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Evaluation of Initial Body Weight and Supplementation Levels on Health and Performance of Newly Received Stocker Calves

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By

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These study objectives were to evaluate the effects of: initial bodyweight, energy supplementation, distance and days traveled and hair coat shedding on performance and health. Crossbred heifers (n=120) were purchased as either lightweight (136 kg) or heavyweight (226 kg) calves. Factors affecting morbidity and growth were tested using Poisson or linear regression (PROC GLIMMIX), with a correlation structure defining clustering by pen. Incidence density was $53.7/10^3$ calf-days and $19.0/10^3$ calf-days for light and heavy initial BW, respectively. Lightweight calves were 2.8 times more likely to be treated for BRD (p=0.02) and each increase in hair shed score increased risk for BRD 1.6 times (p=0.04). Initial BW did not affect gain (P=0.573), but heifers receiving supplementation gained 5.84 kg more than heifers not receiving supplement (P=0.005). Cattle that received LOW HS (n=14) had higher total gain (P=.00016), and ADG (P=.00016) compared to cattle receiving shedding classification of MED to HIGH (n=106).

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NOMENCLATURE

ADF	Acid Detergent Fiber
ADG	Average Daily Gain
BW	Body Weight
BRD	Bovine Respiratory Disease
BVD	Bovine Viral Diarrhea
CP	Crude Protein
DMI	Dry Matter Intake
ME	Metabolizable Energy
NDF	Neutral Detergent Fiber
NEm	Net Energy for Maintenance
PI	Persistently Infected
TDN	Total Digestible Nutrients

CHAPTER I

INTRODUCTION

Stocker cattle systems are a useful component in the beef industry that adds value to cattle and improves cattle health prior to entering the feed yard. On arrival from auction barns, stocker operations utilize several management practices that may increase value and enhance the performance of cattle long term. Management practices include but are not limited to weaning, dehorning, castration, supplemental feeding, and cattle being trained to eat from a feed bunk. This has been demonstrated to limit the stress of comingling and better prepare cattle prior to entering the feed yard. The southeastern United States provides many opportunities to the stocker producer. One of the biggest advantages that exist in this region is the ability to produce large quantities of high quality cool season forages (Starnes et al., 2010). Secondly, Southeastern stocker producers can take advantage of lower feeder cattle prices compared to Midwestern states.

As with other Southeastern cattle, stockers raised in Mississippi are often penalized by buyers based on a poor reputation for performance and health. Busby et al. (2008) conducted a study that compared cattle of Southeastern origin to cattle of Midwestern origin, and found that cattle from the Southeast had decreased rates of mortality, morbidity, and lower treatment costs compared to cattle of Midwestern origin. However, surveys show that Mississippi beef cattle producers are inconsistent in terms of management practices such as weaning and preconditioning cattle prior to being marketed (Little et al., 2000).

Stocker operations take on numerous risks in purchasing feeder cattle particularly in regards to animal health. Cattle entering into the stocker sector of the industry are often naïve and are exposed to a variety of pathogens. The stress that cattle encounter prior to arriving at a stocker operation increases the chance of illness and disease.

Bovine Respiratory Disease (BRD) is the most common and detrimental disease of beef cattle post-weaning (Edwards, 1996). Despite advancements in management and pharmaceuticals, the disease continues to plague the stocker and feedlot sectors of the beef industry (Galyean et al., 1999). Stocker operations can never fully eliminate stress but can reduce the magnitude of the stress. Stocker operations can also reduce the likelihood of BRD by the biological type of cattle purchased. Cernicchiraro et al. (2012) and Sanderson et al. (2008) reported that cattle weighing over 250 kg on arrival had a lower incidence of BRD during receiving periods versus cattle that weighed less than 250 kg on arrival. In addition, both authors reported that cattle that traveled a shorter distance to the facility had a lower incidence of BRD.

Along with improving health, the stocker industry adds weight to cattle prior to being shipped to a commercial feeding facility. Stocker operation creates uniform lots of cattle that can be more precisely managed in a feedlot setting. As previously mentioned, Southeastern cattle operations add cheap gain by utilizing high quality cool season forages. Supplementing forage has been shown to improve gain on multiple occasions (Coelman et al., 1976; Goetsch et al., 1991; Moore et al., 1999; Scholljegerdes and Kronberg, 2010).

Energy is known to be the limiting factor for stocker cattle grazing lush green cool season forage; therefore, rate of gain would be increased if cattle were supplemented with energy. Soyhull pellets are considered a relatively inexpensive energy supplement with the potential to increase gain. Anderson et al. (1998) compared cattle that were supplemented with corn, soyhull pellets or received no supplement while grazing cornstalks. Results showed cattle receiving the soyhull pellets supplement gain 0.07 kg more per day compared to the corn supplement.

Barham et al. (2007) reported feeder cattle with a dead retained hair coat received a discount of $14.00 at auction markets. Thick retained hair coats have been associated with a loss of post weaning growth and slicker hair coats have been associated with an increase in post-weaning growth (Olson et al., 2003; Williams et al., 2006). However, the association between retained hair coats and its effect of animal health has yet to be researched. Ultimately, stocker operations have several management practices at their disposal to increase gain and improve animal health prior to entering a commercial feeding facility. The improvement of cattle's health and gain prior to entering a commercial feeding facility will likely increase performance of cattle long term.

CHAPTER II

LITERATURE REVIEW

Introduction

Stocker cattle systems are a useful component of the beef industry that proves to add value to cattle by improving health and adding body weight (BW) prior to cattle entering a commercial feeding facility. The stocker phase of the beef industry creates uniform lots of cattle that can be more precisely managed in a feedlot setting. In addition, the stocker industry prepares cattle for life in a feedlot setting by training cattle to consume harvested feedstuffs, and allows cattle to become familiar with consuming feeds out of feed bunks.

Gains during the stocker phase can be improved by many management practices such as supplementation and careful consideration of the BW of calves at purchase. Supplementation has been shown to increase gains, allow for increased stocking densities, while extending forage availability for grazing (Lomas et al., 2009). A multitude of supplements are available for cattlemen, and each is better for a particular forage season. Stocker cattle typically range from an initial BW of 130 to 250 kg, and the goal of stocker operations is to add 100 to 200 kg of BW prior to being marketed (Rankins, 2013). The reported value of BW gained during the stocker phase has increased by over 134% in the last decade (Beck et al., 2013). The decision of what weight of calves to purchase depends on many factors such as intended length of ownership, forage availability, and seasonal price trends of feeder cattle. However, each weight class of feeder cattle offers tradeoffs in terms of performance and health.

