The Effects of Low Stress Cattle Handling

And Weaning Training on Post-Weaning

Weight Gain and Calf Activity

Jennifer M. Ligon

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W. Dee Whittier
John F. Currin
Sherrie G. Clark-Deener

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ABSTRACT

The objective of this study was to assess the effect of low stress (LS) handling of beef calves on weight gain and calf activity associated with the weaning process. Cattle were of Angus and Angus cross breeding from two separate herds in Virginia. Handlers for the LS groups went through a short training session. Handlers for the Control (C) groups did not have any special training and handled their group as they would have with no adjustments. Handling and calf activity were monitored each time (6 times) the cows were worked from calving through one month post-weaning. Weights were taken from birth to one month post-weaning. During the week post-weaning the C calves averaged a gain of 4.38 lbs. and the LS calves averaged a gain of 16.94 lbs. One month post-weaning the C calves averaged a gain of 49.01 lbs., while the LS calves averaged a gain of 68.6 lbs. This showed a difference ($p < 0.0001$) between handling method for weight gain in calves for one week and one month post-weaning. Pedometers were used to assess calf activity post-weaning. Steps per hour (SPH) for the week post-weaning was numerically higher for those calves handled conventionally and not trained for weaning. The C calves averaged 1048 to 1629 SPH for the first three days, where the LS calves averaged 443 to 644 SPH for the first three days. Additionally, the artificial insemination conception rates (AICR) were calculated in each herd and treatment groups compared, however results were equivocal. This study demonstrated that handling cattle using low stress techniques can make significant improvements with regard to weaning weights and has potential to increase other areas of production in beef cattle.

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I. Introduction

Producers have worked to improve the gain and profitability of their beef cattle since the initiation of raising cattle as a business entity. They are constantly seeking ways to obtain premium prices for their product without additional input costs. They use to their advantage the improved knowledge that the industry has acquired in genetics, better feed sources, grazing protocols, health programs, etc. These practices usually increase input costs. The question is; are there other areas that can be improved? Are there other areas that may also increase production that will not add to input costs?

Media coverage has increased public awareness of the livestock industry. A portion of the public has demanded the humane treatment of livestock, whether they are consumers of beef or not. Recent survey results from the American Humane Association shows that 94.9% of the respondents are concerned about animal welfare (Radke, 2014). Those respondents were more concerned with food labeled, “humanely raised” than food labeled “organic”, “natural”, or “antibiotic-free”. This survey also indicated that 75.7% of the respondents were willing to pay more for food that was branded with this label (Radke, 2014). Online content and media fuel these issues and has created social issues which have tarnished the industry’s image. This has led to increased expenses for producers, processors, and the beef industry as a whole. These issues have initiated a movement towards better handling practices.

In Virginia, cattle production consists mostly of cow/calf operations. Most producers will separate, wean, and sell their calves all at once without a health program. Thus, the health and growth of that calf will suffer in the hands of and to the detriment of the buyer of those cattle. The Virginia cattle industry has tried to enhance the marketability of their cattle by addressing these issues, encouraging the adoption of veterinary recommended health programs and encouraging the preconditioning of calves. A recommended health program includes pre-weaning vaccinations and worming protocols that insure the good health of the calf. Preconditioning of calves is defined as a management program designed to ensure that a calf's nutritional and health background are optimal for preparing the calf to thrive despite the stress of shipping from its home to other levels throughout the beef industry (Lincoln et al, 1914). The Virginia Cattlemen's Association, veterinary professionals, and extension professionals have devised programs to assist cattle producers with improving the health and management of their cattle in order to obtain premium prices and a stable market for their calves. These programs are initiated and assistance provided by Virginia Cooperative Extension agents, veterinary professionals from the Virginia-Maryland Regional College of Veterinary Medicine and the Virginia Cattlemen's Association. They include the Virginia Quality Assured Feeder Calf Program (VQA) and the Mid-Atlantic Beef Quality Assurance Program (BQA).

VQA is a program sponsored by the Virginia Cattlemen's Association. The goals of the program are to improve the health and genetics of Virginia feeder cattle and identify those producers that have a superior management system, to improve marketability and bring additional returns to them. Another goal is to improve the communication and relationship between buyers and sellers and to ensure those buyers are receiving quality, healthy cattle that will excel in a feedlot setting. There are two categories for marketing VQA calves; a yellow tag denotes cattle subjected to a stringent health program, and a purple tag represents cattle subjected to the health program as well as meeting genetic requirements. The health program requirements are: vaccinations of at least one modified live Infectious Bovine Rhinotracheitis (IBR), Bovine Viral Diarrhea (BVD) (Type I & II), Parainfluenza 3 (PI3), 7-strain Clostridial to prevent backleg or other clostridial bacterial diseases, and Pasteurella (Manheimia with

Leukotoxoid). Vaccinations must be given according to label directions and all vaccinations must be given after 4 months of age and at least 14 days before sale; all vaccinations must be given in the neck area and a processing map and verification form must accompany the cattle; all cattle must weigh at least 400 lbs.; heifers must be guaranteed open; steers must be castrated, healed, and guaranteed against stags; calves must be dehorned and healed; all cattle must be owned by the seller for at least 60 days. The additional genetic requirements for the purple tag program are: identification by breed and above breed average for the sire's yearling weight expected progeny difference (EPD). All producers must also be BQA trained (Virginia Cattlemen's Association website, VQA Marketing Program).

