

intra- and extra-cellular biochemical environments which influence the immune response. Globulins, lysozymes, interferons, and other substances involved in the immune response are synthesized from amino acids, vitamins, and minerals. Hence, a nutritional deficiency of these nutrients could reduce immunological competency, reduce the immune response, and increase susceptibility to disease. Fasting as well as malnutrition can reduce immune response and both reduce resistance to bacterial diseases more than to viral diseases.

Stress and Rumen Environment

Many of the nutrients fed to ruminants never reach the tissues due to fermentation by microorganisms in the rumen. Instead they are converted into other compounds prior to absorption. The rumen of a healthy calf contains billions of bacteria and protozoa. The stresses of weaning, handling, and shipping tend to cause calves to reduce their feed intake. This in turn can reduce the number of bacteria and protozoa in the rumen and alter or decrease the nutrient supplies absorbed (Williams and Mahoney, 1984).

Baldwin (1967) studied changes in the rumen after a 48 hour starvation period and noted the following: 1) Nearly complete absence of rumen protozoa, 2) Rumen bacteria numbers were reduced by 75 to 90% of normal, 3) The surviving bacteria types were markedly reduced, and 4) Total ruminal fermentation activity and capacity was reduced by 85 to 90% of normal. Research by Hamlett et al. (1982) supports these findings. They reported that after weaning calves had been fasted for 24 hours at a auction barn rumen liquid volume decreased by 26%, gas producing potential decreased by 71%, volatile fatty acid concentration

decreased by 25%, and rumen protozoal concentration decreased by 50%.

Since these changes that occur in the rumen are rapid, it is important to reduce stress and feed calves properly to increase their immune response and disease resistance. Nutrient modifications before, during, and after stress have been tested.

Feeding Before Stress

Creep feeding should improve the nutrient status of calves prior to stress but little data on the effect of creep feeding on the feedlot performance and health of stressed calves is available. Pate and Crockett (1974) looked at the effects of creep-feeding calves 24 days before shipping them directly from a Florida ranch to a Texas feedlot at weaning. Creep-fed calves had 42% less weight loss during transit, 13% faster daily feedlot gains, 3% better feed conversion, and 24% less sickness than calves that were not creep fed. In contrast, Stuedemann et al. (1966) reported that creep feeding calves during a 240 day pre-weaning period reduced subsequent feedlot performance.

Feeding During Stress

Feeding during stress includes the post weaning feeding of calves at the farm of origin as well as the feeding of calves through the marketing channels (Cole, 1982). Cole et al. (1978, 1979, 1982) examined the effect of a 30 day post weaning feeding period at the farm of origin on feedlot performance and health of calves. The post weaning feeding of the calves did not affect feedlot gains, but did increase feed intake which resulted in less efficient feedlot gains.

Though the incidence of SFC was reduced, adverse effects on feed efficiency offset this benefit.

Cole et al. (1978, 1979) and Hutcheson et al. (1984) fed newly weaned calves either an oxytetracycline fortified, 50% concentrate diet or hay for three days at the order buyer barn. Diet had no affect on feedlot gains or feed efficiency, but morbidity and mortality were reduced with the concentrate diet. Feeding a 55 to 60% concentrate ration (oxytetracycline fortified) three days prior to shipment also increased weight gains and reduced morbidity and mortality during a 28 day receiving period (Koers et al., 1975a). Cole and Hutcheson (1985) suggested that before a feed and water deprivation period such as marketing and transport, feeder calves should be allowed free choice access to feed and water in order to reduce the amount of time required to restore normal feed intake after arrival at the feedlot.

Feeding After Stress

The diet fed upon arrival at the feedlot also can alter calf health and performance. Hutcheson (1980) reported that the feed intake of newly received calves is subnormal for the first two weeks after arrival at the feedlot and not all calves eat during the first week. Thus, it is important that rations be formulated to be as palatable as possible and fortified to provide enough nutrients for calves eating small amounts of feed. For discussion, this research is divided into sections on protein level and source, concentrate level and source, roughage level and source, mineral levels, vitamin levels, and miscellaneous feed additives (coccidiostats and ionophores).

Protein Level. The protein requirement of newly received calves remains undecided. Cole and Hutcheson (1982) reported a small increase in daily gain (0.22 lbs) and reduction in mortality (15% vs. 8%) when the protein level of the ration was increased from 12 to 16% over a 28 day trial. Cole et al. (1984) later observed increases of 11 to 35% in average daily gain during the first 14 days of two trials when the protein level was increased from 12.5 to 16%. However, by day 28 no differences in gain between the two protein levels were reported. Zinn et al. (1983b) showed small, nonsignificant increases in weight gain over 28 days when the protein level was increased from 14 to 17%. Increasing protein level from 13.3 to 19.3% increased average daily gain and feed efficiency by 15 and 7% in a study by Hinman et al. (1980). Williams and Mahoney (1984) found no difference in performance between rations containing 13.5 and 15.5% protein in two trials conducted in 1972 and 1978. Embry (1977) showed the optimum protein level in receiving rations to be 13.5%.

These trials indicate that the protein requirement of newly received calves is around 13 to 15%. However, Gill et al. (1980) have pointed out that nutrients are required by animals in amounts per head per day which may not relate well to the percentage of a nutrient in the ration.

Protein Source. It is generally recommended that urea should not be fed to stressed feeder calves. However, the data of Cole and Hutcheson (1981) suggest that a ruminal ammonia deficiency can occur following a period without feed and water. Williams and Mahoney (1984) also indicated that urea provides readily available nitrogen for rumen

bacteria and protozoa. Cole et al. (1984) showed that yearling steers efficiently utilized dietary urea with a 11% crude protein receiving ration of which urea comprised about 7% of the dietary nitrogen. But performance suffered when steers were fed a 16% crude protein ration with 15% dietary nitrogen from urea. Phillips (1984) observed that calves fed a receiving ration with corn gluten meal as the protein source and urea providing 20% of the dietary protein had reduced performance over the first 28 days, but by day 56 these calves had compensated and performed equally with those receiving a soybean meal supplement. Gates and Embry (1975) reported that feeding calves 77 grams of urea per day in four pounds of a 32% protein supplement with free choice corn silage reduced feed efficiency 4% as compared to calves fed the same diet with no urea. Preston et al. (1975a) reported that about 30 grams of urea per day in two pounds of supplement decreased gain and efficiency of calves full fed corn silage about 3 to 5%. Feeding 36 grams of urea in two pounds of supplement also reduced the weight gain and efficiency of calves fed prairie hay by 17% (Embry, 1977). These data suggest that urea can be used to supply a portion of the supplemental protein for stressed calves. Williams and Mahoney (1984) recommended that a maximum of 2.2% of the ration protein could be supplied in the form of urea.

The use of rumen bypass protein in receiving diets for stressed calves has received limited attention. Preston and Smith (1974) and Preston et al. (1975b) showed that 0.5 to 0.75 pounds of a protected soybean meal (formaldehyde treated) was equivalent to about one pound of untreated soybean meal in calves fed corn silage. Grigsby (1981) reported that calves receiving a 6% corn gluten meal (high bypass

protein) ration performed as well as calves receiving an 8% soybean meal ration. Phillips and McLaren (1981) also reported favorable performance results with calves receiving a corn gluten meal supplement. Calves receiving a ration containing blood meal, corn gluten meal, and brewers dried grain gained 11% faster and 14% more efficiently than calves receiving cottonseed meal (Zinn et al., 1983b).

Concentrates. In general, as the concentrate level in the receiving diet is increased, weight gains, feed efficiency, morbidity, and treatment days per calf will increase (Koers et al.,1975b; Lofgreen et al., 1975; Lofgreen et al., 1980). Economically superior results have been obtained by newly arrived calves at a concentrate level of 70 to 75% of the diet.

Addis et al. (1980c, 1980e) fed calves 72% concentrate diets composed of barley, milo, wheat, 50:50 barley-milo combination, or a 50:50 barley-wheat combination. Performance was equal though calves receiving the barley-milo or barley-wheat rations tended to gain faster and more efficiently than calves fed other grains.

Lofgreen and Kirksey (1982) reported that calves receiving a 75% concentrate ration during a 28 day receiving period had significantly superior gains and gain to feed ratios as compared to calves receiving two pounds per day of a 40% protein supplement plus free choice native hay for the 28 day period. However, morbidity was slightly lower with the hay plus protein supplement diet. Similarly, Lofgreen et al. (1984a) observed that during the 28 day receiving period, calves fed two pounds daily of a 40% protein supplement plus native hay gained 33 fewer pounds than calves fed a 75% concentrate diet plus hay during the

first week, but 15 pounds more than calves fed hay alone. During the receiving period calves gained more rapidly if fed two pounds daily of 40% protein pellets plus hay than if fed six pounds daily of 13% protein pellets plus hay (Richey et al., 1982). Gill et al. (1982a) reported that switching from two pounds daily of a 40% protein pellet to three pounds daily of a 13% protein pellet on day 10 of the receiving period reduced performance compared to switching to one pound daily of the 40% protein pellet. Adverse effects of grain (starch) on forage intake and digestion may be responsible.

These data indicate that the feeding of high concentrate diets improves the performance of newly received calves but also increases morbidity. Economics will justify the feeding of high concentrate rations if the increased medical costs are offset by decreased total costs per pound of gain due to increased gains and efficiency.

Roughages. Lofgreen et al. (1984a) observed that calves receiving only native grass hay during a 28 day receiving period experienced 65% less morbidity and required 68% fewer treatment days than calves receiving a 75% concentrate ration plus native grass hay. However, calves fed hay simply maintained their weight while those fed concentrates gained 2.15 lbs/day. Similar results with millet hay alone or alfalfa hay alone were reported by Lofgreen et al. (1981). Calves fed only alfalfa hay performed better than calves fed only millet hay.

Lofgreen et al. (1980) reported that feeding free choice alfalfa hay with a 75% concentrate ration during the receiving period reduced morbidity and mortality and increased gain and feed efficiency. In

contrast, in two other trials, Lofgreen et al. (1975, 1981) found no benefit from feeding either alfalfa hay or millet hay with the concentrate ration during the 28 day receiving period. Feeding a 75% concentrate ration for the entire receiving period plus either alfalfa hay or millet hay for the first week reduced sickness without adversely effecting weight gains (Lofgreen et al., 1981). Lofgreen (1982) reported that calves fed a 75% concentrate ration for four weeks plus oat hay during the first week gained faster and more efficiently than calves receiving alfalfa hay during the first week.

Davis (1978) reports that newly received calves experience less sickness and require less feed per pound of gain when fed ground alfalfa as compared to corn silage during the first 28 days in the feedlot. In a three year project with Canadian feedlots (Martin et al., 1982) when corn silage was the major roughage, morbidity and mortality were increased. In contrast, in Ohio studies (Preston et al., 1973; Preston and Kunkle, 1974; Kunkle et al., 1976) calves fed a poor quality hay had higher gains during the first week after arrival than calves fed corn silage, but lower gains after the first week.

These data indicate that feeding a roughage such as alfalfa to calves during the first week of the receiving period reduces morbidity without reducing gains and efficiency. Hence, this practice is economically advantageous. A sequence of feeding hay plus protein supplement early and a 75% concentrate diet later may optimize health and performance.

Minerals. Very little data is available on the mineral requirements of stressed calves. However, recent research evaluated

the level of potassium required for newly received calves. Zinn et al. (1983a) suggested that potassium supplementation influences the animal in three ways: 1) Increased water retention; 2) Enhanced ruminal digestion, particularly of fiber; and 3) Modulated feed consumption patterns. Calves undergo dehydration during shipment and severe dehydration may limit the efficiency of the immune system. Since potassium supplementation increases water retention, animal health also might improve.

Hutcheson et al. (1978) reported that increasing the potassium level of the diet of newly received feeder steers from 1 to 1.5% did not effect morbidity, but increased gains by 15% ($P<.05$) in the first 28 days. In contrast, Cole and Hutcheson (1982) reported that increasing the potassium level of the diet of new feedlot arrivals from 0.8% to 1.3% did not affect rate of gain, but reduced mortality by 47%. Later, Hutcheson et al. (1984) observed reduced morbidity and mortality by increasing the potassium level from 0.9% to 1.4%. Williams and Mahoney (1984) reported that gains and feed efficiency have been improved by increasing the potassium level from 0.8 to 1.4%. In contrast, no benefits were found from increasing the potassium level from 1% to 1.5% in a study by Zinn et al.(1983a).

Vitamins. Research has shown that injections of vitamins A and D generally slightly improve daily gains and feed efficiency in stressed calves but tend to increase morbidity and mortality (Davis et al., 1975; Davis, 1978, 1980; Davis and Caley, 1978, 1981). These workers also have shown that adding an injection of vitamin B_{12} with

vitamins A and D tended to decrease performance and increase sickness as compared to injections of vitamins A and D alone.

Studies which have examined the effect of feeding B-vitamins on the health and performance of stressed calves have produced inconsistent results. Brethour and Duitsman (1972) and Cole et al. (1982) reported that feeding of B-vitamins tended to reduce sickness and improve the performance of stressed calves. Though feeding B-vitamins increased sickness in calves weaned 30 days prior to shipment, it reduced sickness in calves weaned at shipment (Cole et al., 1982). Williams and Mahoney (1984) reported that feeding of B-vitamins decreased performance in calves. The addition of B-complex vitamins and vitamin E to the diet increased weight gains and feed efficiency in newly received calves, by 11% and 15%, respectively (Lee et al., 1985).

Tengerdy (1980) reviewed the effects of vitamin E on immune responses and concluded that supplementing vitamin E in pharmacological doses in well balanced diets increased humoral antibody production against a variety of particulate and soluble antigens. This effect was noted in chickens, mice, turkeys, guinea pigs, and rabbits. Dietary supplementation of vitamin E enhances the humoral immune response of sheep against Clostridium perfringes (Tengerdy et al., 1983). Vitamin E has been shown to increase disease protection in chickens against E. coli infection (Heinzerling et al., 1974a) and in mice against D. pneumonia infection (Heinzerling et al., 1974b). Studies have also shown that high levels of vitamin E may enhance the immune system of swine (Ellis and Vorhies, 1976) and horses (Lewis et al., 1976). Smith et al. (1984) reported that vitamin E supplementation

reduced the incidence and duration of clinical mastitis in dairy cows by 37% and 44%, respectively.

Perry et al. (1968) reported that vitamin E supplementation had no effect on weight gains of feedlot calves. Newland et al. (1966), Lyford and Colby (1967) and Totusek et al. (1968) noted that vitamin E injections had no effects on gains of feedlot calves. In contrast to these studies, Lee et al. (1985) reported that vitamin E supplementation (400 IU/head/day) of the receiving diet of 418 stressed calves improved daily gains and feed efficiency by 5% and reduced morbidity and mortality by 8% and 50%, respectively. The addition of B-complex vitamins and vitamin E to the diet increased weight gains and feed efficiency by 11% and 15%, respectively.

Coccidiostats. Coccidiosis in cattle is a disease caused by Eimeria spp. These are intercellular host-specific parasites that occur in most animals. Coccidiosis is seen more frequently during the cool and wet seasons of the year. It is transmitted by oocysts present in the feces which are picked up from consuming contaminated feed or water or licking contaminated materials. The disease reduces feed consumption and performance and causes mucoid diarrhea and occasionally death due to dehydration.

Coccidiosis causes large economic losses not only from morbidity and death, but also from high treatment cost, reduced feed efficiency, and weight gains. The response of cattle to a coccidiostat depends on their health status. Fox (1984) reviewed recent field data and concluded the following: 1) Low level or subclinical coccidiosis caused serious economic losses and interfered with optimum performance,

2) The severity of the symptoms of coccidiosis was both affected by and contributed to stress, and 3) Medication with a coccidiostat removed one of the stresses associated with cattle husbandry and helped reduce the severity of other diseases.

Much of the recent coccidiosis research has concerned the coccidiostat, decoquinate. Hutcheson and Cummins (1982) reported that including decoquinate in the starting diet of stressed calves for 28 days improved gains and feed efficiency by 10% and 24%, respectively, while reducing morbidity by 6% and mortality by 37%.

Barnes et al. (1984) reported that yearling heifers receiving decoquinate at 30 mg/100 lb body weight while grazing native grass pasture gained 20% faster (2.97 vs 2.47 lb/day) than the control group not fed decoquinate. In another trial, control heifers gained 5% faster (2.91 vs 2.76 lb/day) than those head receiving decoquinate. Barnes et al. (1985) in a subsequent report examined the effect of decoquinate (23 mg/100 lbs body weight) in two trials with 201 heifers receiving low quality grass hay plus two pounds daily of a 38% protein supplement. In both trials, decoquinate significantly increased daily gains over a 58 day period (.79 vs .34 lbs/day and .57 vs .03 lbs/day) and reduced morbidity (38 vs 54% and 16 vs 65%). Lusby et al. (1985) found decoquinate increased weight gains by 26% (1.34 vs 1.06 lbs/day) and reduced morbidity by 29% (34.7 vs 49.0%) in a 56 day trial with heifers fed wheat hay and crabgrass hay plus two pounds daily of a 38% cottonseed meal based supplement.

Fox (1984) reported the results of a field trial in which decoquinate increased daily gains of calves by 12% (.5 vs .56 kg/day), increased feed efficiency by 26%, reduced morbidity by 6%, and reduced

mortality by 37% over a 28 day period. In another field trial, morbidity and mortality were reduced by 18% and 29%, respectively, with decoquinate.

Other studies have reported that including decoquinate in the diet of newly received calves did not alter the performance or health status of the calves (Prouty et al., 1981; Rust et al., 1981; Williams and Mahoney, 1984). This may reflect reduced drug effectiveness, reduced incidence of coccidiosis, or less stress.

Recently the ionophores, monensin and lasalocid, have been tested as coccidiostats in the diets of newly-arrived, stressed calves. Wray et al. (1984) reported that monensin controlled or reduced clinical signs of coccidiosis and Horton (1982) reported that lasalocid at sufficiently high levels is an effective coccidiostat for cattle.

Addis et al. (1980d) investigated the effects of monensin fed at four levels on the health and performance of 445 newly arrived calves during a 56 day trial. Addition of monensin to the receiving diet increased weight gain and feed efficiency by 6.3% and 6.7%, respectively, but had no effect on incidence of sickness. Results were best with monensin at 10 grams per ton of feed during the first two weeks and 30 grams per ton during the last five weeks (with which gains and efficiency were improved by 7.5% and 7.7%, respectively).

Embry (1977) reported that the overfeeding of monensin during periods of stress could reduce feed intake by light calves during this critical time and thereby cause additional stress. Addis et al. (1980e) reported that feed intake by calves was significantly reduced during the first two weeks of the receiving period when monensin was fed at 30 grams per ton of feed and morbidity was increased by 12%.

Hence, the level of monensin recommended during the first two to three weeks that calves are on feed is 10 or 20 grams per ton of feed (Embry, 1977).