The stocker sector of the beef industry is responsible for supplying immunocompetent cattle to commercial feeding facilities that have overcome the stress factors of weaning, vaccinating, and having been commingled prior to entry. However, producers take on multiple risks by purchasing feeder cattle in regards to animal health. Cattle coming into a stocker system are often naïve and are exposed to a variety of pathogens. The exposure to the pathogens is only compounded with the fact that feed intake is low when cattle arrive (Fluharty and Lorech, 1995). Consequently, increasing the nutritional plane in receiving diets can improve gain and initial intake (Cole, 1996). However, increasing the level of nutrition in receiving diets and its effect on animal health offers conflicting results (Galyean et al., 1999).

Ultimately, there are several management practices that can increase the profitability of a stocker operation. The objectives of this literature review are to (1) review the impact of BRD (2) discuss the effects of initial BW, supplementation, distance and days traveled, hair coat shedding impacts on performance and animal health

Bovine Respiratory Disease

Bovine Respiratory Diease is the most common and economically detrimental disease of beef cattle post-weaning (Edwards, 1996). When considering death loss, as well as treatment costs, BRD has been estimated to cause between $500 to $750 million dollars of economic loss to the cattle industry annually (Schneider et al., 2009). Economic losses as a result of BRD morbidity and mortality in newly received cattle continue to persist in the beef industry despite improved pharmaceuticals and vaccination programs (Galyean et al., 1999).

Both viral and bacterial agents are factors for the appearance of BRD (Booker et al., 2009). The major viral components of BRD are bovine herpesvirus type 1 (BHV-1), parainfluenzavirus-3 (PI-3), and respiratory syncytial virus (RSV). These viral components are considered to initiate BRD (Montgomery, 2009). The bacteria that play a role in BRD include *Mannheima hemolytica, Pasteurella multocida* and *Histophilus somni* (Montgomery, 2009). There are numerous physical and chemical barriers that keep bacteria out of the lower respiratory tract, and this is referred to as innate immunity (Smith, 1998). However, when cattle are undergoing stress these barriers are weakened, and this is considered a compromised immune system which is the final component necessary for BRD.

A compromised immune system is a direct result from some form of stress that can stem from numerous sources such as weaning, transportation, commingling, and processing (Schneider et al., 2009). These stress factors enhance predisposing factors for BRD. (Snowder et al., 2006; Callan and Gary, 2002). Environmental risk factors of climate, ambient temperature, dust particles, stocking rate, humidity, and ventilation are also known to increase the occurrence of BRD (Snowder et al., 2009). Stocker operations can never fully eliminate sources of stress; they can only reduce the magnitude.

The time period for which the incidence of BRD is the highest is through the first two weeks after arrival. Snowder et al. (2006) examined health and growth records of 18,112 feedlots and reported the incidence of BRD was observed 5 days after arrival, and the peak occurrence of BRD was observed at day 14. Also, the author noted cattle remained at risk for BRD for approximately 80 days after arrival. When applying these results to the stocker phase of the beef industry, the conclusion can be drawn that for the bulk of days cattle are being stockered the animals are at risk for BRD.

The occurrence of BRD directly impacts a producer's bottom line through the means of greater mortality rate and increases in the amounts of antibiotic used. Indirect loss can stem from a loss of animal performance (Duff and Gaylean, 2007). Several authors found that BRD has a negative impact on ADG during the stocker phase (Holland et al., 2010; Pinchack et al., 2004). Holland et al. (2010) assembled 360 crossbred heifers acquired through multiple auction barns and kept records of the number of times heifers were treated for BRD during the backgrounding stage. The research group found that as the number of treatments increased, BW decreased in a linear fashion. Cattle treated multiple times for BRD required more days on feed in order to reach their target finishing weight. Pinchak et al. (2004) conducted two experiments testing the effects of morbidity on both steers and heifers grazing native grass in the southern plains. The authors concluded that cattle treated for BRD had a lower ADG compared to cohorts that did not experience BRD during the trial. Also, the number of treatments for BRD showed a linear decrease for ADG, similar to Holland et al. (2010). Numerous studies found that in commercial feeding facilities, ADG was higher for healthy cattle, not treated for BRD, compared to cattle treated for BRD (Bateman et al. 1990; Schneider et al. 2009; Snowder et al., 2006). In contrast, several authors observed no difference in ADG for cattle treated for BRD compared to healthy cattle (Jim et al., 1993; Snowder et al., 2007). Several factors could produce differences in ADG in healthy cattle versus cattle treated for BRD. Environmental differences could play a critical role. There are currently no studies that show no differences for ADG in healthy cattle versus cattle treated for BRD in feeder cattle entering the stocker phase of the beef industry (Pinchak et al., 2004).

Effects of Initial BW on Gain and Animal Health

The intended length of the stocker phase, forage availability, and seasonal price trends of feeder cattle are often the deciding factors in determining what weight cattle stocker operations purchase. Light or heavy weight feeder cattle offer contrasting strengths in terms of performance, health, and profitability. Cattle with higher initial BWs have been shown to be more effective at overcoming the stress of weaning, transporting, processing and comingling compared to lighter weight feeder cattle (Cernicchiaro et al., 2015). Cattle weighing less than 200 kg were less likely to be weaned upon arrival, and more prone to respiratory disease (Gaylean et al., 1999), whereas heavier weight cattle were reported to have a lower incidence of BRD and an increased amount of weight gain during the receiving period (Montgomery et al., 2009). On the other hand, young lightweight cattle offer promise through a lower initial investment, a higher stocking rate, and more weight gain potential (Ackerman et al., 2001).

Researchers have found conflicting results for ADG of cattle grazing native forage in the stocker phase. Ackerman et al. (2001) conducted 2 trials spanning over two years that examined the ADG of crossbred light weight steers at an average weight of 150 kg to heavier weight steers weighing an average of 257 kg on native forage. The ADG was higher for the heavier weight steers throughout the study. However, the researchers pointed out that lightweight stockers offer more gain per hectare because of the capability of a higher stocking rate compared to heavier weight stockers. Brazle (2000) pooled results of 11 different studies to evaluate the effect of initial BW on ADG. The author found that cattle with initial BW of 182 to 227 kg had the highest level of gain during the stockering phase. Also, the author noted that cattle weighing 319 kg or higher at the onset of the study had the poorest level of gain. Ultimately, these two studies offer contradicting results, which may due to the differences in what the researchers considered light or heavy weight cattle. However, one could draw the conclusion that there potentially could be an optimal starting weight to maximize gains during the stocker phase. Cattle that are extremely light are more prone to sickness and experience an increased morbidity and mortality rate during the stocker phase. On the other hand, heavy weight cattle offer less weight gain potential due to being more advanced in their growth curve.

Lightweight feeder cattle who have been held at a low nutritional plane will often offer the potential for compensatory gain. Compensatory gain is the result of reduction in net energy maintenance (NEm) and an increase in efficiency of metabolizable energy (ME). Ultimately, cattle better utilize the energy and protein in forage or harvested feedstuffs during periods of compensatory gain; which enables cattle to be more efficient at utilizing a pound of forage or harvested feed to produce a pound of gain (Fox et al., 1974). The ability for cattle to quickly add weight in such an efficient manner proves to be profitable, and is one of the major factors that make lightweight feeder cattle a popular

Supplementation Effects on Performance

The vast majority of stocker operations take advantage of forages for cheap gain to add value to cattle prior to being marketed. Southeastern stocker operations typically turn to ryegrass to stocker cattle during the spring of the year. Ryegrass contains 10 to

16% crude protein (CP) and 56 to 62% total digestible nutrients (TDN) (Ball et al., 2007). Ryegrass alone can typically meet or exceed the nutrient requirements of stocker cattle according to the (NRC, 2000). Supplementing stocker cattle that are grazing forage will further increase growth performance (Coleman et al., 1976; Goetsch et al., 1991; Moore et al., 1999; Scholljegerdes and Kronberg, 2010). The mechanism which causes the improvement of rate of gain is typically through increased capture of forage nitrogen and increased microbial protein production (England and Gill, 1985; Hoover, 1986).

Research offers conflicting results as to how supplementation affects voluntary forage intake. Canton et al. (1997) used 10 crossbred steers on native pasture that were supplemented with barley and reported that supplementation caused a slight elevation of forage intake. Scholljegerdes and Kronberg (2010) supplemented 18 Angus steers grazing native forage and reported there was an increase in forage intake when supplemented with a starch based feed. Moore et al. (1999) compiled a database which included 444 casual comparisons between supplemented, non-supplemented, and control animals. The authors found that supplementation had a negative impact on voluntary forage intake when forage was high in TDN or intake of the forage was greater than 0.07% BW. Bohnert et al. (2011) conducted a trial with four ruminally cannulated steers to evaluate the effect of forage intake and digestion when supplemented with soybean meal. Steers were feed either Kentucky bluegrass straw or warm season tall grass forage, and were either supplemented with soybean meal or not supplemented. Increased voluntary intake of the Kentucky bluegrass straw was observed in steers that were supplemented. However, a decrease in forage intake occurred when cattle were supplemented on warm season tall grass. Moore et al. (1999) stated that supplementation increased feed intake when TDN and CP was deficient. Fischer et al. (2007) conducted two trials with 253 steers that weighed approximately 255 kg in trial 1, and 116 steers that weighed approximately 287 kg in trial 2. Cattle were grazed on wheat pastures and were supplemented with soy hulls or received no supplement. Results showed that forage quality had the greatest effect on forage intake. Cattle supplemented when forage quality was low increased the forage intake. On the other hand, supplementation decreased forage intake when forage was high in nutrients. Ultimately, the conclusion can be drawn that the effect of supplementation on forage intake is dependent on forage quality.

Forage digestion may increase when supplementation of either energy or protein occurs. Guthrie and Wagner (1988) used 16 steers that received 1 of 4 supplements. Steers supplemented with soybean meal or corn experienced a higher level of organic matter digestion, acid detergent fiber digestion (ADF), CP digestion, and cellulose digestion compared to steers supplemented with a mineral-vitamin premix alone. Also, the authors noted supplementation increased forage intake. Scholljegerdes and Kronberg (2010) tested the effects of supplementation on 6 Angus cannulated steers, and noted that supplementation increased organic matter flow to the duodenum. Also, steers that were fed the supplement of flax seed had a lower gain to feed ratio versus the cattle not supplemented.

Loy (2007) reviewed 6 different experiments, and concluded that not only will supplementation increase feed utilization of forage, but will also extend the grazing length of the forage. Likewise, Gulbransen (1976) reported that steer grazing days/hectare or stocking densities were increased 1.25 to 2- fold when steers were supplemented at a level of 1 to 1.5% of their respective BW. Therefore, supplementation may increase ADG, feed utilization, grazing days, and stocking densities.

There are a variety of different supplements that are available to beef producers. Each offers different strengths and is better suited for different forage quality and maturity. When forages are dormant, supplementing protein would allow cattle to better utilize the forage, as the forage is deficient in its level of CP. Many oil seed meals or by-products of the ethanol industry have shown to provide a higher level of CP to cattle grazing dormant forages (Delcurto et al., 1990; Turner and Delcurto 1991; Bodine et al. 2001). However, during the forage growing season cattle are more likely to be deficient in energy rather than protein. The deficiency is typically dependent upon the forage quality and quantity (Caton and Dhuyvetter, 1997). Corn, milo, soybean hulls, wheat middlings and corn gluten feed are popular supplements in the beef industry due to both their high energy and starch content (McCollum, 1997).

Soyhull pellets, a byproduct of the soybean milling industry are produced in large quantities and are relatively inexpensive. Soyhull pellets contain high levels of potentially digestible fiber and can serve as an alternative in several different beef diets (Faulkner et al., 1994). Johnson et al. (1988) reported soybean hulls were equal in energy value to ground corn when fed to 80 head of Hereford heifers. Anderson et al. (1988) evaluated the gain of 48 crossbred heifers that were randomly assigned to receive corn, soyhull pellets, or no energy supplement. The study showed that there was no difference in ADG for heifers fed soyhull pellets versus corn as an energy supplement. Horn et al. (1995) reported that a soyhull pellet energy supplement can cause cattle to experience a higher level of gain versus a corn based energy supplement. However, Scharmon et al.