Lusby et al. (1984) examined the effects of decoquinate and monensin (100 mg/day) on the performance of weaned calves grazing native grass pasture and receiving 0.8 pounds daily of soybean meal supplement. After seven days of feeding, both drugs significantly reduced the number of fecal coccidia, but decoquinate was slightly more effective. No clinical signs of coccidiosis were noted during the 63 day trial. Calves receiving soybean meal plus monensin gained 15% more than those receiving no coccidiostat, while calves receiving decoquinate gained only 1% faster than those receiving no coccidiostat.

Lasalocid fed at 30 grams per ton of feed improved the feed efficiency of newly arrived feedlot calves by 16.8% (Davis, 1982). Gill et al. (1982b) reported that adding lasalocid (50 mg/lb) to a 10% protein pellet fed at two pounds per head daily increased weight gain by 7.8% for steers grazing native grass pasture for 97 days. No signs of coccidiosis were observed in this trial.

These data indicate that feeding coccidiostats may improve weight gains and feed efficiency and decrease morbidity of newly received calves. The response of calves to a coccidiostat depends on the level of coccidiosis infection and the degree of stress the calves are subject to. These data also indicate that even subclinical coccidiosis reduces performance of calves, thereby, increasing economic losses. Under conditions in which calves are heavily stressed and feed intake is likely to be low, the feeding of decoquinate during the stress

period followed by the feeding of monensin or lasalocid during the growing phase might be desirable.

Anthelmintics

Performance responses to anthelmintics by newly received stocker cattle have been variable. An anthelmintic is useless if the calves have minimal parasite burden or if it is ineffective against those parasites present. The pathogen of greatest economical importance to cattle is the abomasal nematode, Ostertagia ostertagi. This review will focus largely on this parasite and its control. Recognition and control of this parasite was recently reviewed by Williams et al. (1984).

To control this parasite in stocker calves, its life cycle must be considered. As with most gastrointestinal nematodes which infect cattle, the Ostertagia ostertagi eggs are shed in the feces. These eggs hatch and develop to the third larval (infective) stage in as few as seven days during the summer, but may require several weeks during the winter. Infective larvae are ingested with forage as an animal grazes. Larvae burrow into glandular tissue of the abomasum and molt to the fourth larval stage about four days later. In its normal life cycle, the parasite grows and molts to the early adult or fifth stage by 10 to 12 days after infection. Then they emerge from the mucosal tissue as adults and mate. Damage to the mucosa as young adults emerge causes diarrhea, weight loss, and reduced feed intake. This cycle continues only during seasons of the year which are favorable for development and survival of free-living stages on pasture. During

seasons adverse to the free-living stage, the fourth stage larva remain in a state of inhibition.

Williams et al. (1984) reported that there are three ostertagia disease types. Type I ostertagiasis is due to rapid accumulation of large numbers of larvae which develop to adults in the normal three week cycle. Type I disease is thought to be common during late winter and early spring in southern temperate regions of the United States. Nearly any broad spectrum anthelmintic is effective at this time.

Pre-type II ostertagiasis encompasses the time period in which conditions are unfavorable for the early fourth stage larvae to develop further. Generally, no clinical effects are apparent at this time. In Oklahoma, this condition occurs during spring to late summer. At this inhibited stage, larvae are not effected by the traditional anthelmintics such as thiabendazole, levamisole, or morantel tartrate.

Type II ostertagiasis is caused by the mass maturation of large numbers of inhibited larvae. This disease occurs when parasitic problems are least expected, late summer through autumn in southern temperate climates. The presence of severe clinical disease is usually low in the type II phase, but may cause high death loss in those few severely affected animals. The traditional anthelmintics have limited effect because such treatment only removes adult worms and may cause maturation of another wave of larva.

Animal performance responses to anthelmintics such as thiabendazole, levamisole, or morantel tartrate by stocker calves have been variable. Davis et al. (1976) reported daily gain and feed efficiency were improved by 41 and 28%, respectively, with their use in 192 feeder calves. In a summary of four trials involving 936 calves,

Davis and Caley, (1979) reported that anthelmintics increased weight gains and feed efficiency by 19.2% and 11.1%, respectively, while reducing sickness by 11.9%. This contrasts with results of Hanke and Lindor (1983) and of Winder et al. (1983) who detected no improvement in performance of feeder calves from treatment with the traditional anthelmintics.

Promising results have been reported with the use of a new anthelmintic, ivermectin. It has been shown to be over 99% effective against inhibited larvae of Ostertagia ostertagi (Williams et al., 1981) while traditional anthelmintics are ineffective against this stage. In addition, ivermectin is efficacious (over 99%) against all types of gastrointestinal nematodes found in the abomasum, small intestine, cecum, and large intestine (Yazwinski et al., 1981; Benz, 1983). Smith (1984) reported that research data indicate that ivermectin is effective against other parasites as well, including the adult and larval stages of essentially all pulmonary and gastrointestinal nematodes, the parasitic stages of the common cattle grub, the cattle sucking lice, the cattle mange mites, several species of ticks, and the larval stages of horn and face flies.

Holste (1983) reported that ivermectin increased daily gains of calves fed a mixture of corn and alfalfa hay for a 110 day period by 11.3%. Ciordia et al. (1984) observed that ivermectin improved weight gains of calves grazing a fescue and bermuda grass pasture by 21%. Lofgreen et al. (1984c) compared the effects of ivermectin and levamisole on performance of newly received calves. Calves receiving ivermectin gained 14% and 6% faster over 28 days and 56 days, respectively, as compared to those head treated with levamisole. In a

subsequent trial, however, Lofgreen et al. (1984d) reported that calves treated with ivermectin gained significantly less weight over a 56 day period than calves treated with levamisole. These data indicate that ivermectin will increase the gains of newly received calves more consistently than the traditional anthelmintics since ivermectin is highly effective against inhibited larvae of Ostertagi ostertagi.

CHAPTER III

THE EFFECT OF MASS MEDICATION ON HEALTH AND PERFORMANCE OF NEWLY ARRIVED STOCKER CATTLE

Summary

A total of 1437 newly received steer and bull calves and yearlings were used in studies to determine the effectiveness of certain mass medication procedures for reducing morbidity due to shipping fever. In one experiment, 1046 head averaging 215 kilograms were divided into two groups: one received routine processing on arrival and the other received routine processing plus long-acting oxytetracycline (LAO) and sustained release sulfadimethoxine (SRS). Morbidity was reduced ($P<.0001$) from 33.2% in the non-mass medicated cattle to 14.6% in those receiving mass medication at processing. The 523 head of non-mass medicated cattle had 1177 sick pen days, while the 523 mass medicated cattle had 424 sick pen days, a reduction ($P<.0001$) from 2.25 to .81 sick days per head. Mass medication improved ($P<.05$) average daily gains and gain to feed ratios by 7.6% (.71 vs .66 kg/head) and 11.2% (.119 vs .107 kg gain/kg feed), respectively.

In the second experiment, 391 head averaging 210 kilograms were divided into four groups: 1) Control (routine processing only), 2) LAO, 3) SRS, and 4) LAO plus SRS. Mass medication with LAO, SRS, and a combination of the two drugs reduced morbidity by 22.1, 10.1, and

11.0%, respectively. The number of sick days per head was reduced by LAO ($P<.05$, 2.56 days) and LAO plus SRS (3.35 days) as compared to the controls (4.34 days). Mass medication had no effect on average daily gains but reduced feed intake ($P<.10$).

Introduction

Between two and five percent of newly arrived stocker cattle received in Oklahoma die of stress related diseases, primarily the shipping fever-bovine respiratory disease complex (BRD), shortly after shipping (Gill, 1985). Morbidity ranges from 0 to 100 percent, with an average probably between 25 and 30 percent. Cattlemen receiving stressed cattle must be prepared with a complete health program to prevent excessive death loss and decreased performance. Because treating BRD is costly, it may be cheaper to prevent its occurrence rather than treat it (NCA, 1979). The administration of intramuscular oxytetracycline for the first three days after arrival of stressed calves in the feedlot has been shown to reduce the incidence of BRD, but this treatment is not always cost effective (Addis et al., 1976; Lofgreen, 1978; Lofgreen, 1983). A disadvantage to this type of program is that all calves must be run through the chute for three successive days, increasing labor costs. Recently developed long-acting oxytetracycline and sustained release sulfas eliminate the need of running calves through the chute for three successive days. Lofgreen (1983, 1984b) reported that the administration of both of these drugs to stressed calves at time of arrival reduced morbidity by 90%. The administration of LAO alone has also been shown to reduce

morbidity due to BRD in stressed calves (Janzen and McManus, 1980; Davis and Carley, 1981; Swafford et al., 1983).

The objective of this study was to evaluate the effect of mass medication with long-acting oxytetracycline and/or sustained release sulfadimethoxine on the health and performance of newly arrived, stressed stocker cattle.

Experimental Procedure

Experiment One

Eleven truck loads of cattle in six different months (designated as trials) were assembled by order buyers with the majority coming from auction barns in the southeastern United States and shipped to Pawhuska, Oklahoma. The origin, arrival date and weight, number of head, and in-transit shrink for each load is summarized in Table I. Newly received cattle were weighed individually off the truck, ear tagged, and poured with famphur systemic insecticide. Following weighing and tagging, cattle were placed in one of nine pens of 20 to 25 animals each, depending on the number of cattle received. Pens were randomly assigned to mass medication (MM) or non-mass medication (NMM) groups. Water and native bluestem grass hay were provided free choice. On the morning following arrival, cattle were processed by pen as follows:

1. Body temperature and time were recorded.

2. Cattle were vaccinated with IBR-PI_3 (MLV) IM, Leptospira pomona bacterin, and Clostridia chauvoei, septicum, novyi, and sordellii bacterin.

TABLE I

ORIGIN, ARRIVAL DATE, NUMBER OF HEAD, ARRIVAL WEIGHT AND IN-TRANSIT SHRINK FOR EACH LOAD OF CATTLE-- MASS MEDICATION EXPERIMENT ONE

	Origin	Arrival Date	Number of Head	Arrival Wt., kg	% Shrink
Trial 1					
Truck 1	FL	9-15-83	101	195	11.3
Trial 2					
Truck 2	OK	10-20-83	95	200	8.5
Truck 3	FL	10-20-83	91	220	10.0
Trial 3					
Truck 4	OK	12-01-83	104	200	NA[a]
Truck 5	OK	12-08-83	88	200	NA[a]
Trial 4					
Truck 6	TN	1-10-84	93	223	7.0
Truck 7	TN	1-12-84	99	219	7.0
Trial 5					
Truck 8	AK	2-18-84	79	242	6.5
Truck 9	AK	2-24-84	90	245	6.0
Trial 6					
Truck 10	MO	3-21-84	101	215	8.0
Truck 11	MO	3-28-84	105	221	NA[a]

[a]NA=not available.

3. Dewormed with levamisole gel.

4. Cattle in the MM group received an injection of long-acting oxytetracycline[1] (22 mg/kg) and sustained release sulfadimethoxine boluses[2] (1 bolus-12.5 g/91 kg of body weight).

5. Cattle in the NMM group received antibiotic treatment if clinical signs of illness were detected or if body temperature exceeded 40°C.

6. Hospital card was initiated (NMM).

7. Animals from the NMM group which were not sick and all MM cattle (sick or well) were returned to their home pen. Sick animals from the NMM group were placed in the hospital pen.

As soon as cattle were placed in their pens, they had ad libitum access to prairie hay and were offered a pelleted feed supplement (Table II) at a rate of .9 kg/head/day for the first 21 days and .45 kg/head/day during days 22-28. The supplements contained 1) no added drugs, 2) lasalocid[3] (165 mg/kg), or 3) decoquinate[4] (110 mg/kg). Three hospital pens were maintained so that sick animals received their assigned feed while out of their home pen.

Mass-medication was assigned at random to either four or five pens in each trial with non-mass medicated cattle being placed in the remainder of the nine pens. In each trial, each feed medication was

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[1]LA-200®, Pfizer, Inc., New York, NY 10017.

[2]Albon-SR®, Hoffman-LaRoche, Inc., Nutley, NJ 07110.

[3]Bovatec®, Hoffman-LaRoche, Inc., Nutley, NJ 07110.

[4]Deccox®, Rhone-Poulenc, Inc., Monmouth Junction, NJ 08852.

TABLE II

COMPOSITION OF FEED SUPPLEMENT

Ingredient	IFN[a]	% As Fed
Soybean Meal	5-20-637	88.9
Salt	6-04-152	3.0
Vitamin A - 30,000 IU/Gram		.22
Premix[b]		.18
Cottonseed Meal	5-01-621	5.0
Dicalcium Phosphate	6-01-080	2.75

[a] International Feed Number.
[b] To provide: 0 for control, 165 mg lasalocid/kg, or 110 mg decoquinate/kg.

fed to at least one pen. Numbers of pens assigned to treatment were balanced between trials.

After processing, cattle were checked twice daily for signs of illness. If an animal was suspected to be sick, it was taken to the processing area where its body temperature was measured and a severity of illness score (slight, moderate, or severe) was assigned. If the body temperature exceeded 40°C the animal was considered sick. The animal could also be classified as sick based on clinical signs. Cattle receiving mass medication were not removed from their pen if they were detected as sick within the first 24 hours after processing.

Medical treatment for sick animals was determined by the ear tag number which was applied at random on arrival. Treatment schedules assigned to non-mass medicated cattle were: A) no treatment (negative controls), B) a sequence of antimicrobial drugs (Table III), or C) an experimental potentiated sulfa (RO5-0037[5]). Cattle treated by schedule B were initially treated with the first drug in the sequence. If body temperature dropped 1.1°C or to less than 40°C, or clinical signs were improved within 24 hours, the first drug was continued for two more days. If no improvement was apparent within 24 hours, the next drug in the sequence was used and the process was repeated until improvement was detected. In trials 3, 4, and 5, drug treatments 1 and 3 were reversed so that the first treatment was amoxicillin. Cattle treated by schedule C received RO5-0037 boluses orally at 66 mg/kg on day one and 33 mg/kg on days 2-5, regardless of response to therapy. If additional treatment was required at the end of the 5 day treatment,

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[5]Primor®, Hoffman-LaRoche, Inc., Nutley, NJ 07110.

TABLE III

SEQUENCE OF DRUGS USED FOR TREATMENT OF BRD--
1983-1984 EXPERIMENTS

Treatment No 1:	OXYTETRACYCLINE (Biomycin-C®) subcutaneously - 11 mg/kg. Plus SULFAMETHAZINE BOLUSES (Sulmet® - 15 gm) 1 bolus/68 kg on day 1. One bolus/136 kg on subsequent days.
Treatment No 2:[a]	ERYTHROMYCIN (Gallamycin®) deep in the muscles - 22 mg/kg
Treatment No 3:[a]	AMOXICILLIN (Amoxi-ject®) subcutaneously 11 mg/kg.
Treatment No 4:[a]	Procaine Penicillin G subcutaneously - 66,000 IU/kg
Treatment No 5:[a]	TYLAN 200 - 22 mg/kg.
Treatment No 6:[a]	SPECTINOMYCIN (Spectam®) - 11 mg/kg.

[a]Some of the antimicrobial drugs used in this study were used for extra-label purpose or at extra-label dosages and require a veterinarian-client-patient relationship before use.

cattle were started on the second drug in the sequence (Table III). Any mass medicated cattle detected as sick were treated initially with the second drug in the antibiotic sequence.

At the end of the 28 day trial, the cattle were held overnight without feed or water, weighed the following morning and, as necessary, cattle were castrated and horns were tipped. Cattle were then returned to the owner.

Experiment Two

Four truck loads (four trials) of cattle were assembled by order buyers from auction barns in Alabama, Tennessee, or Texas and shipped to Pawhuska, Oklahoma. The origin, arrival date and weight, number of head, and in-transit shrink for each load is summarized in Table IV. Newly received cattle were weighed individually off the truck and treated with Lysoff®[6]. Following weighing and tagging, cattle were placed in pens of 20 to 25 animals each depending on the number of cattle received. Cattle were randomly assigned by pen to one of the following treatments: control, receiving no preventative medication; intramuscular injection of long-acting oxytetracycline at a rate of 22 mg/kg; oral administration of sustained release sulfadimethoxine at a rate of 12.5g (one bolus)/91 kg; or administration of both drugs. Water and native bluestem grass hay were available free choice. The morning following arrival, the cattle were processed in the same manner as those in experiment one with the following exceptions: 1) Cattle

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[6]Cutter Laboratories, Shawnee Mission, KS 66201.

TABLE IV

ORIGIN, ARRIVAL DATE, NUMBER OF HEAD, ARRIVAL WEIGHT AND IN-TRANSIT SHRINK FOR EACH LOAD OF CATTLE-- MASS MEDICATION EXPERIMENT TWO

Trial	Origin	Arrival Date	Number of Head	Arrival Wt., kg	% Shrink
1	TN	8-12-84	100	180	NA[a]
2	AL	9-28-84	100	207	7.6
3	AL	11-03-84	95	221	NA[a]
4	TX	12-06-84	96	230	4.3

[a]NA=not available.

with odd-numbered ear tags were dewormed with ivermectin[7] (200mcg/kg) and those with even-numbered ear tags served as controls as part of a deworming trial superimposed on this study and 2) Cattle receiving preventative medication were treated with their respective drugs.

As soon as cattle were placed in their pens, they had ad libitum access to prairie hay and were offered a pelleted feed supplement (Table II - with lasalocid) at a rate of .9 kg/head/day for the first 21 days and .45 kg/head/day during days 22-28.

After processing, cattle were checked twice daily for signs of illness as described in experiment one. Calves receiving preventative medication were not pulled if they were detected as sick within the first 48 hours of the trial. Sick cattle were assigned to medication schedule B (Table III) beginning with Treatment 2. In this experiment, spectinomycin replaced amoxicillin as Treatment 3. Response to drug treatment was measured in the same manner as it was in experiment one.

At the end of the 28 day trial, the cattle were held overnight without feed or water, weighed the following morning and, as necessary, cattle were castrated and horns were tipped. Cattle were then returned to the owner.

Statistical Analysis

Least squares analysis of variance was performed on data for all response criteria within each experiment using the General Linear Model of the Statistical Analysis System (SAS). In experiment one, the initial models across all cattle for weight gains, sick days,

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[7]Ivomec®, MSD Agvet, Rahway, NJ 07065.

morbidity, and mortality included truck, feed treatment, medical treatment (mass vs non-mass medication), all two way interactions, and initial weight.

In experiment two, the initial models for weight gains, sick days, morbidity, and mortality across all cattle included trial, medical treatment, worming treatment, all two way interactions, and initial weight. The initial models for weight gains, sick days, repulls, and response to first drug treatment in the sick cattle included the same sources of variation as the models for all cattle.

In both experiments, data on feed intakes and gain to feed ratios were analyzed using pens as the experimental unit since feed records were kept on a pen basis. The initial models for these two criteria in experiment one included trial, feed treatment, medical treatment, all two way interactions, and initial pen weight. The initial models for these two criteria in experiment two included trial, medical treatment, and initial pen weight.

In both experiments, the initial models were reduced when sources of variation had observed significance levels greater than .20. However, medical treatment was included in all models since it was the source of variation being studied.

Results and Discussion

Experiment One

Effects of mass medication with long-acting oxytetracycline and sustained release sulfadimethoxine on daily gains, sick days, morbidity, and mortality are shown in Table V. Gains in the 28 day

receiving period were significantly increased (P<.05) by mass medication (.71 vs .66 kg/head/day). Gains of those cattle that were never sick were .74 and .77 kg/head/day for the NMM and MM groups, respectively. The number of sick days per head was reduced (P<.0001) by 64% (.81 vs 2.25 days/head) and morbidity was reduced (P<.0001) by 56% (14.6 vs 33.2%) with the administration of mass medication. These reductions in morbidity and hospital pen days and improvements in gains are consistent with results reported by Lofgreen (1983, 1984b). Death loss in this experiment was .76% in both control cattle and mass medicated cattle. Another factor influencing (P<.0001) weight gains, sick days, and morbidity was truck load. Apparently, the response of cattle to mass medication was dependent on such factors as the origin of the cattle and degree of previous stress.

Effects of mass medication on feed intake and gain to feed ratio are reported in Table VI. Mass medication reduced feed intakes (P<.01) from 6.67 to 6.24 kilograms per head per day. This 6.4% reduction in feed intakes combined with the 7.6% increase in daily gains with mass medication resulted in an improvement in gain to feed ratio of 11.2% (P<.05, .119 vs .107 kg gain/kg feed).

Experiment Two

Effects of mass medication with long-acting oxytetracycline, sustained release sulfadimethoxine, or a combination of the two drugs on daily gains, sick days, morbidity, and mortality in cattle in experiment two are reported in Table VII. None of the mass medication procedures altered (P>.05) average daily gains of the cattle. However, the cattle treated with SRS tended to have lower gains than all other

TABLE V

EFFECT OF MASS MEDICATION ON DAILY GAINS, SICK DAYS, MORBIDITY AND MORTALITY IN STRESSED CATTLE--EXPERIMENT ONE

	Controls	Mass Medication
Number of head	523	523
Number of head never sick	352	442
Arrival weight, kg	216	215
Daily gain, kg*	.66[a]	.71[b]
Daily gain of head never sick, kg*	.74	.77
Sick days*	2.25[d]	0.81[c]
Morbidity, %*	33.2[d]	14.6[c]
Total Mortality, %	0.76	0.76
Mortality excluding treatment schedule A cattle, %	0.38	0.76

*Expressed as LSMEANS.
a,b Means with different superscripts differ (P<.05).
c,d Means with different superscripts differ (P<.0001).

TABLE VI

EFFECT OF MASS MEDICATION ON FEED INTAKE AND GAIN TO FEED RATIO--EXPERIMENT ONE

	Controls	Mass Medication
Number of pens	26	25
Feed intake, kg*	6.67[b]	6.24[a]
kg gain/kg feed*	0.107[c]	0.119[d]

*Expressed as LSMEANS.
a,b Means with different superscripts differ (P<.01).
c,d Means with different superscripts differ (P<.05).

TABLE VII

EFFECT OF MASS MEDICATION ON DAILY GAINS, SICK DAYS, MORBIDITY AND MORTALITY IN STRESSED CATTLE--EXPERIMENT TWO

	Controls	LAO	SRS	LAO + SRS
Number of head	98	98	98	97
Number of head never sick	39	52	45	45
Arrival weight, kg	209	210	210	209
Daily gain, kg*	.64	.62	.52	.62
Daily gain of head never sick, kg*	.75	.77	.72	.82
Sick days*	4.34[b]	2.56[a]	4.24[b]	3.35[ab]
Morbidity, %*	60.2	46.9	54.1	53.6
Mortality, %	3.1	1.0	6.1	2.1

*Expressed as LSMEANS.
[a,b]Means with different superscripts differ ($P<.05$).

cattle. Mass medication with a combination of LAO and SRS tended to improve gains of cattle that were never sick (.82 vs .75 kg/head/day). Mass medication with LAO reduced ($P<.05$) the number of sick days per head by 41% (2.56 vs 4.34 days/head). A combination of LAO and SRS reduced ($P>.05$) the number of sick days per head by 22.8% (3.35 days/head). Administration of SRS alone did not affect the number of sick days per head (4.24 days). Morbidity was high in this experiment and all of the mass medication procedures only reduced it slightly. The greatest reduction in morbidity occurred with LAO ($P<.05$) which reduced it by 22.1% (46.9 vs 60.2%). In contrast to the results of experiment one, mass medication with LAO plus SRS in this experiment did not greatly reduce hospital pen days or morbidity.

Effects of the various mass medication treatments on the performance and health of the sick cattle in this experiment are summarized in Table VIII. All three of the mass medication procedures tended to reduce the daily gains of the sick cattle with SRS reducing ($P<.05$) gains by 42.7% (.34 vs .59 kg/day). Weight gains were reduced by 22% and 23.7%, respectively, by LAO and LAO plus SRS. The number of treatments per sick head was increased by 17.6% with SRS (8.36 vs 7.11 days/head), whereas, LAO and LAO plus SRS reduced the number of treatments by 19.8% and 5.6%, respectively. Number of repulls (cattle that had to be treated more than once for respiratory disease) was significantly reduced ($P<.01$) by the administration of LAO (6.1 vs 26.9%) but repulls were increased by SRS by 48.7% (40.0 vs 26.96%). The response to first drug treatment was similar across groups except that SRS reduced response rates by 29.4% (50.0 vs 70.8%).

Feed intakes and gain to feed ratios for the four treatment groups

TABLE VIII

EFFECT OF MASS MEDICATION ON DAILY GAINS, SICK DAYS, REPULLS AND RESPONSE TO FIRST TREATMENT IN SICK CATTLE--EXPERIMENT TWO

	Controls	LAO	SRS	LAO + SRS
Number of head	59	46	53	52
Daily gain, kg*	.59[b]	.46[ab]	.34[a]	.45[ab]
Sick days*	7.11[cd]	5.70[c]	8.36[de]	6.71[c]
Repulls, %*	26.9[de]	6.1[c]	40.0[e]	20.7[cd]
Response to first* treatment, %	70.8	76.8	50.0	65.7

*Expressed as LSMEANS.
a,b Means with different superscripts differ (P<.05).
c,d,e Means with different superscripts differ (P<.01).

TABLE IX

EFFECT OF MASS MEDICATION ON FEED INTAKE AND GAIN TO FEED RATIO--EXPERIMENT TWO

	Controls	LAO	SRS	LAO + SRS
Number of pens	4	4	4	4
Feed intake,kg*	6.71[b]	5.96[a]	6.18a	6.09[a]
kg gain/kg feed*	.101	.103	.086	.105

*Expressed as LSMEANS.
a,b Means with different superscripts differ (P<.10).

are reported in Table IX. All three mass medication procedures reduced feed intake ($P<.10$) as compared to the control cattle. Gain to feed ratios were not altered by the administration of LAO or LAO plus SRS but were reduced by 14.9% with SRS medication.

Discussion

Mass medication with long-acting oxytetracycline and sustained release sulfadimethoxine improved weight gains and reduced sick pen days and morbidity in stressed cattle in experiment one. However, this same procedure did not effect the performance or health of cattle in experiment two. These results did not agree with those expected. With higher morbidity, one would expect mass medication to be of greater benefit than for cattle experiencing little sickness.

Neither of these long-acting drugs maintain therapeutic blood levels past four days. Hence, mass medication would have limited benefit if the majority of the cattle became sick after the first week of the receiving period. But, in both of these experiments, the majority of the cattle requiring treatment were pulled within the first four days following processing. Thus, delayed sickness cannot account for the difference in response observed between the two experiments.

In experiment two, the administration of LAO alone reduced the incidence of sickness, the number of sick days per head, and the number of repulls. Since LAO costs only one-half as much as mass medication with both LAO and SRS, its use would be more likely to be economically advantageous. The administration of SRS alone tended to impair the health and performance of these newly arrived cattle.

The economics of mass medicating cattle depends on the cost and

success of conventional treatment, availability of labor, ability to detect sick cattle early, and on the health status of cattle received. Mass medication at processing would not be economic for fresh, local cattle which experience delayed illness (7-14 days after arrival). Mass medication should reduce labor and drug costs, and increase performance for cattle which are severely stressed from a long trip.

CHAPTER IV

THE EFFECT OF LASALOCID OR DECOQUINATE ON HEALTH AND PERFORMANCE OF NEWLY ARRIVED STOCKER CATTLE

Summary

One thousand forty-six newly received steer and bull calves and yearlings (11 truck loads) averaging 215 kilograms were used in a study to determine the effect of the coccidiostats, lasalocid and decoquinate, on health and performance over a 28 day receiving period. All cattle had ad libitum access to prairie grass hay and were fed .9 kg per day of a soybean meal-based pellet for the first 21 days and .45 kg per day during days 22-28. The pelleted supplement contained no drugs, lasalocid (165 mg/kg feed), or decoquinate (110 mg/kg feed). Lasalocid or decoquinate did not influence the weight gains or health of stressed cattle with the data pooled across loads. However, the number of sick days per head and morbidity tended to be increased with the feeding of lasalocid (1.99 vs 1.65 days and 27 vs 22%). Some truck loads of cattle responded differently to the three supplements than other loads. In some loads, those cattle fed coccidiostats outgained and experienced less sickness than cattle fed the control supplement, whereas, in other loads those cattle fed the control diet performed better than those fed a coccidiostat. No clinical signs of coccidiosis were detected in any of the truck loads. It appeared that the origin

of the cattle, previous history of the cattle, and the degree of previous stress imposed on the cattle affected the response to the feed treatments.

Introduction

Coccidiosis is a common health problem among newly arrived stocker cattle in Oklahoma (Lusby, 1985). The disease causes economic losses due to increased morbidity and death loss, high labor and treatment costs, and reduced feed efficiencies and weight gains. Fox (1984) reviewed recent field data and concluded the following: 1) low level or subclinical coccidiosis caused serious economic losses and interfered with optimum performance, 2) the severity of the symptoms of coccidiosis was both affected by and contributed to stress, and 3) medication with a coccidiostat removed one of the stresses associated with cattle husbandry and helped reduce the severity of other diseases.

The coccidiostat, decoquinate, has been reported to increase weight gains and feed efficiency and reduce morbidity and death loss in stocker steers and heifers (Hutcheson and Cummins, 1982; Fox, 1984; Barnes et al., 1984, 1985; Lusby et al., 1985). Other studies have reported that including decoquinate in the diet of newly received calves did not alter the performance or health status of calves (Prouty et al., 1981; Rust et al., 1981; Williams and Mahoney, 1984). This may reflect either reduced drug effectiveness, reduced incidence of coccidiosis, or less stress.

In addition, the ionophore, lasalocid, when fed at sufficiently high levels is an effective coccidiostat for cattle (Horton, 1982). Also, feeding lasalocid to newly arrived stocker steers exhibiting no

signs of coccidiosis increased weight gains by 7.8% in one trial (Gill et al., 1982b).

The objective of this research was to study the effect of lasalocid or decoquinate on the health and performance of newly arrived stocker cattle.

Experimental Procedure

This study was conducted as part of experiment one of the mass medication study (control vs long-acting oxytetracycline and sustained release sulfadimethoxine) reported in Chapter III of this manuscript. The experimental procedures of this study are described there (Hicks, 1985a).

Pooled data in this study were analyzed statistically using truck means with missing values calculated by standard equations given by Snedecor and Cochran (1967). Truck X feed treatment X medical treatment was used as the error term.

Data on feed intake and gain to feed ratio were analyzed using pens as the experimental unit since feed records were kept on a pen basis. The initial models for these two criteria included truck, feed treatment, medical treatment, all two way interactions, and initial pen weight. Initial models were reduced when sources of variation had observed significance levels greater than .20.

Results and Discussion

Effects of lasalocid or decoquinate on daily gains, sick days, and morbidity across all cattle are presented in Table X. Gains averaged across all cattle (sick and never sick) in the 28 day day receiving

period were not affected by lasalocid or decoquinate. However, gains of those cattle that were never sick were reduced by 6.5% ($P<.10$) with the feeding of decoquinate (.72 vs .77 kg/head/day). The number of sick days per head tended to be increased with the feeding of lasalocid (1.99 vs 1.65 days). Morbidity also was slightly increased in cattle fed lasalocid (27 vs 22%).

Effects of lasalocid or decoquinate on the performance and health of the sick cattle are reported in Table XI. Daily gains tended to be increased in cattle fed lasalocid (.49 vs .45 kg/head). Sick days tended to be decreased with the feeding of decoquinate (5.99 vs 6.19 days/head).

Data on feed intake and gain to feed ratio is presented in Table XII. Feed intake was slightly reduced with the feeding of decoquinate (6.34 vs 6.52 kg/head/day). Gain to feed ratio was not influenced by either lasalocid or decoquinate.

Effects of lasalocid or decoquinate on weight gains, sick days, and morbidity in each truck load of cattle are presented in Table XIII (raw means). Results were inconsistent between truck loads. In some truck loads cattle fed lasalocid had faster gains than control cattle (1, 3, 6,8, and 9), whereas, in other loads cattle fed lasalocid had lower gains than control cattle (2, 7, and 11). Similar inconsistencies on the effect of lasalocid on morbidity were noted. Lasalocid tended to increase morbidity in five loads (1, 2, 4, 6, and 7) and decrease it in four loads (3, 8, 9, and 10). The effects of decoquinate on weight gains and morbidity were also quite variable, tending to increase daily gains in three loads (7, 8, and 9) and decrease gains in seven loads (1, 2, 3, 5, 6, 10, and 11). Similar

TABLE X

EFFECT OF LASALOCID OR DECOQUINATE ON DAILY GAINS, SICK DAYS AND MORBIDITY IN STRESSED CATTLE

	Control	Lasalocid	Decoquinate
Number of head	342	348	356
Number of head never sick	261	265	268
Arrival weight, kg	214	216	217
Daily gain, kg	.69	.68	.65
Daily gain of head never sick, kg	.77[b]	.77[b]	.72[a]
Sick days	1.65	1.99	1.63
Morbidity, %	22.0	27.0	24.0

[a,b]Means with different superscripts differ ($P<.10$).

TABLE XI

EFFECT OF LASALOCID OR DECOQUINATE ON DAILY GAINS AND SICK DAYS IN SICK CATTLE

	Control	Lasalocid	Decoquinate
Number of head	81	83	88
Daily gain, kg	.45	.49	.46
Sick days	6.19	6.11	5.99

TABLE XII

EFFECT OF LASALOCID OR DECOQUINATE ON FEED INTAKE AND GAIN TO FEED RATIO

	Control	Lasalocid	Decoquinate
Number of pens	17	17	17
Feed intake, kg*	6.52	6.51	6.34
kg gain/kg feed*	.112	.114	.113

*Expressed as LSMEANS.

variability in morbidity was observed. Morbidity was higher in those cattle fed decoquinate than in the control cattle in five loads (1, 3, 5, 6, and 11) but lower in four loads (4, 7, 9, and 10).

In this study, the feeding of the coccidiostats, lasalocid or decoquinate, did not affect the health or performance of newly received, stressed cattle. No clinical signs of coccidiosis were detected in any of the cattle during this study. If cattle are not experiencing coccidiosis, a coccidiostat such as decoquinate would have no benefit. Lasalocid, an ionophore, might still improve performance of the cattle (Gill et al., 1982b).

Results of this study suggest that response of newly received cattle to a coccidiostat may depend on the origin of the cattle and the degree of previous stress imposed on the cattle. Barnes et al. (1984) suggested that season of the year also might be another factor affecting the response of cattle to coccidiostats.

The major finding from this study was that in conducting research with newly received cattle (animal health studies) that each truck load of cattle should be considered as a separate trial. Factors such as origin of the cattle, medication history, time in transit, and degree and type of previous stress probably influence the response of cattle to experimental treatments. Thus, one load of cattle may respond differently to treatments than another load. Conclusions drawn from animal health research using one load of cattle can not be applied to cattle in general since the next load of cattle may respond differently.

TABLE XIII

EFFECT OF LASALOCID OR DECOQUINATE ON DAILY GAINS, SICK DAYS AND MORBIDITY IN STRESSED CATTLE-- RAW MEANS FOR EACH LOAD

	Number of Head	Daily Gain, kg	Sick Days	% Morbidity
Trial 1				
Truck 1				
Control	34	1.09	1.3	23.5
Lasalocid	33	1.13	3.3	48.5
Decoquinate	34	1.09	2.1	48.1
Trial 2				
Truck 2				
Control	42	.96	.6	11.9
Lasalocid	32	.87	1.3	18.8
Decoquinate	21	.79	.6	14.3
Truck 3				
Control	20	.68	1.2	25.0
Lasalocid	29	.76	.3	10.3
Decoquinate	42	.56	1.4	26.2
Trial 3				
Truck 4				
Control	35	1.02	1.3	25.7
Lasalocid	23	.96	2.5	47.8
Decoquinate	46	1.02	1.3	21.7
Truck 5				
Control	22	.81	0	0
Lasalocid	44	.80	0	0
Decoquinate	22	.72	.6	13.6
Trial 4				
Truck 6				
Control	21	.70	1.3	19.0
Lasalocid	41	.73	1.7	26.8
Decoquinate	31	.65	1.0	25.8
Truck 7				
Control	44	.63	4.0	40.9
Lasalocid	22	.55	5.9	68.2
Decoquinate	33	.73	2.2	36.4

TABLE XIII (Continued)

	Number of Head	Daily Gain, kg	Sick Days	% Morbidity
Trial 5				
Truck 8				
Control	20	.34	2.0	30.0
Lasalocid	20	.44	.8	15.0
Decoquinate	39	.45	2.0	30.8
Truck 9				
Control	36	.27	4.9	66.7
Lasalocid	36	.31	3.4	50.0
Decoquinate	18	.40	4.5	61.1
Trial 6				
Truck 10				
Control	45	.55	.2	4.4
Lasalocid	22	.55	0	0
Decoquinate	34	.46	0	0
Truck 11				
Control	23	.57	0	0
Lasalocid	46	.55	0	0
Decoquinate	36	.49	.3	5.5

CHAPTER V

THE EFFECT OF INTERFERON ON HEALTH AND PERFORMANCE OF NEWLY ARRIVED STOCKER CATTLE

Summary

Three hundred thirty-two newly received steer and bull calves and yearlings averaging 223 kilograms were divided into two groups. One hundred seventeen head received routine processing upon arrival and 215 head received routine processing plus intranasal administration of recombinant leukocyte hybrid A/D interferon (INF). Administration of interferon reduced ($P<.05$) morbidity by 20.6% (39.7% for INF cattle vs 50.0% for controls). Sick days were reduced ($P<.01$) by 33.3% with INF treatment (3.2 vs 4.8 days/head) and repulls were decreased by 39.5% (11.8 vs 19.5%). Cattle treated with INF tended to gain faster (11.4%) than control cattle (.78 vs .70 kg/head/day), consumed less fed ($P<.05$) and had 16.3% higher ($P<.05$) gain to feed ratios (.107 vs .092 kg gain/kg feed).