(1994) reported cattle fed a corn based energy supplement had an ADG of 0.47 kg/day compared to soyhull pellet supplement that gained 0.37 kg/day. The author noted that the steers had a higher level of intake of the soyhull pellets versus the corn supplement.

Soyhull pellets can serve as energy source and provides cattle with a source of fiber. High fiber energy supplements provide a means of supplementing forage without incurring the negative associative effects that occur when low fiber, highly concentrated feeds are added to forage (Highfill et al., 1987). Fiber digestibility increased for cattle when supplemented with soyhull pellets versus corn while consuming wheat silage (Boggs and Okotie-Eboh, 1985). Highfall et al. (1987) evaluated fiber digestion on 4 Angus cows and reported an increase in ADF digestion and neutral fiber digestion (NDF) digestion when hay was supplemented with soyhull pellets versus corn. In conclusion, soyhull pellets seem to be a valid energy supplement for cattle consuming forage. Producers may expect similar ADG in soyhull pellets versus corn when fed as an energy supplement and should expect an increase in fiber digestion.

Supplementation Effects on BRD

Feeder cattle experience numerous stressors in transit to a stocker operation or commercial feeding facility. Nutrition plays a key role in keeping the cattle's immune system functioning and improper nutrition will inevitably lead to a compromised immune system (Cole, 1996). Feed intakes of newly arrived stressed calves are often low for the first two weeks (Fluharty and Lorech, 1995). Loyd et al. (2011) found that freshly weaned heifer calves took 10.7 days to consume enough feed to meet their NEm requirements. Cole and Hutcheson (1988) reported that maximum feed intake following feed withdrawal will only be obtained if the diet fed after the withdrawal had a higher dietary level of CP compared to the diet fed prior to withdrawal. Along with increasing the CP level, supplying sufficient amounts of energy should be of interest for producers. Cole (1996) stated that energy is the first limiting factor in market/transport-stressed calves. When energy increases in receiving diets, intake increases, growth performance improves, and consequently cost of gain decreases. Therefore, it is crucial to deliver a nutrient dense receiving diet in order to combat a low feed intake in order to maximize gains during the receiving period.

Increasing the amount of CP in the receiving diet and its effects on performance and BRD has been an area of interest for many researchers. Cole and Hutcheson (1990) reported that increasing the level of CP resulted in an increased amount of gain in cattle through the first 14 days of arrival. Fluharty and Loerch et al. (1995) evaluated the performance for 240 crossbred steers for ADG, feed utilization, and feed to gain. The authors noted there was an 18 % increase in dry matter intake (DMI) in cattle fed 18% CP versus 12 and 14%. Also, the authors saw a linear increase in feed to gain and ADG as the level of CP increased from 11 to 26 %. Therefore, increasing CP levels in starting diets has been associated with an increase in gain.

Increasing supplementation and its effect on health offer unclear results. Cole (1996) evaluated the effects of supplementing steer calves with energy, and reported that although supplementation has a positive effect on performance; supplementation also increased the morbidity and mortality of calves. In terms of increasing the CP level in receiving diets, Galyean et al. (1999) pooled the results from 15 trials from Galyean et al. (1993) and Fluharty and Loerch (1995) to investigate BRD morbidity and receiving diet CP level. Galyean et al. (1999) found that morbidity increased with increasing CP concentration and that performance was equal to or superior to calves fed lower protein levels. Cole and Hutcheson (1990) evaluated the effects of increasing CP and its effects on animal health. The study included two trials with 256 steers in experiment 1 and 86 steers in experiment 2. The authors reported that increasing CP in the receiving diet did not significantly affect morbidity or mortality. Braud et al. (2015) assembled 244 crossbred steers at a weight of approximately 220 kg, and noted no interaction in morbidity or mortality when cattle were fed either 17.1 or 11.1% CP in the diet. Whitney et al., (2006) studied CP level and its affect on febrile response on 33 early weaned steers challenged with BHV-1. The authors concluded that cattle fed the highest level of CP had the strongest febrile response. Ultimately, the role of CP on animal health is unclear.

Transportation on Health and Performance

The stress of transportation can produce several negative consequences, such as the reduction of BW, reduction of feed consumption, as well as the impairment of the immune system and increased morbidity and mortality (Grandin, 1997). The length of time that cattle are deprived of water and feed will undoubtedly result in immediate weight loss of cattle due to shrink. Self and Gay (1972) compiled data from 53 shipments that consisted of over 4,685 feeder cattle. The distance shipped ranged from 240 to 1,824 km, and as the distance shipped increased the amount of shrink that each load incurred increased. The amount of shrink each animal incurs could take a few hours to over 30 days to replenish (Coffey et al., 2001). The ability of cattle to recover the weight lost during transportation is dependent on the distance traveled. Fill shrink or the loss of the organic matter and water in the rumen is lost early during the transportation period, but can be recovered quickly after cattle arrive at their destination. Tissue shrink is associated with weight loss to the carcass and occurs in the latter half of a long transportation period and tissue shrink takes longer to recover (Barnes et al., 2007).

Sanderson et al. (2008) recorded the incidence of BRD for 12 weeks in 122 pens of cattle in commercial feeding facilities. The pens of cattle were segmented by state the cattle were received from. The authors concluded as the distance traveled to the feedlot increased the incidence of BRD increased and animals traveling longer distances had a decrease in ADG. Cernicchiraro (2012) evaluated the distance traveled and its effect on BRD morbidity, and animals traveling longer distance had an increase in BRD morbidity a decrease in ADG. The study included 14,601 truckloads of cattle that spanned over a twelve year period. Ultimately, as the distance traveled increased the likelihood for BRD increased while ADG decreased. However, most research that has been conducted pertaining to this issue has been conducted in commercial feeding facilities and not the stocker industry. Therefore, it would be valuable to conduct more research in the stocker industry on the effects of distance traveled on BRD incidence and gain which would allow producers to more effectively manage cattle coming in from long distances.

Effects of Hair Shedding on Gain and Health

The principal method for heat removal in cattle is through evaporative cooling. An animal's success at cooling itself is directly influenced by many factors including humidity, wind speed, and physiological factors such as respiration rate and activity of sweat glands (Blackshaw and BlackShaw, 1994). Cattle with dark, thick wooly coats are at a disadvantage in hot, humid climates and are at increased risk of heat stress, dehydration and loss of performance (Gray et al., 2011). On the other hand, cattle that have shed their hair coat have lower body temperatures and an increase in gain (Williams et al., 2006).