Introduction

Interferon is a small protein produced or released by animal cells in response to invasion by viral or certain nonviral stimuli which indirectly protects other cells against viral damage by stimulating the production of new antiviral polypeptide or protein (Rosenquist, 1973).

Interferon is believed to play an important role in the recovery of host animals from viral infections (Isaacs, 1963; Baron et al., 1966) which is independent of the body's specific immune mechanisms (Rosenquist and Loan, 1969).

Viruses of almost every major viral group have been shown to induce and be affected by interferon though some are more efficient stimulators of interferon production or are more sensitive to its actions than others (Rosenquist, 1973). Those viruses most commonly associated with the Bovine Respiratory Disease (BRD) complex that have been shown to induce interferon production are infectious bovine rhinotracheitis (IBR) and parainfluenza-3 (Rosenquist and Loan, 1967, 1969). Interferon has been shown to protect against heterologous respiratory tract viral infections (Todd et al., 1972; Cummins and Rosenquist, 1980, 1982a, 1982b). Cummins and Hutcheson (1983) reported that calves orally administered with interferon once daily on the day of and for two days subsequent to IBR virus inoculation gained faster than control calves and calves receiving interferon intravenously or intranasally.

The objective of this research was to study the effect of intranasal administration of recombinant leukocyte hybrid A/D interferon on the health and performance of newly arrived stocker cattle.

Experimental Procedure

Four truck loads (trials) of cattle were purchased by order buyers from auction markets in Alabama, Kentucky, Texas, and Oklahoma and shipped to Pawhuska, Oklahoma. The arrival date and weight, origin,

number of head, and in-transit shrink for each load is summarized in Table XIV. Newly received cattle were weighed individually as unloaded, ear tagged and treated with Lysoff®[1]. Following weighing and tagging cattle were placed in pens of 20 to 25 animals each depending on the number of cattle received. Cattle were randomly assigned by pen to one of the following two treatments: controls (received no interferon) or intranasal administration of recombinant leukocyte hybrid A/D interferon at one million units per kg of body weight. Water and native bluestem grass hay were provided free choice. The morning following arrival, the cattle were processed as follows:

1. Body temperature and time were recorded.

2. Cattle were vaccinated with IBR-PI_3 (MLV) IM, Leptospira pomona bacterin and Clostridia chauvoei, septicum, novyi, and sordellii bacterin.

3. Cattle in interferon treatment groups received intranasal administration of interferon.

4. Cattle with odd-numbered ear tags were dewormed with ivermectin[2] (200mcg/kg) and those cattle with even-numbered ear tags served as controls as part of a deworming trial superimposed on this study.

5. Cattle were started on antibiotic treatment if clinical signs of illness were detected or if body temperature exceeded 40°C except for one-third of the cattle which received no treatment if they became sick.

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[1]Cutter Laboratories, Shawnee Mission, KS 66201

[2]Ivomec®, MSD Agvet, Rahway, NJ 07065

TABLE XIV

ORIGIN, ARRIVAL DATE, NUMBER OF HEAD, ARRIVAL WEIGHT AND IN-TRANSIT SHRINK FOR EACH LOAD OF CATTLE--INTERFERON STUDY

Trial	Origin	Arrival Date	Number of Head[a]	Arrival Wt., kg	% Shrink
1	AL	10-12-84	98	217	6.9
2	KY	11-14-84	91	230	5.0
3	TX	12-20-84	93	216	6.9
4	OK & TX	2-15-85	87	226	7.4

[a]19 and 18 head from trials 1 and 2, respectively, used in other experiments (not interferon).

6. For sick cattle, a hospital card was initiated and the calf was placed in a hospital pen.

As soon as cattle were placed in their pens, they had ad libitum access to bluestem hay and were offered a pelleted feed supplement (Table II - with lasalocid) at a rate of .9 kg/head/day for the first 21 days and .45 kg/head/day during days 22-28.

After processing, cattle were checked twice daily for signs of illness. If an animal was suspected to be sick, it was moved to the processing area where its body temperature was determined and a severity of illness score (slight, moderate, or severe) was assigned. If the body temperature exceeded 40°C the animal was considered sick. Animals could also be classified as sick based on clinical signs.

Medical treatment for sick animals was determined by the ear tag number which was applied at random on arrival. Treatment schedules were (A) no treatment (negative controls), (B) a sequence of antimicrobial drugs listed in Table XV, or (C) an experimental potentiated sulfa (RO5-0037[3]) substituted for Treatment 1 in Table XV. Cattle treated by schedules B and C were initially treated with the first drug in the sequence. If body temperature dropped by 1.1°C or to less than 40°C, or clinical signs were improved within 24 hours, the drug was continued for two more days. If no improvement was apparent within 24 hours, the next drug in the sequence was applied and the procedure repeated until improvement was detected. Cattle treated by schedule C received RO5-0037 boluses orally (66 mg/kg on day one and 33 mg/kg/day thereafter).

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[3]Primor®, Hoffmann-LaRoche, Inc., Nutley, NJ 07110.

TABLE XV

SEQUENCE OF DRUGS USED FOR TREATMENT OF BRD--
1984-1985 EXPERIMENTS

Treatment No 1:	OXYTETRACYCLINE (Biomycin-C®) subcutaneously - 11 mg/kg.
	Plus
	SULFAMETHAZINE BOLUSES (15 gm) 1 bolus/68 kg on day 1. One bolus/136 kg on subsequent days
Treatment No 2:[a]	ERYTHROMYCIN (Gallamycin®) deep in the muscles - 22 mg/kg
Treatment No 3:[a]	SPECTINOMYCIN (Spectam®) - 11 mg/kg.
Treatment No 4:[a]	Procaine Penicillin G subcutaneously - 66,000 IU/kg.
Treatment No 5:[a]	TYLAN 200 - 22 mg/kg.

[a]Some of the antimicrobial drugs used in this study were used for extra-label purpose or at extra-label dosages and require a veterinarian-client-patient relationship before use.

At the end of the 28 day trial, the cattle were held overnight without feed or water, weighed the following morning and, as necessary, cattle were castrated and horns were tipped. Cattle were then returned to the owner.

Least squares analysis of variance was performed on data for all response criteria using the General Linear Model of the Statistical Analysis System (SAS). The initial models across all cattle for weight gains, sick days, morbidity, and mortality included trial (truck load), medical treatment (INF), ivermectin, all two way interactions, and initial weight. These same models were also used in analyzing the data with all the sick head pulled at processing excluded. The initial models for weight gains, sick days, repulls, and response to first drug treatment in the sick head included the same sources of variation with the addition of sick treatment. Feed intakes and gain to feed ratios were analyzed using pens as the experimental unit since feed records were kept on a pen basis. The initial models for these two criteria included medical treatment, trial, and initial pen weight. All models were reduced when sources of variation had observed significance levels greater than .20. However, medical treatment remained in all models since it was the source of variation being studied.

Results and Discussion

Effects of interferon on weight gains, sick days, morbidity, and mortality across all cattle are presented in Table XVI. Average daily gains during the 28 day receiving period were .78 kg/day for cattle treated with INF and .70 kg/day for the control cattle. The average number of sick pen days per head was significantly decreased ($P<.01$)

with INF treatment from 4.8 to 3.2 days. Morbidity was high in both groups, but was lower ($P<.05$) in the INF group (39.7 vs 50.0%). Death loss was decreased in the INF treated group (3.1 vs 4.6%). The death loss percentage among cattle that were treated when they became ill by treatment schedule B or C was 1.6% in the control cattle and 0% in the cattle treated with INF.

Average daily gains of the cattle that were never sick were 1.0 and .90 kg/head/day for control cattle and cattle treated with INF, respectively. Apparently the increased gains observed in all cattle treated with INF were due to reduced sickness. It appears that interferon does not increase weight gains of cattle that never become sick.

Effects of interferon on the health and performance of the sick cattle are reported in Table XVII. Daily gains of the sick cattle were increased by 30.4% with INF administration (.61 vs .46 kg/head). The number of treatment days per sick head tended to be lower in the INF treated group (9.1 vs 9.7 days) and the number of repulls also tended to be lower in this group (11.8 vs 19.5%). Cattle treated with INF tended to responded more favorably to first drug treatment (49.3 vs 43.5%).

Feed intakes and gain to feed ratios are presented in Table XVIII. Interferon treatment reduced feed intake ($P<.05$) from 7.93 to 7.37 kg per head per day. This 7.1% reduction in feed intake combined with the 11.4% increase in daily gains with INF treatment resulted in an improvement ($P<.05$) in gain to feed ratio of 16.3% (.107 vs .092 kg gain/kg feed).

Interferon should begin affecting the animal's non-immune defenses

TABLE XVI

EFFECT OF INTERFERON ON DAILY GAINS, SICK DAYS, MORBIDITY AND MORTALITY IN STRESSED CATTLE

	Controls	Interferon
Number of head	117	215
Number of head never sick	59	126
Arrival weight, kg	223	222
Average daily gain, kg*	.70	.78
Daily gain of head never sick, kg*	1.00	.90
Sick days*	4.8^{b}	3.2^{a}
Morbidity, %*	50.0^{d}	39.7^{c}
Total Mortality, %*	4.6	3.1
Mortality excluding treatment schedule A cattle, %*	1.6^{f}	0^{e}

*Expressed as LSMEANS.
a,b Means with different superscripts differ (P<.01).
c,d Means with different superscripts differ (P<.05).
e,f Means with different superscripts differ (P<.10).

TABLE XVII

EFFECT OF INTERFERON ON DAILY GAINS, SICK DAYS, REPULLS AND RESPONSE TO FIRST TREATMENT IN SICK CATTLE

	Controls	Interferon
Number of head	58	89
Average daily gain, kg*	.46	.60
Sick days*	9.7	9.1
Repulls, %*	19.5	11.8
Response to first treatment, %*	43.5	49.3

*Expressed as LSMEANS.

TABLE XVIII

EFFECT OF INTERFERON ON FEED INTAKE AND GAIN TO FEED RATIO

	Controls	Interferon
Number of pens	6	11
Feed intake, kg*	7.93^{b}	7.37^{a}
kg gain/kg feed*	$.092^{a}$	$.107^{b}$

*Expressed as LSMEANS.
^{ab}Means with different superscripts differ, ($P<.05$).

approximately 24 hours after administration (Fulton, 1985). Hence, the data also was analyzed with those cattle pulled as sick at processing excluded from the model (15 control head and 19 INF head) since INF could not have affected the initial sickness in these cattle. Effects of interferon on weight gains, sick days, morbidity, and mortality with these head excluded are summarized in Table XIX. Average daily gains tended to be higher in the INF treated group (.79 vs .74 kg/day). Cattle treated with INF had fewer sick days ($P<.01$, 2.5 vs 4.0 days/head) and lower morbidity (35.4 vs 43.8%). Mortality was higher in the cattle treated with INF (3.1 vs 2.4%).

Effects of interferon on the health and performance of sick cattle with those head pulled at processing excluded are presented in Table XX. Cattle treated with INF tended to have higher weight gains (.62 vs .49 kg/head/day), fewer sick days (8.4 vs 9.3 days/head), and fewer repulls (12.3 vs 21.9%) than control cattle. Response to first drug treatment was also higher in the INF treated group (56.4 vs 51.7%).

Under the conditions of this study health and performance of newly arrived cattle tended to be improved by treatment with intranasal recombinant leukocyte hybrid A/D interferon. Interferon holds promise as a means of reducing sickness and improving health in stressed stocker cattle. However, further studies need to be conducted with INF before definite conclusions concerning its effects and economics can be made.

TABLE XIX

EFFECT OF INTERFERON ON DAILY GAINS, SICK DAYS, MORBIDITY AND MORTALITY IN STRESSED CATTLE WITH SICK HEAD PULLED AT PROCESSING EXCLUDED

	Controls	Interferon
Number of head	102	194
Arrival weight, kg	223	223
Average daily gain, kg*	.74	.79
Sick days*	4.0[b]	2.5[a]
Morbidity, %*	43.8	35.4
Total Mortality, %*	2.4	3.1
Mortality excluding treatment schedule A cattle, %*	1.0	0

*Expressed as LSMEANS.
[a,b]Means with different superscripts differ (P<.01).

TABLE XX

EFFECT OF INTERFERON ON DAILY GAINS, SICK DAYS, REPULLS AND RESPONSE TO FIRST TREATMENT IN SICK CATTLE WITH HEAD PULLED AT PROCESSING EXCLUDED

	Controls	Interferon
Number of head	43	68
Average daily gain, kg*	.49	.62
Sick days*	9.3	8.4
Repulls, %*	21.9	12.3
Response to first treatment, %*	51.7	56.4

*Expressed as LSMEANS.

CHAPTER VI

THE EFFECT OF RESPIRATORY SYNCYTIAL VIRUS VACCINE ON HEALTH AND PERFORMANCE OF NEWLY ARRIVED STOCKER CATTLE

Summary

One-hundred forty three newly received steer and bull calves and yearlings averaging 214 kilograms were divided into two groups. Eighty-four head received routine processing upon arrival and 59 head received routine processing plus respiratory syncytial virus (RSV) vaccine. Vaccination with RSV vaccine decreased daily gain (.73 vs .61 kg/head). Morbidity was higher for the RSV vaccine group than for the control cattle (64.8 vs 47.3%). Sick days were higher in the RSV vaccine group (6.4 vs 4.5 days/head) and death loss was higher in the vaccinated group also (13.6 vs 2.4%). In this study, the use of RSV vaccine was detrimental to the health and performance of newly received stressed cattle during a 28 day receiving period.

Introduction

Respiratory syncytial virus (RSV) has been detected in respiratory infections of cattle with severe clinical and pathological features (Rosenquist, 1974) and recent work suggested that RSV may be associated with the Acute Respiratory Distress Syndrome of calves (Frey, 1983). Antibody surveys have shown that the virus is common in cattle

populations (Rosenquist, 1983). A modified live virus vaccine was recently introduced onto the market for use in cattle. The objective of this research was to study the effect of RSV vaccine on the health and performance of newly arrived stocker and feeder cattle.

Experimental Procedure

Three truck loads (three trials) of cattle were purchased by order buyers from auction markets in Alabama, Kentucky, and Tennessee and shipped to Pawhuska, Oklahoma. The arrival date and weight, origin, number of head, and in-transit shrink for each load is summarized in Table XXI. Trials one and two had cattle which were part of the interferon study. Newly received cattle were handled and processed in the same manner as described for the interferon study, Chapter V of this manuscript (Hicks, 1985b), except that the cattle were randomly assigned by pen to one of the following two treatments: unvaccinated controls or intramuscular vaccination with respiratory syncytial virus vaccine[1]. After processing, cattle were checked twice daily for signs of illness and treated as described in the interferon experiment (Hicks, 1985b).

Least squares analysis of variance was performed on data for all response criteria using the General Linear Model of the Statistical Analysis System (SAS). The initial models across all cattle for weight gains, sick days, morbidity, and mortality included trial (truck load), medical treatment (RSV), ivermectin, all two way interactions, and

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[1]Bovine Respiratory Syncytial Vaccine (serial number 57), Norden Laboratories, Lincoln, NE.

TABLE XXI

ORIGIN, ARRIVAL DATE, NUMBER OF HEAD, ARRIVAL WEIGHT AND IN-TRANSIT SHRINK FOR EACH LOAD OF CATTLE--RSV VACCINE STUDY

Trial	Origin	Arrival Date	Number of Head[a]	Arrival Wt., kg	% Shrink
1	TN	8-18-84	94	220	8.3
2	AL	10-12-84	98	217	6.9
3	KY	11-14-84	91	230	5.0

[a]25, 60 and 55 head from trials 1, 2 and 3, respectively used in other experiments (not RSV).

initial weight. The initial models for weight gains, sick days, repulls, and response to first drug treatment in the sick cattle included the same sources of variation with the addition of sick treatment. Feed intake and gain to feed ratio were analyzed using pens as the experimental unit since feed records were kept on a pen basis. The initial models for these two criteria included medical treatment, trial, and initial weight. All models were reduced when sources of variation had observed significance levels greater than .20. However, medical treatment remained in all models since it was the source of variation being studied.

Results and Discussion

Effects of RSV vaccine on weight gains, sick days, morbidity, and mortality are shown in Table XXII. Average daily gains during the 28 day receiving period were .73 kg/day for the control cattle and .61 kg/day for those cattle vaccinated with RSV vaccine. However, cattle vaccinated with RSV vaccine that were never sick gained faster ($P<.05$) than control cattle (1.25 vs 1.09 kg/head/day). The average number of sick days per head was increased ($P<.10$) with RSV vaccine from 4.5 to 6.4 days. Morbidity was high in both groups, but greater ($P<.05$) in the group vaccinated with RSV vaccine (64.8 vs 47.3%). Death loss was increased ($P<.01$) in the RSV vaccine group (13.6 vs 2.4%). The death loss percentage among cattle that were treated when they became ill by treatment schedule B or C was 5.3% in the RSV vaccinated group and 0% in the unvaccinated controls.

Effects of RSV vaccine on the health and performance of the sick cattle are shown in Table XXIII. Daily gains of the sick cattle were

decreased by 49% by RSV vaccination (.25 vs .49 kg/head). The number of treatment days per sick head was increased from 9.3 days to 11.4 days with RSV vaccine. Number of repulls were higher in the RSV vaccinated group (38.4 vs 23.5%). Cattle vaccinated with RSV vaccine also tended to have a lower response to first drug treatment (42.1 vs 51.9%).

Feed intakes and gain to feed ratios are presented in Table XXIV. Feed intake was increased in the RSV vaccine group. However, since weight gains were lower for RSV cattle, gain to feed ratio was decreased ($P<.05$) by RSV vaccination.

Under the conditions of this study, health and performance of newly arrived cattle were impaired by treatment with respiratory syncytial virus vaccine. This vaccine offered no economic advantage in processing of stressed cattle in this study.

TABLE XXII

EFFECT OF RSV VACCINE ON DAILY GAINS, SICK DAYS, MORBIDITY AND MORTALITY IN STRESSED CATTLE

	Controls	RSV Vaccine
Number of head	84	59
Number of head never sick	44	21
Arrival weight, kg	213	215
Average daily gain, kg*	.73	.61
Daily gain of head never sick, kg*	1.09[c]	1.25[d]
Sick days*	4.5[a]	6.4[b]
Morbidity, %*	47.3[c]	64.8[d]
Total Mortality, %*	2.4[e]	13.6[f]
Mortality excluding treatment* schedule A cattle, %	0.0[e]	5.3[f]

*Expressed as LSMEANS.
[a,b]Means with different superscripts differ (P<.10).
[c,d]Means with different superscripts differ (P<.05).
[e,f]Means with different superscripts differ (P<.01).