Gray et al., (2011) estimated the effect of hair coat shedding on adjusted 205 day weaning weights of Angus calves. Hair coat scores were taken, on a 1 to 5 scoring system, on 532 Angus dams. The authors found a strong negative correlation ($r = -0.58$) between hair coat shedding and 205 day weaning weights, and concluded that dams that shed earlier in the spring weaned heavier calves. Williams et al. (2006) published similar results of the negative attributes of hair coat on weaning weight. Williams et al. (2006) found that hair coat scores negatively affected post weaning growth ($r = -0.30$).Olson et al. (2003) found that fuller hair coats negatively affected post weaning growth In conclusion, several studies have been conducted in the cow/calf sector to evaluate the affects of shedding on performance, but little research is available for the post weaning growth of cattle.

CHAPTER III

EVALUATION OF INITIAL BODY WEIGHT AND SUPPLEMENTATION LEVELS ON HEALTH AND PERFORMANCE OF NEWLY RECEIVED STOCKER CALVES

Objectives

The objectives of this study were to evaluate the effects of: (1) initial BW, energy supplementation, hair coat shedding, distance and days traveled, impacts on performance and animal health

Materials and Methods

All procedures in this study were approved by the Institutional Animal Care and Use Committee at Mississippi State University (IACUC #15-032).

Animals and Management

Crossbred heifer calves (n=120) were purchased with two levels of initial BW from an order buyer in southeast and all cattle represented Southeastern origin. The cattle for this study were all black hided or black white faced but differences in breed composition were observed (90 % English influence, 6 % Brahman influence, 4 % Continental influence. Heifers were housed at the Mississippi Agriculture and Forestry Experiment Station H.H. Leveck Animal Research Center located at Mississippi State, MS. The 45-day trial lasted from May 8, 2015 to June 22, 2015. Heifers were housed in

.81 hectare paddocks which were planted with Marshall Ryegrass. Pens were blocked by forage availability and heifers were stratified by Brahman breed influence then randomly assigned to pen within BW group (6 head per pen).

Upon arrival, heifers were placed on a 24 hr. receiving period with free choice ryegrass and water. On day 0, cattle were weighed, individually identified, and vaccinated for infectious bovine rhinotracheitis (IBR), bovine viral diarrhea (BVD), parainfluenza virus type 3 (PI3), and bovine respiratory syncytial virus (BRSV) using a killed vaccine (Viralshield 6, Novartis Animal Health Cambridge, MA). Also, on day 0 cattle were vaccinated for *Clostridium chauvoei* (Blackleg), septicum (Malignant edema), novyi (Black disease), sordellii and perfringens Types C and D (Enterotoxemia) using a killed vaccine (Vision 7 Intervet/Schering-Plough Animal Health Summit, NJ). Heifers were dewormed on day 0 with Fenbendazole (Safeguard ®10 % suspension, Merck Animal Health, White House Station, NJ) and Levasole (Prohibit, Agri. Laboratories LTD, St. Joseph, MO). Cattle were ear notched for persistent BVD infection (PI) testing. Ear notches were sent to Mississippi State University Veterinary Research and Diagnostic Laboratory for analysis and all heifers tested negative. Cattle were weighed every 14 days through day 42 of the 45 day trial.

Cattle were examined daily on horseback by a trained observer at 0700 h for visual signs of BRD (e.g., nasal discharge, ocular discharge, lethargy, inappetence, coughing, and labored breathing). Calves that showed visual signs of BRD were pulled for further examination and a rectal temperature was taken and recorded. Bovine respiratory disease was diagnosed at the first clinical sign with a body temperature greater than 40 ° C.

Morbidity was measured as incidence density and was calculated as: number of new BRD cases divided by calf days at risk. Days at risk were defined as the number of days from arrival until a calf: 1) was first diagnosed with BRD; 2) died; or 3) finished the trial.

Calves receiving supplement (1% BW soyhull pellets) were fed once daily. Supplement composition is presented in Table 3.1. Free choice mineral (Purina, Wind-Rain®, Purina Mills, Gray Summit, MO) was provided. Feed amounts were adjusted following weight collection.

Auction barn tags were recorded with individual identifications (n=96). The auction barn code corresponded with what auction barn cattle were purchased at. Distance traveled was determined by adding the distance from the auction barn to the order buyer's facility and from the order buyer's facility to the Mississippi Agriculture and Forestry Experiment Station H.H. Leveck Animal Research Center. Heifers were assembled during an 8 day period and days to facility were determined by the difference in heifer's arrival date to their respective sale date.

Forage measurements were taken weekly. The sword height was taken using a falling plate disk meter. The first site of contact was randomly selected by walking a random number of steps into the pasture. Thereafter, a fixed number of steps were used for each contact using a zig-zag pattern and the data collector made 90 contacts in each paddock.

Shedding and pattern score were assigned on day 30 of the trial. Two trained technicians scored cattle by using the shedding system described by Grey et al. (2011)

and the scoring system is presented in Table 3.2. Pattern scores were from a scale 1 to 5 and the description of the scoring system is present in Table 3.3.

Statistical Analysis

This study was a 2 x 2 factorial design with 2 levels of intial BW (136 kg or 226 kg) and 2 levels of energy supplementation (supplemented with soyhull pellets at 1 % BW or no supplementation). All data were analyzed using SAS software version 9.3 (SAS Institute Inc., Cary, NC). The model included weight classification, days to facility, shedding score, pattern score, and distance traveled and diet as fixed effects with BRD incidence density and gain as response variables. Differences were tested by Poisson regression in a generalized linear mixed model (PROC GLIMMIX). All models accounted for clustering by pen. Interactions for BW and supplementation were tested. Significance was defined at $p \leq 0.05$.