TABLE XXIII

EFFECT OF RSV VACCINE ON DAILY GAINS, SICK DAYS, REPULLS AND RESPONSE TO FIRST TREATMENT IN SICK CATTLE

	Controls	RSV Vaccine
Number of head	40	38
Average daily gain, kg*	.49[b]	.25[a]
Sick days*	9.3[a]	11.4[b]
Repulls, %*	23.5	38.4
Response to first treatment, %*	51.9	42.1

*Expressed as LSMEANS.
a, bMeans with different superscripts differ (P<.10).

TABLE XXIV

EFFECTS OF RSV VACCINE ON FEED INTAKE AND GAIN TO FEED RATIO

	Controls	RSV Vaccine
Number of pens	4	3
Feed intake, kg*	7.20	8.26
kg gain/kg feed*	.105[b]	.072[a]

*Expressed as LSMEANS.
a, bMeans with different superscripts differ (P<.05).

CHAPTER VII

THE EFFECT OF LIVE *PASTEURELLA HEMOLYTICA* VACCINE ON HEALTH AND PERFORMANCE OF NEWLY ARRIVED STOCKER CATTLE

Summary

Five hundred four newly received steer and bull calves and yearlings averaging 241 kilograms were divided into two groups. Two hundred fifty-six head received routine processing upon arrival and 248 head received routine processing plus live *Pasteurella hemolytica* (PH) vaccine. Vaccination with PH vaccine decreased ($P<.10$) the incidence of sickness by 18% (33.1% for PH cattle vs 40.4% for controls). Sick days also were lower in the PH vaccine group (2.2 vs 2.7 days/head) and death loss was decreased ($P<.10$) by vaccination from 1.2% to 0%. Daily gains were not affected by vaccination with PH vaccine in this study.

Introduction

Pasteurella hemolytica has been known to be associated with the shipping fever-bovine respiratory disease (BRD) complex since the 1950's (Carter, 1954; Gale and King, 1961). More recently it was isolated from the pneumonic lungs of feedlot cattle (Hjerpe and Routen, 1976; Martin et al., 1980). It is the most commonly isolated bacterial

pathogen from the acutely affected bovine lung (Brown, 1979; Frank and Smith, 1983).

Over the past 50 years much research as been conducted with Pasteurella bacterins in an effort to control BRD. Wilkie (1980) reviewed studies on the biological control of BRD and concluded that Pasteurella bacterins have no obvious use in control of the disease. Field trials have shown that the bacterins increase morbidity and mortality and decrease weight gains in feedlot cattle (Woods, et al., 1976; Martin et al., 1980; Amstutz et al., 1981). Recent research with live Pasteurella hemolytica vaccine has shown more promising results (Hutcheson et al., 1983; Purdy et al., 1983). Smith (1983) reported results of field trials in which PH vaccine was used in commercial cattle, preconditioned cattle, and feedlot cattle. It reduced morbidity by 89%, 77%, and 44%, respectively.

The objective of this research was to study the effect of PH vaccine on the health and performance of newly arrived stocker and feeder cattle.

Experimental Procedure

Six truck loads (trials) of cattle were purchased by order buyers from auction markets in Georgia, Kansas, Mississippi, Oklahoma, Tennessee, and Texas and shipped to Pawhuska, Oklahoma. The arrival date and weight, origin, number of head, and in-transit shrink for each load is summarized in Table XXV. Newly received cattle were weighed individually off the truck, ear tagged, and treated with Lysoff®[1].

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[1]Cutter Laboratories, Shawnee Mission, KS 66201

TABLE XXV

ORIGIN, ARRIVAL DATE, NUMBER OF HEAD, ARRIVAL WEIGHT AND IN-TRANSIT SHRINK FOR EACH LOAD OF CATTLE--PH VACCINE STUDY

Trial	Origin	Arrival Date	Number of Head	Arrival Wt., kg	% Shrink
1	TN	9-30-84	80	250	5.8
2	GA	11-18-84	77	245	9.0
3	MS	2-06-85	91	223	9.7
4	TX & OK	2-12-85	92	236	3.4
5	KS	3-10-85	88	250	4.8
6	KS	3-18-85	76	251	5.1

Following weighing and tagging, cattle were randomly divided into two groups and placed in separate pens. Water and native bluestem grass hay were provided free choice. The morning following arrival, the cattle were processed as follows:

1. Body temperature and time were recorded.

2. Cattle were vaccinated with IBR-PI_3 (MLV) IM, Leptospira pomona bacterin and Clostridia chauvoei, septicum, novyi, and sordellii bacterin.

3. Cattle with even-numbered ear tags were vaccinated intradermally with live Pasteurella hemolytica vaccine[2] (.5ml/head) and those head with odd-numbered ear tags served as controls.

4. Dewormed with ivermectin[3] (200mcg/kg).

5. Cattle were started on antibiotic treatment if clinical signs of illness were detected or if body temperature exceeded 40°C.

6. For sick cattle, a hospital card was initiated and the calf was placed in a hospital pen.

As soon as cattle were placed in their pens, they had ad libitum access to bluestem grass hay and were offered a pelleted feed supplement (Table XXVI) at a rate of .9 kg/head/day for the first 21 days and .45 kg/head/day during days 22-28. In Trials 2 through 6, a vitamin E supplementation study was superimposed across this vaccine experiment. In each of these trials, one pen of cattle received a feed supplement containing vitamin E (1760 IU/kg) and the other pen received

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[2]PRECON-PH®, AGRI-BIO Corp., Gainsville, GA 30501

[3]Ivomec®, MSD Agvet, Rahway, NJ 07065

TABLE XXVI

COMPOSITION OF FEED SUPPLEMENTS--
PH VACCINE, VITAMIN E STUDY

Ingredient	IFN[a]	% As Fed	
		Control	Vitamin E
Soybean Meal	5-20-637	88.9	88.5
Cottonseed Meal	5-01-621	5.0	5.0
Salt	6-04-152	3.0	3.0
Vitamin E - 220,000 IU/kg[b]		0	.4
Vitamin A - 30,000 IU/Gram		.22	.22
Premix[c]		.18	.11
Dicalcium Phosphate	6-01-080	2.75	2.75

[a]International Feed Number.
[b]To provide 1760 IU vitamin E/kg.
[c]To provide 165 mg lasalocid/kg.

supplement without addition of vitamin E (Table XXVI). Two hospital pens were maintained so that sick animals received their assigned feed while out of their home pen.

After processing, cattle were checked twice daily for signs of illness as described in the experimental procedures for the interferon study, Chapter V of this manuscript (Hicks, 1985b). Medical treatment for sick animals was determined by the ear tag number. The same treatment schedules as outlined for the interferon study were followed except that no negative controls were included. Response to drug treatment was determined in the same manner as in the interferon study.

At the end of the 28 day trial, the cattle were held overnight without feed or water, weighed the following morning and, when necessary, cattle were castrated and horns were tipped. Cattle were then returned to the owner.

Least squares analysis of variance was performed on data for all response criteria using the General Linear Model of the Statistical Analysis System (SAS). The initial models across all cattle for weight gains, sick days, morbidity, and mortality included trial (truck load), feed treatment, PH vaccine, all two way interactions, and initial weight. These same models were also used in analyzing the data with all the sick head pulled at processing excluded. The initial models for weight gains, sick days, repulls, and response to first drug treatment in the sick cattle included the same sources of variation with the addition of sick treatment. All models were reduced when sources of variation had observed significance levels greater than .20. However, PH vaccine remained in all models since it was the source of variation being studied.

Results and Discussion

Effects of PH vaccine on weight gains, sick days, morbidity, and mortality are shown in Table XXVII. Average daily gains during the 28 day receiving period were not affected by the administration of PH vaccine. The number of sick days per head was reduced 18.5% in the vaccinated cattle (2.2 vs 2.7 days/head). Morbidity was reduced ($P<.10$) from 40.4% to 33.1% with PH vaccine (18.1% reduction) and death loss was lower ($P<.10$) in the PH vaccinated group.

Effects of PH vaccine on the health and performance of the sick cattle are shown in Table XXVIII. Those sick cattle vaccinated with PH vaccine tended to gain slightly faster than those not vaccinated (.29 vs .25 kg/head/day). The number of sick days per head and and the number of repulls tended to be greater in the vaccinated cattle than the nonvaccinated cattle (6.4 vs 6.2 days/head and 16.9 vs 14.4%). Trial two was the only trial in which PH vaccine appeared to increase repulls. The response of sick cattle to first drug treatment was greater in the vaccinated cattle (65.1 vs 52.9%). None of these differences proved significant.

The data was also analyzed with those sick cattle pulled at time of processing excluded from the model (33 control head and 30 PH head) since it would take approximately 24 hours for the vaccine to have an affect on the cattle (Perino, 1985). Effects of PH vaccine on weight gains, sick days, morbidity, and mortality with these head excluded are presented in Table XXIX. The number of sick pen days per head was significantly reduced ($P<.05$) by 28.6% in the PH vaccinated cattle as compared to the nonvaccinated cattle (1.5 vs 2.1 days). This reduction

TABLE XXVII

EFFECT OF PH VACCINE ON DAILY GAINS, SICK DAYS, MORBIDITY AND MORTALITY IN STRESSED CATTLE

	Controls	PH Vaccine
Number of head	256	248
Number of head never sick	152	165
Arrival weight, kg	241	240
Average daily gain, kg*	.42	.45
Daily gain of head never sick, kg*	.55	.56
Sick days*	2.7	2.2
Morbidity, %*	40.4^{b}	33.1^{a}
Mortality, %	1.2^{b}	0.0^{a}

*Expressed as LSMEANS.
a,bMeans with different superscripts differ ($P<.10$).

TABLE XXVIII

EFFECT OF PH VACCINE ON DAILY GAINS, SICK DAYS, REPULLS AND RESPONSE TO FIRST TREATMENT IN SICK CATTLE

	Controls	PH Vaccine
Number of head	104	83
Average daily gain, kg*	.25	.29
Sick days*	6.2	6.4
Repulls, %*	14.4	16.9
Response to first treatment, %	52.9	65.1

*Expressed as LSMEANS.

is greater than was observed with all cattle in the model. Morbidity was 22.8% lower in the PH vaccinated cattle than in the nonvaccinated cattle (25.1 vs 32.5%).

Effects of PH vaccine on the health and performance of the sick cattle with those head pulled at processing excluded are reported in Table XXX. The results were quite similar to those observed with all sick head left in the model. The number of repulls for both vaccinated and nonvaccinated cattle was much lower with the data analyzed this way (8.6% for controls and 9.4% for PH cattle). It would appear that most of the cattle requiring retreatment for sickness were originally pulled at processing.

Under the conditions of this study, health and performance of newly arrived cattle tended to be improved by treatment with live Pasteurella hemolytica vaccine. Vaccinated cattle experienced less sickness and required fewer treatments for BRD than nonvaccinated cattle. Smith (1983) in a trial with newly arrived feedlot calves noted greater benefits with PH vaccination (morbidity and treatment days reduced 44 and 40%, respectively) than were observed in this study. Purdy (1983) also reported that the vaccine tended to reduce mortality in 41 feeder calves. These data suggest that PH vaccine can improve the health of stressed cattle.

TABLE XXIX

EFFECT OF PH VACCINE ON DAILY GAINS, SICK DAYS, MORBIDITY AND MORTALITY IN STRESSED CATTLE WITH SICK HEAD PULLED AT PROCESSING EXCLUDED

	Controls	PH Vaccine
Number of head	223	218
Arrival weight, kg	234	244
Average daily gain, kg*	.45	.52
Sick days*	2.1[b]	1.5[a]
Morbidity, %*	32.5[d]	25.1[c]
Mortality, %	.45	0.0

*Expressed as LSMEANS.
a,b Means with different superscripts differ (P<.05).
c,d Means with different superscripts differ (P<.10).

TABLE XXX

EFFECT OF PH VACCINE ON DAILY GAINS, SICK DAYS, REPULLS AND RESPONSE TO FIRST TREATMENT IN SICK CATTLE WITH HEAD PULLED AT PROCESSING EXCLUDED

	Controls	PH Vaccine
Number of head	71	53
Average daily gain, kg*	.21	.25
Sick days*	5.9	5.9
Repulls, %*	8.6	9.4
Response to first treatment, %	52.6	68.3

*Expressed as LSMEANS.

CHAPTER VIII

THE EFFECT OF VITAMIN E SUPPLEMENTATION ON HEALTH AND PERFORMANCE OF NEWLY ARRIVED STOCKER CATTLE

Summary

Five hundred two newly received steer and bull calves and yearlings averaging 242 kilograms were used in a study to determine the effect of vitamin E supplementation on health and performance over a 28 day receiving period. All cattle had ad libitum access to prairie hay and were fed .9 kg/day of a soybean meal-based pellet for the first 21 days and .45 kg/day during days 22-28 with 252 of the cattle receiving vitamin E in their supplement (1760 IU/kg supplement). Cattle fed vitamin E gained .53 kg/day compared to .43 kg/day for control cattle ($P<.01$). Feed intake was not effected by vitamin E supplementation but cattle fed vitamin E had 28.6% higher gain to feed ratios than control cattle (.063 vs .049 kg gain/kg feed). The number of sick pen days per head was reduced by 15.6% (2.7 vs 3.2 days/head) and morbidity was reduced by 13.4% (37.5 vs 43.3%) with vitamin E supplementation. These data suggest that vitamin E supplementation improved the performance of newly received, stressed cattle.

Introduction

Supplementing vitamin E in pharmacological doses in well balanced diets has been shown to increase humoral antibody production against a variety of particulate and soluble antigens in chickens, mice, turkeys, guinea pigs, and rabbits (Heinzerling et al., 1974a, 1974b; Tengerdy, 1980). Studies also have shown that high levels of vitamin E may enhance the immune system of swine (Ellis and Vorhies, 1976), sheep (Tengerdy et al., 1983), and horses (Lewis et al., 1976). Smith et al. (1984) reported that vitamin E supplementation reduced the incidence and duration of clinical mastitis in dairy cows.

Little research has been conducted on the effects of vitamin E on the health, immune response or performance of beef cattle. Early research showed vitamin E supplementation or injection had no effect on weight gains of feedlot calves (Newland et al., 1966; Lyford and Colby, 1967; Perry et al., 1968; Totusek et al., 1968). In contrast to these studies Lee et al. (1985) reported that vitamin E supplementation (400 IU/head/day) of the receiving diet of stressed calves improved daily gains ($P<.08$) and feed efficiency ($P<.02$) by 5% and reduced morbidity and mortality by 8% and 50%, respectively.

The vitamin E requirement of young calves is thought to be between 15 and 60 IU/kg of dry diet (NRC, 1984). Normal diets are thought to supply adequate amounts of vitamin E for adult cattle. However, the nutrient needs of stressed cattle may be greater due to reduced feed and water intake and health problems. Therefore, the objective of this research was to study the effect of dietary vitamin E supplementation

(1760 IU/kg feed) on the health and performance of newly arrived stocker cattle.

Experimental Procedure

Six truck loads (trials) of cattle were purchased by order buyers from auction markets in Georgia, Kansas, Mississippi, Oklahoma, and Texas and shipped to Pawhuska, Oklahoma. The arrival date and weight, origin, number of head, and in-transit shrink for each load is summarized in Table XXXI. This study was superimposed across the live Pasteurella hemolytica (PH) vaccine experiment (Chapter VII of this manuscript). For the experimental procedures of this study, refer to those given for the PH vaccine experiment (Hicks, 1985c).

Least squares analysis of variance was performed on data for all response criteria using the General Linear Model of the Statistical Analysis System (SAS). The initial models across all cattle for weight gains, sick days, morbidity, and mortality included trial (truck load), feed treatment, PH vaccine, all two way interactions, and initial weight. These same models were also used in analyzing the data with all the sick head pulled at time of processing excluded. The initial models for weight gains, sick days, repulls, and response to first drug treatment in the sick cattle included the same sources of variation with the addition of sick treatment. Data on feed intake and gain to feed ratios were analyzed using pens as the experimental unit since feed records were kept on a pen basis. The initial models for these two criteria included trial, feed treatment, and initial pen weight. All models were reduced when sources of variation had observed significance levels greater than .20. However, feed treatment remained

TABLE XXXI

ORIGIN, ARRIVAL DATE, NUMBER OF HEAD, ARRIVAL WEIGHT AND IN-TRANSIT SHRINK FOR EACH LOAD OF CATTLE--VITAMIN E STUDY

Trial	Origin	Arrival Date	Number of Head	Arrival Wt., kg	% Shrink
1	GA	11-12-84	79	249	7.6
2	GA	11-18-84	77	245	9.0
3	MS	2-06-85	91	223	9.7
4	TX & OK	2-12-85	92	236	3.4
5	KS	3-10-85	88	250	4.8
6	KS	3-18-85	76	251	5.1

in all models since it was the source of variation being studied.

Results and Discussion

Effects of vitamin E supplementation on weight gains, sick days, morbidity, and mortality are presented in Table XXXII. Gains in the 28 day receiving period were significantly increased ($P<.01$) by vitamin E supplementation (.53 vs .43 kg/head/day). Daily gains of those cattle that were never sick were .61 and .67 kg/head/day for control cattle and cattle fed vitamin E, respectively. The number of sick pen days per head tended to be lower for the cattle fed supplemental vitamin E than for the control cattle (2.7 vs 3.2 days). Morbidity was also lower in these cattle (37.5 vs 43.3%). Death loss was 1.6% in the control cattle and 1.2% in the vitamin E cattle.

Effects of vitamin E supplementation on the health and performance of the sick cattle are reported in Table XXXIII. Those sick cattle fed vitamin E gained .32 kg/day compared to .26 kg/day for sick control cattle. The number of treatment days per head tended to be lower in the vitamin E group (6.6 vs 7.0 days). However, the number of repulls was greater for the vitamin E cattle than for the control cattle (17.8 vs 13.3%). The response to first drug treatment was similar for both treatments (61.5% and 58.8% for vitamin E and controls, respectively).

Feed intakes and gain to feed ratios are reported in Table XXXIV. Vitamin E supplementation did not affect feed intake (8.00 vs 7.99 kg/head/day for vitamin E and control, respectively). However, due to the 23.3% increase in daily gains, feed to gain ratio was increased from .049 to .063 kg gain/kg feed.

Effects of vitamin E supplementation on the health and the performance of cattle with those sick head pulled at time of processing excluded from the analysis are presented in Tables XXXV and XXXVI. Excluding these head from the analysis did not change the interpretation of results. With the data analyzed in this manner, cattle fed vitamin E gained 22.2% faster than control cattle ($P<.05$, .55 vs .45 kg/head/day). Vitamin E supplementation reduced morbidity by 11.7% (30.9 vs 35.0%) and sick days by 12.5% (2.1 vs 2.4 days/head). In the sick cattle, vitamin E supplementation tended to increase gains and reduce sick days.

Under the conditions of this study, vitamin E supplementation (1760 IU/kg supplement or 1600 IU/head/day) significantly increased weight gains and tended to reduce sickness in newly received, stressed stocker cattle. These results are consistent with those reported by Lee et al. (1985). These studies suggest that the vitamin E requirement of stressed cattle is higher than the 15 to 60 IU/kg of dry diet that is suggested by NRC (1984) for young calves. More studies need to be conducted in stressed cattle with different levels of the vitamin to determine its requirement for such cattle.

TABLE XXXII

EFFECT OF VITAMIN E SUPPLEMENTATION ON DAILY GAINS, SICK DAYS, MORBIDITY AND MORTALITY IN STRESSED CATTLE

	Controls	Vitamin E
Number of head	252	250
Number of head never sick	146	158
Arrival weight, kg	240	244
Average daily gain, kg*	.43[a]	.53[b]
Daily gain of head never sick, kg*	.61[a]	.67[b]
Sick days*	3.2	2.7
Morbidity, %*	43.3	37.5
Mortality, %	1.8	1.6

*Expressed as LSMEANS.
a,bMeans with different superscripts differ (P<.01).

TABLE XXXIII

EFFECT OF VITAMIN E SUPPLEMENTATION ON DAILY GAINS, SICK DAYS, REPULLS AND RESPONSE TO FIRST TREATMENT IN SICK CATTLE

	Controls	Vitamin E
Number of head	106	92
Average daily gain, kg*	.26	.32
Sick days*	7.0	6.6
Repulls, %*	13.3	17.8
Response to first treatment, %	58.8	61.5

*Expressed as LSMEANS.

TABLE XXXIV

EFFECT OF VITAMIN E SUPPLEMENTATION ON FEED INTAKE AND GAIN TO FEED RATIO

	Controls	Vitamin E
Number of pens	6	6
Feed intake, kg*	8.00	7.99
kg gain/kg feed*	.049	.063

*Expressed as LSMEANS.

TABLE XXXV

EFFECT OF VITAMIN E SUPPLEMENTATION ON DAILY GAINS, SICK DAYS, MORBIDITY AND MORTALITY IN STRESSED CATTLE WITH SICK HEAD PULLED AT PROCESSING EXCLUDED

	Controls	Vitamin E
Number of head	216	222
Arrival weight, kg	240	245
Average daily gain, kg*	.45[a]	.55[b]
Sick days*	2.4	2.1
Morbidity, %*	35.0	30.9
Mortality, %	.93	.45

*Expressed as LSMEANS.
[a,b]Means with different superscripts differ ($P<.05$).

TABLE XXXVI

EFFECT OF VITAMIN E SUPPLEMENTATION ON DAILY GAINS, SICK DAYS, REPULLS AND RESPONSE TO FIRST TREATMENT IN SICK CATTLE WITH HEAD PULLED AT PROCESSING EXCLUDED

	Controls	Vitamin E
Number of head	68	63
Average daily gain, kg*	.20	.30
Sick days*	6.6	6.2
Repulls, %	8.2	9.5
Response to first treatment, %*	62.9	64.1

*Expressed as LSMEANS.

CHAPTER IX

THE RESPONSE OF NEWLY ARRIVED STOCKER CATTLE TO DIFFERENT MEDICAL REGIMENS

Summary

Five hundred twenty-four newly received steer and bull calves and yearlings that required treatment for sickness were used in three different experiments to study the response of cattle treated with oxytetracycline (OTC) plus sulfamethazine boluses (SB), amoxicillin, or potentiated sulfa boluses (PSB). In experiment one, 173 head of 523 received cattle became sick and were treated as follows: 28 head received OTC plus SB, 35 head received amoxicillin, 67 head received PSB, and 43 head served as negative controls (not treated for sickness). The percent responses to the three drug treatments were 82.1%, 45.7%, and 91.0% for OTC plus SB, amoxicillin, and PSB, respectively. In experiment two, 219 head of 463 received cattle became sick and were treated as follows: 75 head received OTC plus SB, 83 head received PSB, and 61 head served as negative controls. The percent response to the two drugs were 56.0% and 51.1% for OTC plus SB and PSB, respectively. The negative controls were sick for more ($P<.05$) days than either of the treated groups and death loss was much higher (32.8 vs 3.2% of the sick cattle). In experiment three, 237 of 502 cattle were treated with either OTC plus SB (107 head) or PSB (130 head). The responses to OTC plus SB and PSB were 59.3% and 57.5%,

respectively. The percent death losses in the three experiments were .76%, 5.4%, and 1.8%, respectively.

Introduction

Between two and five percent of newly arrived stocker cattle received in Oklahoma die of stress related diseases, primarily the Bovine Respiratory Disease (BRD) complex, shortly after shipping (Gill, 1985). Morbidity ranges from 0 to 100 percent with an average between 25 and 30 percent. In order to prevent excessive death loss and decreased performance, sick cattle must respond to drug therapy. Studies have shown that cattle exhibiting signs of BRD respond well to oxytetracycline or sulfamethazine treatment (Breeze and Magonigle, 1979; Breeze et al., 1980; Nash, 1983). The PSB used in this study was an experimental potentiated combination drug employing sulfadimethoxine and ormetoprim in a ratio of 5:1. The objective of this research was to study the response of sick cattle that were treated with either OTC plus SB or PSB.

Experimental Procedure

Experiment one was a study to determine the effect of mass medication on the health and performance of stocker cattle. The procedures for this experiment are given under experiment one of Chapter III of this manuscript (Hicks, 1985a).

Experiment two was a study to determine the effect of respiratory syncytial virus vaccine or interferon on the health and performance of stocker cattle. The procedures for this experiment are given in Chapters V and VI of this manuscript (Hicks, 1985b, 1985d).

Experiment three was a study to determine the effect of a live Pasteurella hemolytica vaccine on the health and performance of stocker cattle. The procedures for this experiment are given in Chapter VII of this manuscript (Hicks, 1985c).

Least-squares analysis of variance was performed on data for all response criteria within each experiment using the General Linear Model of the Statistical Analysis System (SAS). In experiment one, the initial models for weight gains, sick days, repulls, and response to treatment included truck, feed treatment, sick treatment, all two way interactions, and initial weight. In experiment two, the initial models included truck, ivermectin, medical treatment (interferon or RSV vaccine), sick treatment, all two way interactions, and initial weight. In experiment three, the initial models included truck, PH vaccine, feed treatment, sick treatment, all two way interactions, and initial weight. All models were reduced when sources of variation had observed significance levels greater than .20.

Results and Discussion

In experiment one, cattle treated with PSB or OTC plus SB responded significantly ($P<.05$) better than cattle treated with amoxicillin (Table XXXVII). Only 45.7% of the cattle treated with amoxicillin responded (recovered from sickness), whereas, response rates of 91% and 82.1% were observed in cattle treated with PSB and OTC plus SB, respectively. Cattle treated for sickness gained 31 to 59% faster than negative control cattle (.39 kg/day) with cattle receiving OTC plus SB having the highest weight gains (.62 kg/day). Cattle treated with PSB had gains similar (.59 kg/day) to those treated with

OTC plus SB. Negative control cattle had a greater number of sick days (8.4 days/head) than treated cattle with the OTC plus SB group having the fewest sick days (5.2 days/head). Number of repulls (cattle that had to be treated more than once for respiratory disease) were highest in the PSB cattle (20.9%). Death loss in the negative control cattle was 4.7% of those getting sick, versus 3.0%, 0%, and 0% of those becoming sick in the PSB, OTC plus SB and amoxicillin groups, respectively.

In contrast to the above results, cattle in experiments two and three tended to respond slightly better when treated with OTC plus SB versus PSB. In experiment two, 56.0% of the cattle treated for BRD responded to OTC plus SB and 51.1% responded to PSB. The responses in experiment three were similar (59.3% for OTC + SB vs 57.5% for PSB). In these two experiments, daily gains tended to be greater for cattle treated with PSB. The PSB treated head gained 0.02 and 0.09 kg/head more than the OTC plus SB cattle in experiments one and two, respectively. However, these same cattle tended to require more treatment days to recover from sickness (Exp. 1- 8.3 vs 7.4 days/head and Exp. 2- 7.0 vs 6.7 days/head). Compared to experiment one, the PSB treated cattle had fewer repulls than the OTC plus SB cattle in both experiments two and three. The death loss in these two experiments was similar for the OTC plus SB and PSB groups. In experiment two, the negative control cattle had a greater ($P<.05$) number of sick days than either of the treated groups (12.2 vs 7.9 days/head) and the mortality rate was much greater (32.8% vs 3.2%). In this experiment there was a definite economic advantage with the treatment of sick cattle. The response to treatment in these experiments was much lower than that

observed in experiment one probably due to the fact that these cattle were less productive, sicker cattle than those in experiment one as evidenced by lower gains and higher morbidity. Studies done at Pawhuska tend to indicate that morbid, poorer performing cattle are less likely to respond to medical treatment.

Under the conditions of these experiments there were no real differences in the response and performance of sick cattle treated with OTC plus SB or PSB. Either medical regimen is useful in the treatment of newly arrived, stressed cattle showing symptoms of BRD.

TABLE XXXVII

EFFECT OF DIFFERENT MEDICAL REGIMENS ON DAILY GAINS, SICK DAYS, REPULLS AND RESPONSE TO FIRST TREATMENT IN SICK CATTLE

	Head No.	Daily* Gains kg	Sick* Days	Repulls* %	Response* %	Mortality[a] %
Experiment 1						
OTC + SB	43	.62	5.2	7.1	82.1[e]	0.0
Amoxi	35	.51	6.9	14.3	45.7[d]	0.0
PSB	67	.59	6.5[b]	20.9	91.0[e]	3.0
Controls	43	.39	8.4	7.0[c]	----	4.7
Experiment 2						
OTC + SB	75	.38	7.4[f]	24.3	56.0	2.6
PSB	83	.40	8.3[f]	18.5	51.1	3.8
Controls	61	.38	12.2[g]	10.1[c]	----	32.8
Experiment 3						
OTC + SB	107	.27	6.4	19.4	59.3	3.7
PSB	129	.36	7.1	12.8	57.5	3.8

*Expressed as LSMEANS.
[a]Percent of sick cattle
[b]Protocol required at least a 5 day treatment period.
[c]Many of these cattle never recovered and remained in the sick pen the entire trial
[d,e]Means with different superscripts differ (P<.01)
[f,g]Means with different superscripts differ (P<.05)

CHAPTER X

THE EFFECT OF IVERMECTIN ON HEALTH AND PERFORMANCE OF NEWLY ARRIVED STOCKER CATTLE

Summary

Eight hundred fifty-five newly received steer and bull calves and yearlings were used in two different experiments to determine the effect of ivermectin on performance and health. This study was superimposed across the two experiments. In experiment one, 391 head averaging 210 kilograms were divided into two groups. One hundred ninety-three received routine processing on arrival and 198 received routine processing plus ivermectin. Deworming with ivermectin increased daily gains by 28.3% ($P<.001$, .68 vs .53 kg/head). The number of sick days per head decreased slightly with ivermectin (3.5 vs 3.8 days/head).

In experiment two, 463 head averaging 218 kilograms were divided in two groups. Two hundred twenty-three received routine processing on arrival and 240 received routine processing plus ivermectin. Ivermectin treatment increased daily gains by 31.1% ($P<.001$, .80 vs .61 kg/head). Ivermectin also tended to reduce the number of sick days per head (4.3 vs 5.0 days/head) and reduce morbidity (48.6 vs 51.3%).

Introduction

The effects of anthelmintics on the performance of newly received stocker cattle has been variable (Davis and Caley, 1979; Hanke and Lindor, 1983; Winder et al., 1983). An anthelmintic is of no benefit if the cattle have minimal parasite burden or if resistance is present. The most pathogenic and economically important internal parasite of cattle is considered to be the abomasal nematode, Ostertagia ostertagi. Traditional anthelmintics have shown limited effectiveness against pre-type II and type II ostertagiasis (Williams et al., 1984).

Ivermectin has shown over 99% efficacy against inhibited larvae of Ostertagia ostertagi (Williams et al. 1981) and against all types of gastro-intestinal nematodes (Yazwinski et al., 1981; Benz, 1983). It has been reported to improve weight gains of feeder calves by 11 to 21% (Holste, 1983; Ciordia et al., 1984; Lofgreen et al., 1984c). The objective of this research was to study the effect of ivermectin on the health and performance of newly arrived stocker cattle.

Experimental Procedure

Experiment one determined the effect of mass medication on the health and performance of stocker cattle. The procedures for this experiment are given under in Chapter III (experiment two) of this manuscript (Hicks, 1985a).

Experiment two determined the effect of respiratory syncytial virus (RSV) vaccine or interferon on the health and performance of stocker cattle. The procedures for this experiment are given in Chapters V and VI of this manuscript (Hicks, 1985b, 1985d).

Least-squares analysis of variance was performed on data for all response criteria within each experiment using the General Linear Model of the Statistical Analysis System (SAS). In both experiments, the initial models for weight gains, sick days, morbidity, and mortality included trial (truck load), ivermectin, medical treatment (mass medication, interferon or RSV vaccine), all two way interactions, and initial weight. The initial models for weight gains, sick days, and repulls in the sick cattle included the same sources of variation with the addition of sick treatment. All models were reduced when sources of variation had observed significance levels greater than .20. However, ivermectin remained in all models since it was the source of variation being studied.

Results and Discussion

Effects of ivermectin on weight gains, sick days, morbidity, and mortality are shown in Table XXXVIII. In both experiments average daily gains were significantly increased by treatment with ivermectin. In experiment one gains were increased by 28.3% with ivermectin (.68 vs .53 kg/head) and in experiment two gains were increased by 31.1% (.80 vs .61 kg/head). The average number of sick pen days per head tended to decrease in cattle which received ivermectin. Morbidity was high in both groups, but ivermectin tended to reduce it slightly. Ivermectin had no effect on death loss in either experiment.

Average daily gains by the sick cattle were also significantly increased by ivermectin in both experiments (Table XXXIX). In experiment one gains were increased by 51.4% (.56 vs .37 kg/head) and in experiment two gains increased by 60% (.48 vs .30 kg/head). The

TABLE XXXVIII

EFFECT OF IVERMECTIN ON DAILY GAINS, SICK DAYS, MORBIDITY AND MORTALITY IN STRESSED CATTLE

	Experiment 1		Experiment 2	
	Controls	Ivermectin	Controls	Ivermectin
Number of head	193	198	223	240
Number of head never sick	89	92	113	131
Arrival weight, kg	207	212	218	218
Daily gain, kg*	.53[a]	.68[b]	.61[a]	.80[b]
Daily gain of head never sick, kg*	.71[e]	.82[f]	.84[c]	1.10[d]
Sick days*	3.8	3.5	5.0	4.3
Morbidity, %*	53.9	53.5	51.3	48.6
Total Mortality, %	2.6	3.5	5.8	5.0
Mortality excluding trt schedule A cattle, %	2.6	3.5	1.3	0.8

*Expressed as LSMEANS.

[a,b]Means within an experiment with different superscripts differ ($P<.001$).

[c,d]Means within an experiment with different superscripts differ ($P<.05$).

[e,f]Means within an experiment with different superscripts differ ($P<.10$).

number of sick days per head was not effected by ivermectin. Number of repulls was significantly decreased by ivermectin in experiment two (11.2% vs 24.4%) but not in experiment one.

The average daily gains for cattle in each truck load are listed in Table XXXX. In three of the loads, cattle treated with ivermectin gained faster ($P<.05$) than the control cattle. Load 5 of the interferon experiment is the only load in which control cattle gained more than cattle treated with ivermectin. With some loads, cattle may have been dewormed prior to arrival at the station which could explain why certain loads (MM #1, INF #3 and INF #5) showed no favorable response to ivermectin.

Under the conditions of this study, weight gains of newly arrived cattle were significantly increased by treatment with ivermectin over a 28 day receiving period. Thus, this practice should be economically beneficial for producers if increased gains are retained and cost of treatment remains low.

TABLE XXXIX

EFFECT OF IVERMECTIN ON DAILY GAINS, SICK DAYS AND REPULLS IN SICK CATTLE

	Experiment 1		Experiment 2	
	Controls	Ivermectin	Controls	Ivermectin
Number of head	104	106	113	108
Daily gain, kg*	.37[a]	.56[b]	.30[a]	.48[b]
Sick days*	7.1	6.9	9.6	9.1
Repulls, %*	23.6	23.5	24.4[d]	11.2[c]

*Expressed as LSMEANS.

[a,b]Means within an experiment with different superscripts differ ($P<.001$).

[c,d]Means within an experiment with different superscripts differ ($P<.05$).

TABLE XXXX

RATE OF GAIN BY TRUCK LOAD--IVERMECTIN

Load[a]	Origin	Arrival Date	Daily Gain, kg[b]	
			Controls	Ivermectin
MM #1	TN	8-12-84	.66	.70
INF #1	TN	8-18-84	.67[c]	.91[d]
MM #2	AL	9-28-84	.48[c]	.83[d]
INF #2	AL	10-11-84	.10[c]	.79[d]
MM #3	AL	11-03-84	.70	.86
INF #3	KY	11-14-84	1.01	1.04
MM #4	TX	12-06-84	.24	.37
INF #4	TX	12-20-84	.42	.55
INF #5	OK & TX	2-15-85	.87	.82

[a]MM= Mass medication experiment.
INF= Interferon and RSV vaccine experiment.
[b]Daily gain expressed as LSMEANS.
[c,d]Means with different superscript differ (P<.05).

LITERATURE CITED

Addis, D.G., J.G. Clark, J.R. Dunbar, G.P. Lofgreen and D.D. Hinman. 1980a. Preventive medication for feedlot replacement calves. In: Stress Calf Studies. Univ. California Cooperative Extension for Riverside and Imperial Counties, p. 63.

Addis, D.G., D.D. Hinman, J.G. Clark, G.P. Lofgreen and J.R. Dunbar. 1980b. Stress study- castration, branding. In: Stress Calf Studies. Univ. California Cooperative Extension for Riverside and Imperial Counties, p. 74.

Addis, D.G., G.P. Lofgreen, J.G. Clark, C. Adams, E. Prigge, J.R. Dunbar and B. Norman. 1980c. Barley versus wheat in receiving rations for new calves. In: Stress Calf Studies. Univ. California Cooperative Extension for Riverside and Imperial Counties, p. 123.

Addis, D.G., G.P. Lofgreen, J.G. Clark, C. Adams, E. Prigge, J.R. Dunbar and B. Norman. 1980d. Rumensin in receiving rations for new cattle. In: Stress Calf Studies. Univ. California Cooperative Extension for Riverside and Imperial Counties, p. 133.

Addis, D.G., G.P. Lofgreen, J.G. Clark, J.R. Dunbar and C. Adams. 1980e. Barley versus milo in receiving rations. In: Stress Calf Studies. Univ. California Cooperative Extension for Riverside and Imperial Counties, p. 93.