Table 3.1 Nutrient composition of soyhull pellets

Item[1]	Nutrient Composition[2]
DM, %	88.3
CP, % of DM	12.6
NEm, mcal/kg DM	0.64
NEg, mcal/kg DM	0.38
ADF, % of DM	52.2
NDF, % of DM	74.5
CF, % of DM	0.97

[1] DM=dry matter, CP=crude protein, NEm=net energy maintenance, NEg=net energy gain, ADF=acid detergent fiber, NDF=neutral detergent fiber, CF=crude fat
[2] Nutrient composition determined by Cumberland Valley Analytical Services

Table 3.2 Description of hair coat shedding score

Hair Shedding Score	Definition
5	Full winter coat
4	Coat exhibits initial shedding
3	Coat is halfway shed
2	Coat is mostly shed
1	Slick, short summer coat

Adapted from Gray et al., 2011

Table 3.3 Description of hair pattern score

Pattern Score	Definition
5	Winter coat no shedding
4	A slick strip down to topline
3	A slick strip down the topline and the back of hindquarters
2	Animal is shed off to below the middle of the ribcage
1	Slick, shedding complete

CHAPTER IV

RESULTS AND DISCUSSION

Effects on Gain

Average arrival weight for all heifers was 202 ± 41.34 kg. On day 0 lightweight heifers weighed 164 ± 15.19 and heavyweight heifers weighed 242 ± 16.98 kg. Table 4.1 gives the effect of BW and diet on gain during the trial. No differences in gain and ADG were seen when comparing the lightweight cattle (164 ± 15.19 kg) to heavyweight cattle (242 ± 16.98 kg) for initial bodyweight (P=0.573). These results differ from Brazle (2000) who pooled results from 11 different studies of heifers grazing native grass for 81 days, and reported heifers having initial body weights of 182 to 226 kg had an increased gained compared to cattle weighing less than 181 kg on arrival. Ackerman et al. (2001) conducted two trials that compared the gain of lightweight steers weighing 141 ± 17 kg (n = 214) in trial 1 and 160 ± 23 kg (n = 193) in trial 2 to heavyweight steers that weighed 265 ± 17 kg (n = 115) in trail 1 and 248 ± 13 kg (n = 126) in trial 2. Both studies showed that heavier weight steers out gained the lighter weight steers while grazing native grass. The differences found in this study could be due to several different factors, including the study length and stocking rate. The current study stockered cattle for 45 days and both cited studies stockered cattle over 70 days. Perhaps a longer period of time is needed to detect differences in gain. Also, stocking rates were based on a per head basis in the current study and Ackerman et al. (2001) calculated stocking rate on a pound/acre basis.

Results for supplementation effects on gain are displayed in Table 4.1. As anticipated, supplementation increased total gain and ADG ($P = 0.005$). Similar results were published by Coleman et al. (1976) who compared the performance of 433 steers grazing native pasture and reported that supplemented cattle outgained cattle that did not receive the corn based supplement. Likewise, Goetsch et al. (1991) used crossbred heifers ($n = 96$) and found that cattle supplemented while grazing lush green forage had a higher total gain versus cattle not supplemented. Therefore, providing cattle with additional nutrients by supplementation can positively affect gain. Comparing supplemented pens, to pens that received no supplement, there were no difference in forage sward height at the conclusion of the trial ($P = 0.172$). Moore et al. (1999) compared the forage intake of cattle that were supplemented and not supplemented and found that when cattle were grazing high quality grass, supplementation had a negative impact on forage intake. It is possible that the shorter grazing period in the current study may have negated difference in comparing ending forage sward height as supplementation has been associated on multiple occasions to lengthen grazing days (Gulbransen, 1976; Loy, 2007).

Results for hair shedding on gain are in on Table 4.2. Pattern had no effect on gain ($P=0.64$). Cattle that received the low hair shedding classification (1 to 2.5) ($n=14$) had a higher total gain ($P=0.00016$), and ADG ($P=0.00016$) compared to cattle receiving shedding classification of medium to high (2.5 to 5.0 $n=106$). Similar results were reported by Williams et al. (2006) who found a negative correlation ($r = -0.30$) with hair coat scores and post weaning growth. The author concluded as hair coat score increased, post weaning growth decreased. Olson et al. (2013) evaluated the effect of hair coat on post weaning growth of Charolais-sired heifers, and concluded heifers with shorter hair coats gained faster for the first three months following weaning

Ninety six heifers were able to be traced to the auction barn. The impacts of distance traveled on health are displayed in Table 4.4. All heifers observed were from auction barns in Alabama or Mississippi, and the distance traveled ranged from 321 km to 547 km. Heifers that traveled more than 483 km (n = 21) gained an average of 19.71 kg throughout the study. Heifers that traveled 322 to 482 km (n = 49) gained an average of 24.71 kg and heifers that traveled less than 321 km (n = 26) gained an average of 21.00 kg through the study. Heifers that traveled 322 to 482 km gained more than heifers that traveled more than 483 km (P = 0.05). However, no differences were detected in comparing heifers who traveled less than 322 km to heifers that traveled more than 483 km (P = 0.65) or heifers that traveled 322 to 482 km (P = 0.12).This differs from Cernicchiaro et al. (2012) who found that as the distance traveled increased the ADG decreased. However, cattle used in the Cernicchiaro et al. (2012) study traveled from 250 to 1000 km and came from all parts of the United States. The differences in the results are likely due to the lack of variation in distance traveled within the current study.

Heifers were assembled by the order buyer during an 8 day window. Heifers either stayed at the order buyer facility between 2 to 4 days (n = 85) or stayed at the order buyers for 8 days (n = 11). Heifers that stayed at the facility for 8 days gained 7.91 kg more than heifers that stayed at the order buyer,s from 2 to 4 days (P = 0.01). Heifers were given free choice hay and water at the order buyer's facility. Several factors could be responsible for the differences in gain. First, the stress of marketing had already peaked at the order buyer's facility resulting in a reduced amount of stress when cattle arrived to the research facility, which allowed for more gain during the stockering period. A second mechanism could be that the free choice hay did not meet the NEm requirements resulting in more shrink at the order buyer's facility; consequently cattle experienced more compensatory gain when arriving at the research facility.

Effects on BRD Incidence

Seventy five heifers were treated for BRD giving a cumulative incidence for BRD of 62.5%. During the study, 47 lightweight heifers were treated for BRD for over 941 days at risk, giving a total incidence density of 53.7 cases of BRD per 1000 calf-days. BRD cumulative incidence for lightweight calves was 78.33% with mortality of 0%. Heavyweight heifers were treated for BRD 28 times for over 1686 days at risk, giving a total incidence density of 19.0 cases for 1000 calf days (Figure 4.1). The BRD cumulative incidence for heavyweight heifers totaled 46.77% with a mortality rate of 0%. Lightweight calves were 2.8 times more likely to be treated for BRD (p=0.02). These results are similar to those reported by Sanderson et al. (2008) who followed 122 pens of cattle in commercial feeding facilities for 12 weeks and reported heavier arrival weights were associated with decreased morbidity risk. Pinchak et al. (2007) used heifers (n=633) weighing 237 kg to test the effects of initial BW on BRD incidence, and found lighter calves at arrival had a greater incidence of BRD.