Addis, D.G., G.P. Lofgreen, J.G. Clark, J.R. Dunbar, C. Adams and F.D. Cress. 1976. Preventive medication for feedlot replacement calves. California Ag. 30:18.

Amstutz, H.E., L.A. Horstman and R.L. Morter. 1981. Clinical evaluation of the efficacy of Haemophilus somnus and Pasteurella sp. bacterins. Bovine Pract. 16:106.

Amstutz, H.E., R.L. Morter and C.H. Armstrong. 1982. Antimicrobial resistance of strains of Pasteurella hemolytica isolated from feedlot cattle. Bovine Pract. 17:52.

Axe, D., J. Riley and M. Spire. 1984. Medication programs for newly received calves. Kansas State Univ. Cattleman's Day, Report of Progress. 448:124.

Baldwin, R.L. 1967. Effect of starvation and refeeding upon rumen function. Okla. State Univ. Preconditioning Seminar, p. 40.

Barnes, K.C., K.S. Lusby, F. Still and D. Taylor. 1984. Deccox-mineral feeding studies-- Okmulgee County, Oklahoma. Okla. Agr. Exp. Sta. Res. Rep. MP-116:130.

Barnes, K.C., K.S. Lusby, F. Still and D. Taylor. 1985. Deccox-mineral feeding studies-- Okmulgee County, Oklahoma. Okla. Agr. Exp. Sta. Res. Rep. MP-117:257.

Baron, S. 1970. The biological significance of the interferon system. Arch. Int. Med. 12:84.

Baron, S., C.E. Buckler, R.M. Friedman and R.V. McCloskey. 1966. Role of interferon during viremia. II. Protective action of circulating interferon. J. Immunol. 96:17.

Bennett, B.W. and G.P. Rupp. 1983. A comparison of differing levels of liquamycin LA-200 with other therapeutic regimens for the treatment of bovine respiratory disease. In: R.W. Loan (Ed.). Bovine Respiratory Disease, A Symposium. Texas A & M Univ. Press, p. 474 (Abstr.).

Benz, G.W. 1983. Anthelmintic efficacy of ivermectin against gastrointestinal nematodes in calves. Am. J. Vet. Res. 44:1363.

Breeze, R.G., L.H. Lauerman, J.A. Schmitz and R.A. Magonigle. 1980. Evaluation of a long-acting oxytetracycline for treatment of Pasteurella pneumonia in calves. Bovine Pract. 15:96.

Breeze, R.G. and R.A. Magonigle. 1979. A long-acting tetracycline for treatment of Pasteurella pneumonia in calves. Bovine Pract. 14:15.

Brethour, J.R. and W.W. Duitsman. 1972. Ascorbic acid, aureo S-700, sodium bicarbonate, and thiamine in post-weaning, stress rations. Kansas State Univ. Roundup Report, Bull. 556:35.

Brown, K.I. 1959. Stress and its implication in poultry production. World's Poultry Sci. 15:255.

Brown, L.N. 1979. Current observations on the bovine respiratory disease complex in high plains feedyards. Proc. 12th Annual Conv. Am. Assoc. Bovine Pract., p. 164.

Bryne, B.J., F.R. Abinanti and R.J. Huebner. 1961. Experimental immunization of cattle with myxovirus parainfluenza-3 vaccines. Cornell Vet. 51:211.

Camp, T.H., R.A. Stermer, D.G. Stevens, and J.P. Anthony. 1983. Shrink of feeder calves as an indicator of incidence of bovine respiratory disease and time to return to purchase weight. J. Anim. Sci. 57 (Suppl. I):66.

Camp, T.H., D.G. Stevens, R.A. Stermer and J.P. Anthony. 1981. Transit factors affecting shrink, shipping fever and subsequent performance of feeder calves. J. Anim. Sci. 52:1219.

Carter, G.R. 1954. Observations on the pathology and bacteriology of shipping fever in Canada. Can. J. Comp. Med. 18:359.

Carter, G.R. 1973. Pasteurella infections as sequela to respiratory viral infections. J. Am. Vet. Med. Assoc. 163:863.

Church, T.L. 1980. Health management of feedlot cattle. Proc. 13th Annual Conv. Am. Assoc. Bovine Pract., p. 115.

Ciordia, H., H.C. McCampbell, G.V. Calvert and R.E. Plue. 1984. Effect of ivermectin on performance of beef cattle on Georgia pastures. Am. J. Vet. Res. 45:2455.

Cole, N.A. 1982. Nutrition-health interactions of newly arrived feeder cattle. Proc. Symposium on Management of Food Producing Animals. Volume II. Purdue Univ., p. 683.

Cole, N.A. and D.P. Hutcheson. 1981. Influence on beef steers of two sequential short periods of feed and water deprivation. J. Anim. Sci. 53:907.

Cole, N.A. and D.P. Hutcheson. 1982. Protein and K levels for stressed feeder calves. J. Anim. Sci. 55 (Suppl. I):414.

Cole, N.A. and D.P. Hutcheson. 1985. Influence of prefast feed intake on recovery from feed and water deprivation by beef steers. J. Anim. Sci. 60:772.

Cole, N.A., D.P. Hutcheson, J.B. McLaren and W.A. Phillips. 1984. Influence of pretransit zeranol implant and receiving diet protein and urea levels on performance of yearling steers. J. Anim. Sci. 58:527.

Cole, N.A., J.B. McLaren and D.P. Hutcheson. 1982. Influence of preweaning and B-vitamin supplementation of the feedlot receiving diet on calves subjected to marketing and transit stress. J. Anim. Sci. 54:911.

Cole, N.A., J.B. McLaren and M.R. Irwin. 1978. Preshipment feeding of stressed feeder calves. J. Anim. Sci. 47 (Suppl. I):256.

Cole, N.A., J.B. McLaren and M.R. Irwin. 1979. Influence of pretransit feeding regimen and posttransit B-vitamin supplementation on stressed feeder steers. J. Anim. Sci. 49:310.

Coleman, J.D. 1973. Texas observations on the treatment and management of light incoming calves. First Annual Texas Beef Conf. Proc.

Collier, J.R. 1967. Bacterial diseases. Okla. State Univ. Preconditioning Seminar, p. 16.

Collier, J.R. 1968a. Pasteurella in bovine respiratory disease. J. Am. Vet. Med. Assoc. 152:824.

Collier, J.R. 1968b. Significance of bacteria in bovine respiratory disease. J. Am. Vet. Med. Assoc. 153:1645.

Collier, J.R., W.W. Brown and T.L. Chow. 1962. Microbiologic investigations of natural epizootics of shipping fever of cattle. J. Am. Vet. Med. Assoc. 140:807.

Cope, G.E. 1978. For better health ship them full. Proc. 11th Annual Am. Assoc. Bovine Pract., p. 116.

Cummins, J.M. and D.P. Hutcheson. 1982. Effect of interferon on feedlot cattle. Proc. 15th Annual Conv. Am. Assoc. Bovine Pract., p. 109.

Cummins, J.M. and D.P. Hutcheson. 1983. The use of human leukocyte interferon in cattle during an IBR virus infection. In: R.W. Loan (Ed.). Bovine Respiratory Disease, A Symposium. Texas A & M Univ. Press, p. 484 (Abstr.).

Cummins, J.M. and B.D. Rosenquist. 1980. Protection of calves against rhinovirus infection by nasal secretion interferon induced by infectious bovine rhinotracheitis virus. Am. J. Vet. Res. 41:161.

Cummins, J.M. and B.D. Rosenquist. 1982a. Temporary protection of calves against adenovirus infection by nasal secretion interferon induced by infectious bovine rhinotracheitis virus. Am. J. Vet. Res. 43:955.

Cummins, J.M. and B.D. Rosenquist. 1982b. Partial protection of calves against parainfluenza-3 virus infection by nasal secretion interferon induced by infectious bovine rhinotracheitis virus. Am. J. Vet. Res. 43:1334.

Davis, G.V. 1978. Starting rations and procedures for stressed calves. Proc. 11th Annual Am. Assoc. Bovine Pract., p. 118.

Davis, G.V. 1980. Influence of Haemophilus somnus vaccine and vitamins A,D or A,D,B12 on the performance of stressed calves. Kansas State Univ. Cattle Feeders Day, Report of Progress. 383:18.

Davis, G.V. 1982. Effects of aureomycin and bovatec on the performance of feedlot calves. Kansas State Univ. Cattle Feeders Day, Report of Progress. 416:33.

Davis, G.V. and H.K. Caley. 1978. Influence of vitamins, anthelmintics and grub control chemicals on health and gain of stressed calves. Kansas State Univ. Cattle Feeders Day, Report of Progress. 327:26.

Davis, G.V. and H.K. Caley. 1979. Effects of tramisol, thiabendazole or valbazen on health and performance of stressed calves. Kansas State Univ. Cattle Feeders Day, Report of Progress. 357.

Davis, G.V. and H.K. Caley. 1981. Influence of preventive medication and vitamins on the performance and health of stressed steer calves. Kansas State Univ. Cattle Feeders Day, Report of Progress. 401:2.

Davis, G.V., H.K. Caley, S.E. Leland and A.B. Erhart. 1975. Effects of vitamins A and D, castration methods, drug injection methods, and anthelmintics on health and gain of stressed calves. Kansas State Univ. Cattle Feeders Day, Report of Progress. 243:24.

Davis, G.V., S.E. Leland, H.K. Caley and A.B. Erhart. 1976. Effects of anthelmintics on health and gain of stressed calves. Kansas State Univ. Cattle Feeders Day, Report of Progress. 273:35.

Dunbar, J.R., D.G. Addis, G.P. Lofgreen, J.G. Clark and G.L. Crenshaw. 1980. Effect of receiving rations on the health of newly arrived calves. In: Stress Calf Studies. Univ. California Cooperative Extension for Riverside and Imperial Counties. p. 29.

Edwards, A.J. 1983. The effectiveness of liquamycin LA-200 as a therapeutic treatment for respiratory disease in feeder cattle. In: R.W. Loan (Ed.). Bovine Respiratory Disease, A Symposium. Texas A & M Univ. Press, p. 473 (Abstr.).

Ellis, R.P. and M.W. Vorhies. 1976. Effect of supplemental dietary vitamin E on the serologic response of swine to an Escherichia coli bacteria. J. Am. Vet. Med. Assoc. 168:231.

Embry, L.B. 1977. Feeding and management of new feedlot calves. South Dakota State Univ. Cattle Feeders Day, p. 47.

Fales, W.H., L.A. Selby, J.J. Webber, L.J. Hoffman, L.D. Kinter, S.L. Nelson, R.B. Miller, J.G. Thorne, J.T. McGinity and D.K. Smith. 1982. Antimicrobial resistance among Pasteurella spp recovered from Missouri and Iowa cattle with bovine respiratory disease complex. J. Am. Vet. Med. Assoc. 181:477.

Farley, H. 1932. An epizootiological study of shipping fever in Kansas. J. Am. Vet. Med. Assoc. 80:165.

Fox, J.E. 1984. Subclinical coccidiosis infection in calves. Proc. 17th Annual Conv. Am. Assoc. Bovine Pract., p. 182.

Frank, G.H. 1983. Bacteria as etiologic agents in bovine respiratory disease. In: R.W. Loan (Ed.). Bovine Respiratory Disease, A Symposium. Texas A & M Univ. Press, p. 347.

Frank, G.H. and P.C. Smith. 1983. Prevalence of Pasteurella haemolytica in transported calves. Am. J. Vet. Res. 44:981.

Frey, M.L. 1983. Bovine respiratory syncytial virus and acute respiratory distress syndrome in cattle. Bovine Pract. p. 73.

Fulton, R.W. 1985. Personal communication. Okla. State. Univ.

Fulton, R.W. and J.M. Cummins. 1983. Antiviral activity of human alpha and bovine nasal secretion interferons. In: R.W. Loan (Ed.). Bovine Respiratory Disease, A Symposium. Texas A & M Univ. Press, p. 486 (Abstr.).

Gale, C. and N.B. King. 1961. Isolation of a virus from clinical shipping fever in cattle. J. Am. Vet. Med. Assoc. 138:235.

Gates, R.N. and L.B. Embry. 1975. Soybean meal or urea during feedlot adaptaton and growing of calves. South Dakota State Univ. Cattle Feeders Day, Research Summaries, p. 27.

Gill, D.R. 1985. Personal communication. Okla. State Univ.

Gill, D.R. and E.J. Richey. 1982. Health nutrition and management of new cattle. Okla. Cattle Feeders Seminar, p. BB-1.

Gill, D.R., S. Armbruster and E.J. Richey. 1980. The nutrition of newly received stressed stocker cattle. Okla. State Univ. Beef Symposium, p. I-10.

Gill, D.R., F.N. Owens, K.S. Lusby and E.J. Richey. 1982a. The effect of low level energy vs protein on just-received stocker steers. Okla. Agr. Exp. Sta. Res. Rep. MP-112:83.

Gill, D.R., E.J. Richey, F.N. Owens and K.S. Lusby. 1982b. Effect of lasalocid on weight gains of stocker steers. Okla. Agr. Exp. Sta. Res. Rep. MP-112:85.

Greathouse, T.R., H.E. Henderson and J.R. Males. 1968. Effect of pre- and post-weaning treatment on performance of feeder calves. Mich. State Univ., Mich. Beef Cattle Day Rep., p. 5.

Griffin, D. 1983. Stocker calf receiving, vaccination and treatment program. Proc. 16th Annual Conv. Am. Assoc. Bovine Pract., p. 127.

Grigsby, M.E. 1981. Protein supplementation for stressed calves. New Mexico State Univ. Clayton Livestock Res. Center Progress Rep. No. 25.

Hamlett, P.J., W.S. Damron, J. B. McLaren and N.A. Cole. 1982. Changes in rumen characteristics of Southeastern feeder calves during market-transit stress. J. Anim. Sci. 55 (Suppl. I):186.

Hamby, A.H., N.B. King and A.L Trapp. 1965. Attempt at immunizing cattle against shipping fever. A field trial. Am. J. Vet. Res. 26:897.

Hamby, A.H., A.L. Trapp and C. Gale. 1964. Futher preliminary studies on transmission of shipping fever in calves. Am. J. Vet. Res. 25:128.

Hamby, A.H., A.L. Trapp, C. Gale and N.B. King. 1963. Experimental transmission of shipping fever in calves. Am. J. Vet. Res. 24:287.

Hanke, H.E. and L.K. Lindor. 1983. Comparison of various dewormers on feedlot performance of yearling steers. Minn. Beef Report B-305.

Heinzerling, R.H., C.F. Nockels, C.L. Quarles and R.P. Tengerdy. Protection of chicks against E. Coli infection by dietary supplementation with vitamin E. 1974a. Proc. Soc. Exp. Biol. Med. 146:279.

Heinzerling, R.H., R.P. Tengerdy, L.L. Wick and D.C. Lueker. Vitamin E protects mice against Diplococcus pneumonia type I infection. 1974b. Infection and Immun. 10:1292.

Herrick, J.B. 1969. Preconditioning, its national status. J. Am. Vet. Med. Assoc. 154:1163.

Herrick, J.B. 1979. Feeder cattle health, committee report. Proc. Livestock Conservation Institute, p. 115.

Hicks, R.B. 1985a. The effect of mass medication on health and performance of newly-arrived stocker cattle. Chapter III of this manuscript.

Hicks, R.B. 1985b. The effect of interferon on health and performance of newly-arrived stocker cattle. Chapter V of this manuscript.

Hicks, R.B. 1985c. The effect of live Pasteurella hemolytica vaccine on health and performance of newly-arrived stocker cattle. Chapter VII of this manuscript.

Hicks, R.B. 1985d. The effect of respiratory syncytial vaccine on health and performance of newly-arrived stocker cattle. Chapter VI of this manuscript.

Hinman, D.D., D.G. Addis, G.P. Lofgreen and J.G. Clark. 1980. Protein levels in receiving rations. In: Stress Calf Studies. Univ. California Cooperative Extension for Riverside and Imperial Counties, p. 47.

Hjerpe, C.A. and T.A. Routen. 1976. Practical and theoretical considerations concerning treatment of bacterial pneumonia in feedlot cattle, with special reference to antimicrobic therapy. Proc. 9th Annual Conv. Am. Assoc. Bovine Pract., p. 97.

Hoerlein, A.B. 1964. Research on shipping fever. Okla. Vet. 11:6.

Hoerlein, A.B. 1973. Preconditioning of beef cattle. J. Am. Vet. Med. Assoc. 163:825.

Hoerlein, A.B. and C.L. Marsh. 1957. Studies on the epizootiology of shipping fever in calves. J. Am. Vet. Med. Assoc. 131:123.

Hoerlein, A.B., M.E. Mansfield, F.F. Abinanti and R.J. Huebner. 1959. Studies of shipping fever of cattle. I. Parainfluenza-3 virus antibodies in feeder calves. J. Am. Vet. Med. Assoc. 135:153.

Hoerlein, A.B., S.P. Saxena and M.E. Mansfield. 1961. Studies on shipping fever of cattle. II. Prevalence of Pasteurella species in nasal secretions from normal calves and calves with shipping fever. Am. J. Vet. Res. 22:470.

Holste, J.E. 1983. Productivity studies with ivermectin in beef cattle. Proc. 16th Annual Conv. Am. Assoc. Bovine Pract., p. 69.

Hoorn, B. and D.A.J. Tyrrell. 1966. Effects of some viruses on ciliated cells. Am. Rev. Resp. 93:156.

Horton, G.M.J. 1982. Efficacy of lasalocid against coccidia in cattle. In: Stuart, R.L. and C.R. Zimmerman. Bovatec Symposium Proc. Hoffman La-Roche Inc. Nutley, NJ.

Hutcheson, D.P. 1980. Observations on receiving new cattle. Eighth Annual Texas Beef Conf. Proc.

Hutcheson, D.P. and J.M. Cummins. 1982. The use of decoquinate in the diets for starting stressed feeder calves. J. Anim. Sci. 55 (Suppl. I):505.

Hutcheson, D.P., N.A. Cole and J.B. McLaren. 1978. Potassium addition to receiving diets of transported feeder calves. Proc. Western Section Am. Soc. Anim. Sci., p. 400.

Hutcheson, D.P., N.A. Cole and J.B. McLaren. 1984. Effects of pretransit diets and post-transit potassium levels for feeder calves. J. Anim. Sci. 58:700.

Hutcheson, D.P., J.M. Cummins and A. Confer. 1983. The use of a live Pasteurella haemolytica vaccine in feedlot cattle. In: R.W. Loan (Ed.). Bovine Respiratory Disease, A Symposium. Texas A & M Univ. Press, p. 477 (Abstr.).

Isaacs, A. 1963. Interferon. Advan. Virus Res. 10:1.

Janzen, E.D. and R.F. McManus. 1980. Observations on the use of a long-acting oxytetracycline for in-contact prophylaxis of undifferentiated bovine respiratory disease in feedlot steers under Canadian conditions. Bovine Pract. 15:87.