As shown in Figure 4.2, there were no differences for supplemented groups for BRD incidence. Cattle receiving supplement were treated for BRD 36 times for over 1367 days at risk, giving a total incidence density of 27.4 cases of BRD per 1000 calf-days. The cumulative incidence for cattle receiving the supplement was 60 %. Cattle receiving no supplement were treated 39 times for over 1260 days at risk, giving a total incidence of 37.2 cases of BRD per 1000 calf-days. The cumulative incidence for cattle receiving no supplement was 65%. This differs from the results found by Cole (1996) who found that increasing the energy in diets through supplementation caused an increase in morbidity and mortality of steer calves. However, Cole and Hutcheson (1990) found that raising the CP of receiving diets had no effect on BRD morbidity and mortality. Also, Braud (2015) compared diets containing 11.1% or 17.1% CP for 244 steers and reported that BRD morbidity and mortality were similar for cattle fed both diets. However, all cited articles were conducted in a drylot setting where as cattle in the current study were supplemented on pasture. Commercial feeding facilities struggle to get newly received cattle to consume enough feed in order to meet their NEm requirement (Loyd et al. 2007). The low intake is associated with the stress of weaning, marketing and being comingled. Low intakes can stem from cattle not being trained to eat harvested feedstuffs and eating from feed bunks. If cattle are on forage previously, intakes may increase on arrival due to being trained to consume forage. It is possible that ryegrass allowed cattle to overcome low dry matter intakes resulting in a lower BRD incidence. There was no difference found in distance traveled on BRD incidence (P=0.77).

Pattern had no effect on BRD incidence (P=0.67). Table 4.3 shows that cattle that received the hair classification of low had a lower morbidity percent compared to cattle that had the hair classification of medium or high (P=0.04).Cattle with an increased hair score increased their risk for BRD 1.6 times. Barham et al. (2007) reported feeder cattle with a dead retained hair coat received a discount of $14.00 in auction barns in Arkansas.

The discount in most cases is associated with a loss of performance which was also the case in this study. Gray et al. (2011) reported that cattle with retained hair coats are at an increased risk for heat stress. It is possible that the additional stress from the cattle's decreased ability to cool further weakened the immune system, and increased the incidence for BRD.

There was no difference found in distance traveled on BRD incidence (P = 0.77). This differs from Sanderson et al. (2008) who found that as distance traveled increased BRD morbidity increased. These differences could be due to lack of variation in distance traveled in the current study.

Heifers that were treated for BRD once (n = 57) had a higher total gain 24.07 ± 1.55 kg than heifers treated 2 or 3 times (n = 18) for BRD 20.822 ± 2.52 kg. Heifers not treated (n = 45) gained 20.94 ± 1.67 kg, but no differences arose when comparing heifers not treated for BRD to heifers treated once for BRD (P = 0.12), or two or more time for BRD (P = 0.96). Holland et al. (2010) found that heifers not treated for BRD had the highest ADG during a 45 day receiving period and there was a linear decrease in ADG for every time a heifer was treated for BRD. Similar results were found by Pinchak et al. (2004), who found that cattle not treated for BRD had a higher ADG than cattle treated for BRD while being stockered on warm season grasses. However, cattle not treated for BRD did not posse clinical signs of BRD, but could have been infected with the disease which would hinder their gain during the trial.

Conclusions

This study showed no difference in gain within the first 45 days of a stockering period of heavyweight calves versus lightweight calves. However, cattle with higher initial BW had a lower incidence of BRD. This study found that supplementing cattle had a positive effect on gain. However, within this study there was no relationship between supplementation and BRD incidence. Also, this study shows that not only will retained hair coats affect the gain of cattle, but retained hair coats will also increase the incidence of BRD.

Implications

Many environmental and biological factors are evaluated in order to decide what type cattle to purchase for stocker operation. This study shows that lightweight cattle have a higher incidence of BRD and cattle that have retained hair coats in late spring months are lower performers and are more risk at for BRD. Future research should be conducted in order determine the economic impacts of the results discovered in this study.

Table 4.1 Effect of initial bodyweight and diet on gain during a 45 day receiving period in heifers

	Initial Weight[1]			Diet[2]		
Item	Light	Heavy	P-value	Supplement	No Supplement	P-value
Gain, kg	25.98 ± 2.03	24.85 ± 1.88	0.573	28.34 ± 1.90	22.50 ± 2.02	0.005
ADG, kg/d	0.67 ±0.05	0.64 ±0.05	0.573	0.73 ± 0.05	0.57 ± 0.05	0.005

[1]Initial BW light = 164 ± 15.19 kg or heavy 242 ± 16.98 kg
[2]Diet supplemented at 1% BW with soyhull pellets or no supplement

Table 4.2 Effect of hair coat shedding on gain in heifers during a 45 day receiving period while grazing ryegrass

	Shedding Score[1]		
Item	Low	Medium	High
Gain, kg	31.34 ± 2.91[a]	23.32 ± 2.56[b]	21.59 ± 1.66[b]
ADG, kg/d	0.80 ± 0.07[a]	0.60 ± 0.07[b]	0.55 ± 0.04[b]
No. of calves	14	25	81

[1]Shedding Score, Low = ≤2, Medium = 2.5-3.0, High = ≥3.5
[a,b]Means within row with differing superscripts differ (P < 0.05)

Table 4.3 Effect of hair coat shedding on BRD morbidity in heifers during a 45 day receiving period while grazing ryegrass

	Shedding Score[1]		
Item	Low	Medium	High
Morbidity,%	42.8	60	66.7
No. Pulls	6	15	54
No. of calves	14	25	81

1Shedding Score, Low = ≤2, Medium = 2.5-3.0, High = ≥3.5
a,bMeans within row with differing superscripts differ (P < 0.05)

Table 4.4 Effects of distance and days traveled on gain during a 45 day receiving period in heifers grazing ryegrass

	Distance Traveled[1]			Days to Arrival[2]		
Item	<321 km	322 to 482 km	>483 km	2-4 days	≥ 8 days	P-value
Gain, kg	21.00 ± 2.08[ab]	24.71 ± 1.63[b]	19.71± 2.12[a]	21.45 ± 1.28	29.38 ± 2.95	0.014
ADG,kg/d	0.53 ± 0.05[ab]	0.63± 0.04[b]	0.50± 0.05[a]	0.55 ± 0.03	0.75 ± 0.05	0.014

[1]Distance traveled, distance = <200 miles, distance = 201 to 300 miles distance = >301 miles
[2] Days to arrival, 2-4 days = 2 to 4 days from auction barn to stocker operation, ≥8 days = more than 8 days from auction barn to stocker operation
[a,b]Means within row with differing superscripts differ (P < 0.05)

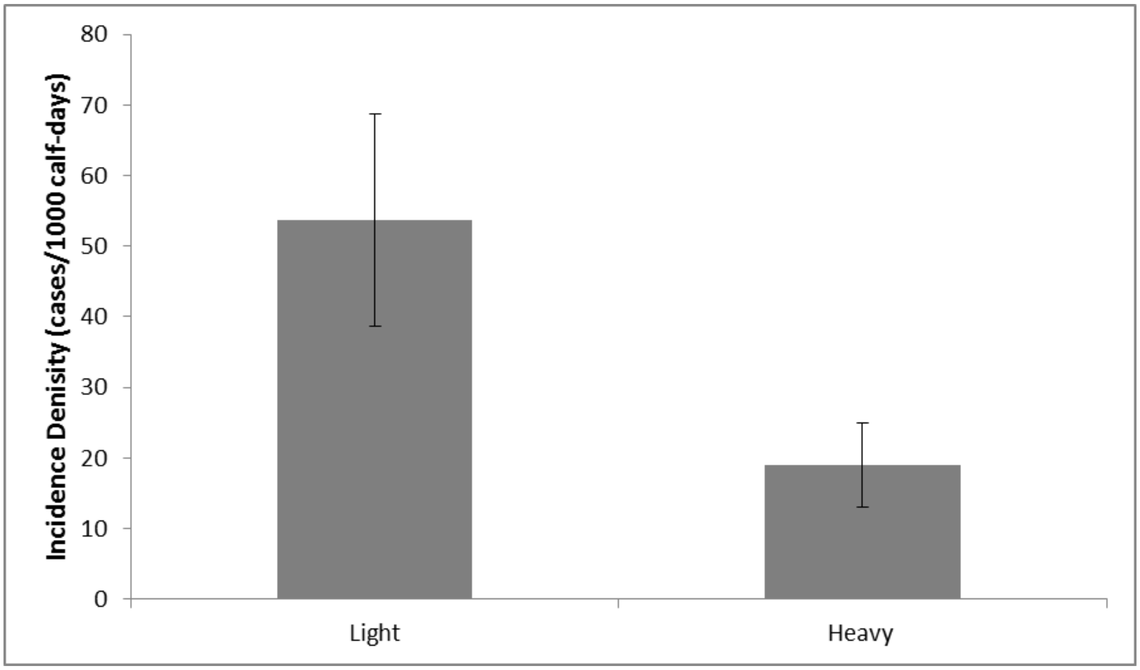

Figure 4.1 Effect of initial BW on bovine respiratory disease incidence density[1]

[1]Light = 126 kg initial weight, Heavy = 226 kg initial weight
[2] P = 0.002
[3]Relative Risk= Light 2.8 times more likely to be treated for BRD

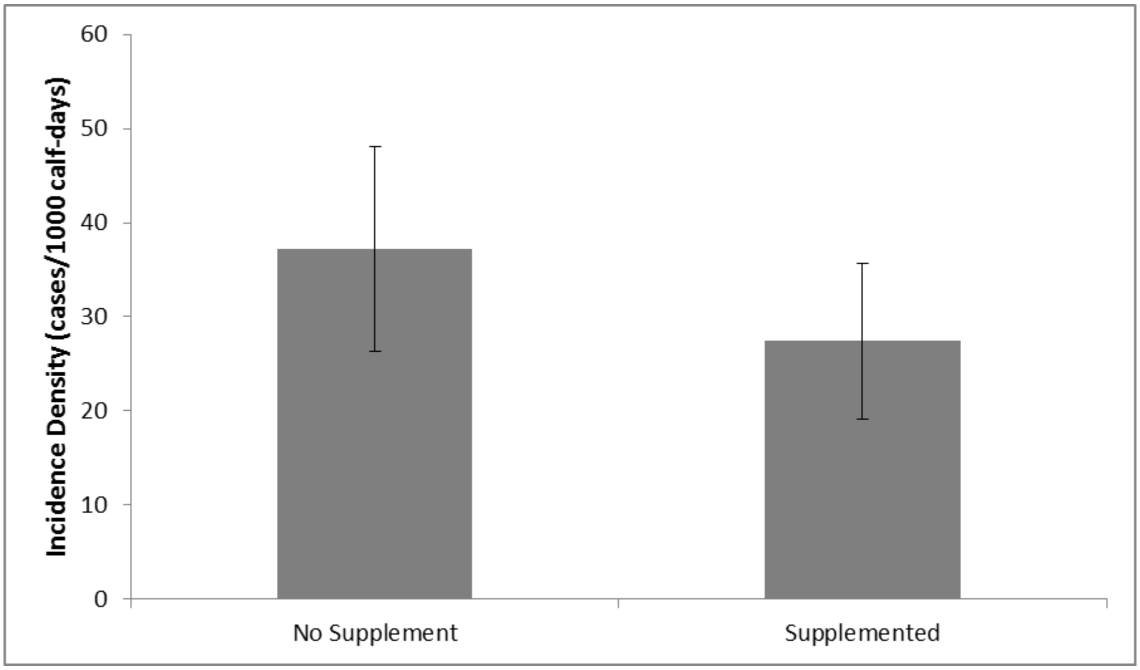

Figure 4.2 Effect of diet on bovine respiratory disease incidence density[1]

[1]Supplemented 1% BW with soyhull pellets
[2] P=0.48
[3]Relative Risk= No Supplement 1.56 times more likely to get treated for BRD

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