Jensen, R., R.E. Pierson, P.M. Braddy, D.A. Saari, L.H. Lauerman, J.J. England, H. Keyvanfar, J.R. Collier, D.P. Horton, A.E. McChesney, A. Benitez and R.M. Christie. 1976. Shipping fever pneumonia in yearling feedlot cattle. J. Am. Vet. Med. Assoc. 169:500.

Knight, A.P., R.E. Pierson, A.B. Hoerlein, J.H. Collier, D.P. Horton and J.B. Pruett. 1972. Effect of vaccination time on morbidity, mortality, and weight gains of feeder calves. J. Am. Vet. Med. Assoc. 161:45.

Koers, W.C., J.C. Parrott, L.B. Sherrod, R.H. Klett and G.E. Cope. 1975a. Preshipment feeding of heavily stressed calves. J. Anim. Sci. 41:408 (Abstr.).

Koers, W.C., J.C. Parrot, L.B. Sherrod, R.H. Klett and W.G. Sheldon. 1975b. Receiving and sick pen rations for stressed calves. J. Anim. Sci. 41:408 (Abstr.).

Kunkle, W.E., A.W. Fetter and R.L. Preston. 1976. Effect of initial diet on cattle performance and subsequent adaptation to high concentrate diets. J. Anim. Sci. 42:1263.

Lee, R.W., R. Stuart, K. Perryman and K. Ridenour. 1985. Effect of vitamin supplementation of receiving diets on the performance of stressed beef calves. Kansas State Univ.Cattle Feeders Day, Report of Progress. 474:14.

Lewis, K.J., C.F. Nockels, T.L. Barber and T.E. Watson. 1976. Vitamin E enhancement of the immune response in horses. Colo. State Univ. Res. Highlights. Gen. Series. 960:22.

Lillie, L.E. 1974. The bovine respiratory disease complex. Can. Vet. J. 9:233.

Lofgreen, G.P. 1978. The influence of a three-day mass administration of oxytetracycline to newly arrived calves. New Mexico State Univ. Clayton Livestock Res. Center Progress Rep. No. 3.

Lofgreen, G.P. 1979. The relationship of arrival temperature and subsequent sickness in newly arrived southern calves. New Mexico State Univ. Clayton Livestock Res. Center Progress Rep. No. 12.

Lofgreen, G.P. 1982. Limited hay and mass medication in receiving programs for stressed calves. New Mexico State Univ. Clayton Livestock Res. Center Field Day, p. 1.

Lofgreen, G.P. 1983. Mass medication in reducing shipping fever-bovine respiratory disease complex in highly stressed calves. J. Anim. Sci. 56:529.

Lofgreen, G.P., D.G. Addis, J.R. Dunbar and J.G. Clark. 1978. Time of processing calves subjected to marketing and shipping stress. J. Anim. Sci. 47:1324.

Lofgreen, G.P., D.G. Addis, J.R. Dunbar, J.G. Clark and G.L. Crenshaw. 1973. Handling light calves on arrival at the feedlot. First Annual Texas Beef Conf. Proc.

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

Lofgreen, G.P., A.E. El Tayeb and H.E. Kiesling. 1981. Millet and alfalfa hays alone and in combination with high-energy diet for receiving stressed calves. J. Anim. Sci. 52:959.

Lofgreen, G.P., H.E. Kiesling, M.G. Shafer and D.R. Garcia. 1984a. Influence of day of processing on performance of newly received stressed calves. New Mexico State Univ. Clayton Livestock Res. Center Field Day, p. 14.

Lofgreen, G.P., H.E. Kiesling, M.G. Shafer and D.R. Garcia. 1984b. Mass medication for reducing shipping fever in native calves. New Mexico State Univ. Clayton Livestock Res. Center Field Day, p. 1.

Lofgreen, G.P. and R.E. Kirksey. 1982. Effect of receiving rations on subsequent performance on grass. New Mexico State Univ. Livestock Res. Briefs Cattle Growers Shortcourse, p.17.

Lofgreen, G.P., M.G. Shafer and D.R. Garcia. 1984c. A comparison of the stress of dipping and worming vs the use of ivermectin in processing calves. New Mexico State Univ. Clayton Livestock Res. Center Progress Rep. No. 36.

Lofgreen, G.P., M.G. Shafer and D.R. Garcia. 1984d. Continued studies on the use of ivermectin in processing newly received calves. New Mexico State Univ. Clayton Livestock Res. Center Progress Rep. No. 37.

Lofgreen, G.P., L.H. Stinocher and H.E. Keisling. 1980. Effects of dietary energy, free choice alfalfa hay and mass medication on calves subjected to marketing and shipping stress. J. Anim. Sci. 50:590.

Lusby, K.S., V.J. Brorsen, V.L. Stevens and R.M. Farabough. 1985. Effects of feeding deccox in growing rations for stocker heifers. Okla. Agr. Exp. Sta Res. Rep. MP-117:262.

Lusby, K.S., D.R. Gill and H.E. Jordan. 1984. Effects of supplemental protein with rumensin or deccox on fecal coccidia and performance of weaned calves grazing late summer native range. Okla. Agr. Exp. Sta. Res. Rep. MP-116:136.

Lyford, S.J. and B.E. Colby. 1967. Blood tocopherol levels in beef cattle. J. Anim. Sci. 26:877 (Abstr.).

Madin, S.H., C.J. York and D.G. McKercher. 1956. Isolation of the infectious bovine rhinotracheitis virus. Science. 124:721

Martin, S.W. 1983. Vaccination: Is it effective in preventing respiratory disease or influencing weight gains in feedlot calves? Can. Vet. J. 24:10.

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

Martin, S.W., A.H. Meek, D.G. Davis, R.G. Thompson, J.A. Johnson, A. Lopez, L. Stephens, R.A. Curtis, J.F. Prescott, S. Rosendal, M. Saven, A.J. Zubaidy and M.R. Bolton. 1980. Factors associated with mortality in feedlot cattle: The Bruce County beef cattle project. Can. J. Comp. Med. 44:1.

Mohler, J.R., A.E. Wright, M.M. MacKellar and F.C. Bishopp. 1942. Losses caused by animal diseases and parasites in keeping livestock. USDA Yearbook of Agriculture. Ed. G. Hambridge.

McLaren, J.B., N.A. Cole, M.R. Irwin, E.L. Moody, J.R. McCurley and P.C. Smith. 1978. The effect of farm of origin on health and performance of feeder calves in transit and after arrival at the feedlot. J. Anim. Sci. 47 (Suppl. I):268.

Nash, D. 1983. A comparison of three therapeutic programs for the treatment of shipping fever in weaned calves. In: R.W. Loan (Ed.). Bovine Respiratory Disease, A Symposium. Texas A & M Univ. Press, p. 471 (Abstr.).

National Research Council. 1984. Nutrient Requirements of Beef Cattle, National Academy of Sciences, Washington, D.C. p. 27.

NCA. 1979. Protecting against respiratory disease in calves. Natl. Cattlemen's Assoc. Beef Business Bull., Vol. 3(3) Sept. 21.

Newland, H.W., H.E. Henderson and D.E. Ullrey. 1966. Injectable vitamins A and E for finishing cattle. J. Anim. Sci. 25:907 (Abstr.).

Pate, F.M. and J.R. Crockett. 1974. Feeding beef calves at weaning. Florida Beef Cattle Short Course.

Perino, L.J. 1985. Personsal communication. Okla. State Univ.

Perry, T.W., W.M. Beeson, W.H. Smith, R.B. Harrington and M.T. Mohler. 1968. Interrelationships among vitamins A, E and K when added to the rations of finishing beef cattle. J. Anim. Sci. 27:190.

Phillips, W.A. 1982. Factors associated with stress in beef cattle. Proc. Symposium on Management of Food Producing Animals. Volume II. Purdue Univ., p. 640.

Phillips, W.A. 1984. The effect of protein source on the poststress performance of steer and heifer calves. Nutrition Reports International. 30:853.

Phillips, W.A. and K.B. Leining. 1981. Weight changes during transportation of stocker calves. Okla. Agr. Exp. Sta. Res. Rep. MP-108:111.

Phillips, W.A. and J.D. McLaren. 1981. The impact of farm of origin and post-shipment diet on the performance of stocker calves. Okla. Agr. Exp. Sta. Res. Rep. MP-108:108.

Preston, R.L. and W.E. Kunkle. 1974. Role of roughage source in the receiving ration of yearling feeder steers. Ohio Agr. Res. Dev. Center Res. Summary. 77:51.

Preston, R.L. and C.K. Smith. 1974. Role of protein level, protected soybean protein, and roughage on the performance of new feeder calves. Ohio Agr. Res. Dev. Center Res. Summary. 77:47.

Preston, R.L., F.M. Byers, P.E. Moffitt and C.F. Parker. 1975a. Soybean meal and urea as sources of supplemental protein for newly received feeder calves. Ohio Agr. Res. Dev. Center, Ohio Beef Cattle Day and Cattlemens Roundup, p. 6.

Preston, R. L., C.K. Smith and F.M. Byers. 1975b. Role of protein level, protected soybean meal, and urea-treated corn silage on the performance of new feeder calves. Ohio Agr. Res. Dev. Center, Ohio Beef Day and Cattlemens Roundup, p. 1.

Preston, R.L., C.K. Smith and W. Kunkle. 1973. Role of roughage source and medication in early feedlot performance of feeder calves. Ohio Agr. Res. Dev. Center Res. Summary. 68:33.

Prouty, F.L., F.J. Delfino, W.H. Hale and T.H. Noon. 1981. Starting feedlot cattle: Off-truck body temperature, hospital therapy, decoquinate, levamisole phosphate and castrated bulls versus steers. J. Anim. Sci. 53:190 (Abstr.).

Purdy, C.W., C.W. Livingston, G.H. Frank, J.M. Cummins, N.A. Cole, R.W. Loan, B.B. Gauer and D.P. Hutcheson. 1983. A profile of lightweight feeder calves vaccinated with modified live Pasteurella hemolytica. In: R.W. Loan (Ed.). Bovine Respiratory Disease, A Symposium. Texas A & M Univ. Press, p. 464 (Abstr.).

Reggiardo, C. 1979. Role of BVD virus in shipping fever of feedlot cattle. Case studies and diagnostic considerations. Proc. 22nd Annual Meeting Am. Assoc. Vet. Lab. Diagnosticians, p. 315.

Reisinger, R.C., K.L. Heddleston and C.A. Monthei. 1959. A myxovirus (SF-4) associated with shipping fever of cattle. J. Am. Vet. Med. Assoc. 135:147.

Richey, E.J., D.R. Gill, F.N. Owens and K.S. Lusby. 1982. Protein vs energy in receiving diets for stocker cattle. Okla. Agr. Exp. Sta. Res. Rep. MP-112:81.

Rosenquist, B.D. 1973. Induction and biological significance of interferon, with particular reference to cattle. Am. J. Vet. Res. 163:821.

Rosenquist, B.D. 1974. Isolation of respiratory syncytial virus from calves with acute respiratory disease. J. Infect. Dis. 130:177.

Rosenquist, B.B. 1983. Viruses as etiologic agents of bovine respiratory disease. In: R.W. Loan (Ed.). Bovine Respiratory Disease, A Symposium. Texas A & M Univ. Press, p. 363.

Rosenquist, B.D. and R.W. Loan. 1967. Interferon production with strain SF-4 of parainfluenza-3 virus. Am. J. Vet. Res. 28:619.

Rosenquist, B.D. and R.W. Loan. 1969. Production of circulatory interferon in the bovine species. Am. J. Vet. Res. 30:1293.

Rust, S.R., D.R. Gill, E.J. Richey and F.N. Owens. 1981. The effects of decoquinate on gains of stressed cattle. Okla. Agr. Exp. Sta. Res. Rep. MP-108:167.

Schake, L.M., E.R. Lindstrom, C.R. Connor and H.A. Fitzhugh, Jr. 1971. Influence of season of year upon performance of feedlot cattle. Texas A and M Univ. Beef Cattle Res., p. 22.

Schipper, I.A. and C.L. Kelling. 1974. Prophylatic use of antibiotics in preventing bovine respiratory disease complex. Vet. Med./ Small An. Clinician. 69:1396.

Smith, C.K. 1983. The use of a live Pasteurella hemolytica vaccine to prevent bovine respiratory disease. In: R.W. Loan (Ed.). Bovine Respiratory Disease, A Symposium. Texas A & M Univ. Press, p. 470 (Abstr.).

Smith, R.A. 1984. What's new in feedlot animal health. Okla. State Univ. 20th Annual Cattle Feeder's Seminar, p. B-1.

Smith, K.L., J.H. Harrison, D.D. Hancock, D.A. Todhunter and H.R. Conrad. 1984. Effect of vitamin E and selenium supplementation on incidence of clinical mastitis and duration of clinical symptoms. J. Dairy Sci. 67:1293.

Stalheim, O.H.V. 1983. Mycoplasmal respiratory disease of ruminants: A review and update. J. Am. Vet. Med. Assoc. 182:403.

Stephens, L.R., P.B. Little, B.N. Wilkie and D.A. Barnum. 1981. Infectious thromboembolic meningoencephalitis in cattle: a review. J. Am. Vet. Med. Assoc. 178:378.

Stuedemann, J.A., S.A. Ewing, J.J. Guenther and G.V. Odell. 1966. Effect of pre-weaning plane of nutrition or growth and development of beef calves. Okla. Agr. Exp. Sta. Progress Rep. MP-78:18.

Swafford, W.S., J.M. Cummins and D.P. Hutcheson. 1983. The efficacy of liquamycin LA-200 in preventing shipping fever. In: R.W. Loan (Ed.). Bovine Respiratory Disease, A Symposium. Texas A & M Univ. Press, p. 468 (Abstr.).

Sweat, R.L. 1967. Isolation of myxovirus parainfluenza-3 from cattle with respiratory diseases. J. Am. Vet. Med. Assoc. 150:172.

Tengerdy, R.P. 1980. Effect of vitamin E on immune responses. In: L.J. Machlin (Ed.) p. 429. Vitamin E, A Comprehensive Treatise. Marcel Dekker, Inc. New York, NY.

Tengerdy, R.P., D.L. Meyer, L.H. Lauerman, D.C. Lueker and C.F. Nockels. 1983. Vitamin E enhanced humoral antibody response to Clostridium perfringens type D in sheep. Br. Vet. J. 139:147.

Todd, J.D., F.J. Volenc and I.M. Paton. 1972. Interferon in nasal secretions and sera of calves after intranasal administration of avirulent infectious bovine rhinotracheitis virus: association of interferon in nasal secretions with early resistance to challenge with virulent virus. Infect. Immun. 5:699.

Totusek, R., J.E. Tanner, R. Renbarger, L.G. Franks and N.B. Whitfield. 1968. The value of vitamin E injections for feedlot calves. Okla. Agr. Exp. Sta. Res. Rep. MP-80:69.

Trapp, A.L., A.H. Hamby, C. Gale and N.B. King. 1966. Lesions in calves exposed to agents associated with the shipping fever complex. Am. J. Vet. Res. 27:1235.

Trueblood, M.S. and J. Manjara. 1972. Response of bovine viruses to interferon. Cornell Vet. 62:3.

USDA. 1952. Agricultural Statistics. U.S. Dept. of Agri.

USDA. 1980. Agricultural Statistics. U.S. Dept. of Agri.

Wieringa, F.L., R.A. Curtis and O.M. Radostits. 1974. The effect of preconditioning on weight gain and shrinkage in beef calves. Can Vet. J. 11:309.

Wieringa, F.L., R.A. Curtis and R.A. Willoughby. 1976. The influence of preconditioning on plasma corticosteroid levels, rectal temperatures and the incidence of shipping fever in beef calves. Can. Vet. J. 17:280.

Wilkie, B.N. 1980. Principles of biological control of shipping fever. Proc. 13th Annual Am. Assoc. Bovine Pract., p. 113.

Williams, D.L. and J.H. Mahoney. 1984. Pre-weaning and post-weaning nutrition. Proc. 17th Annual Conv. Am. Assoc. Bovine Pract., p. 98.

Williams, J.C., J.W. Knox, B.A. Bauman, T.G. Snider, M.G. Kimball and T.J. Hoerner. 1981. Efficacy of ivermectin against inhibited larvae of Ostertagia ostertagi. Am. J. Vet. Res. 42:2077.

Williams, J.C., K.S. Marbury, S.W. Scheide, D.G. Luther, J.W. Knox, M.D. Kimball and T.G. Snider,III. 1984. Ostertagia ostertagi: clinical condition, recognition of disease states, and approaches to control through anthelmintics and management. Proc. 17th Annual Conv. Am. Assoc. Bovine Pract., p. 42.

Wilson, W.O. 1971. Evaluation of stressor agents in domestic animals. J. Anim. Sci. 32:578.

Winder, J.A., K.S. Lusby, D.R. Gill and T.L. Evicks. 1983. Affect of various anthelmintics on rate of gain and fecal egg count of steers grazing wheat pasture. Okla. Agr. Exp. Sta. Res. Rep. MP-114:223.

Woods, G.T., M.E. Mansfield, G.F. Cmarik and G. Marquis. 1976. A four year clinical and serologic study of the use of inactivated parainfluenza-3 virus vaccines and pasteurella sp. bacterins in beef calves. Vet. Med. Small Anim. Clin. 69:474.

Wray, M.I., R.P. Basson, D.. Feller, R.D. Olson, L.E. Watkins, P.R. Fitzgerald, B.E. Stromberg and G.W. Davis. 1984. Effect of monensin on cattle coccidiosis. J. Anim. Sci. 59 (Suppl. I):395.

Yazwinski, T.A., M. Williams, T. Greenway, and W. Tilley. 1981. Anthemmintic activities of ivermectin against gastrointestinal nematodes of cattle. Am. J. Vet. Res. 42:481

Young, B.A. 1981. Cold stress as it affects animal production. J. Anim. Sci. 52:154.

Zinn, R.A., D. Axe, D. Addis, J.G. Clark, J. Dunbar and B. Norman. 1983a. Potassium in receiving rations for light weight calves. California Feeders Day Report, p. 52.

Zinn, R.A., D. Axe, D. Addis, J.G. Clarke, J. Dunbar and B. Norman. 1983b. Protein supplementation for the stressed calf. California Feeders Day Report, p. 58.

Zinn, R.A., J.R. Dunbar and B.B. Norman. 1985a. Relative effects of dehorning and castration on early health and performance of feedlot calves. California Feeders Day Report, p. 97.

Zinn, R.A., J.R. Dunbar and B.B. Norman. 1985b. Influence of time of processing on early health and performance of feedlot calves. California Feeders Day Report, p. 90.

Zweiacher, E.R., R.M. Durham, B.D. Boren and C.T. Gaskins. 1979. Effects of method and time of castration of feeder calves. J. Anim. Sci. 49:5.

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