Beef Quality Assurance is a mid-Atlantic states' program sponsored by Virginia Polytechnic Institute and State University, the Virginia-Maryland Regional Veterinary College, and Virginia Cooperative Extension. It is a program put into place so that producers will work together to assure consumer confidence in Virginia beef through improved techniques and practices, research and education. The program was established in 1987, partially funded by the Beef check-off. It provides producers with the tools and training to ensure animal health and welfare that furnishes a safe and wholesome beef product. The main objectives are to set standards for pre-harvest production that can be met or exceeded; to establish proper and efficient record keeping; to provide hands-on training and educational opportunities through BQA-certified veterinarians and BQA-certified extension agents. This ensures that the cow/calf segment of the beef industry is responsible for the production of safe food products and responds to consumer demands for animal welfare by enforcing superior practices in animal care, handling, and management. The Virginia BQA program is part of the Mid-

Atlantic and National Beef Quality Assurance Programs (Virginia Tech's Department of Animal and Poultry Sciences website, Virginia Beef Quality Assurance Program).

A significant aspect of the BQA program is cattle handling. The Mid-Atlantic BQA producer certification manual states, "Handling procedures must be safe for the cattle and caretakers and cause as little stress as possible." It also states that facilities should be utilized to take advantage of the cattle's natural instincts (Mid-Atlantic BQA, 2010). Compliance with the BQA standards is vital to maintain quality cattle. Handling techniques are an aspect of the program that may have the potential for the most improvement as well as have the most benefit.

The VQA and BQA programs are utilized by local cattlemens' associations that work with their producers participating in them to pool their cattle. Graders go to the farm and grade weighed cattle. The cattle are then grouped in single, double, or multiple producer, co-mingled 50,000 lb trailer load lots. They are sold through the VQA program over Tel-O-Auction on designated days each year. These programs and cooperation of producers are unique to this region and have increased profits for those participating.

In the past there has been a designation for VQA weaned cattle that are feed bunk and water trough broke and ready for the feedlot. With the recent revisions of the VQA program, the weaned designation was removed. However, producers see a definite buyer preference for weaned cattle. Therefore producers have received premiums for weaning their calves and preconditioning them for 45 to 60 days prior to their sale. Producers are also encouraged by extension and veterinary professionals to continue to wean their cattle to take advantage of these premiums, as well as prepare a healthier quality product for the buyers, which in turn enhances the buyers' confidence in the quality of Virginia cattle. Many of the local cattlemen's associations require weaning to participate in their Tel-O-Auction sales.

Buyers of Virginia cattle prefer the peace of mind of a weaned and preconditioned calf. Producers want to provide that to the buyers. Some producers and some cattle have a difficult time with this process. One of the most stressful times for cattle in the cow/calf operation is weaning. Herein lies the challenge for Virginia producers to wean and feed calves for an additional 45 to 60 days and see adequate gains or to at least minimize the calves' weight loss due to stress. Can positive human handling (Low Stress cattle handling) at times of normal cow and calf management procedures lower the stress response and negative weight gain of calves at weaning?

II. Review of the Related Literature:

There have been a number of studies that have examined less stressful ways of carrying out the weaning process. Conventional farming operations mostly practice complete separation of cows and calves, which includes the stress of nutritional changes due to the cessation of milk consumption, as well as a change in the physical and social environment. These factors have been determined to cause stress in newly weaned calves, whether they are sold immediately or back-grounded for 30 to 60 days before sale. Growth rates are normally reduced in the days following weaning due to the behavioral stress response (Weary et al, 2008). This study found that at 18 hours post-weaning there was a peak of the stress response and that this timing is partially in response to gut fill or hunger. The behavior stress response usually displayed during artificial weaning is increased vocalizations (Lidfors, 1996; Marchant-Forde et al, 2002) and increased activity such as walking and/or pacing (Weary and Chua, 2000; Loberg, et al 2008; Price et al, 2003; Solano et al, 2007), both energy consuming behaviors. The energy costs of walking could range anywhere from 4% to 24% over maintenance requirements (Ribeiro et al, 1977).

Studies show that separation of the factors, the removal of milk consumption and the physical and social environment change, can relieve some of the stress. Researchers have experimented with methods such as inserting nose flaps to prevent suckling, which has allowed the calf to remain in the same physical and social environment, and fence-line weaning, which also allows the calf to have a similar physical and social environment but prevents nursing. Some studies have shown these options, which practice separation of the stressful factors to be beneficial (Haigh et al, 1997; Loberg et al, 2008) while others have not (Enriquez et al, 2010). Enriquez (2010) attributed the non-beneficial results to dividing the stressful growth-inhibiting occurrences from one largely stressful occurrence to multiple smaller stressful occurrences that correlate the same amount of stress over time. What other practices could have an effect on stress and the weaning process? Some research groups (Newberry et al, 2008) believe that more investigation is needed to adjust weaning management protocols to minimize separation stress on the cows and the calves. Other researchers (Krohn et al, 2003) have noted that calves handled while separated from their dams will show a higher degree of affinity towards humans and that this handling during times of separation will have the same positive affect. This could be due to the fact that separation from the dam disrupts the social environment of the calf and makes it seek new social bonds elsewhere (Krohn et al, 2003).

Low Stress (LS) Cattle Handling

There is a practice of working cattle with reduced stress employed by those individuals who have been known to 'think outside the box' when compared to the majority of the beef industry. Bud Williams and Temple Grandin are the most well-known advocates for these methods. They have seen the benefits of these methods and know that controlling the handling situation so that it is a good experience is most important. These individuals have tried to familiarize and popularize these techniques and the importance to the cattle industry.

"After many years of studying animals it is my belief that their emotions have a lot to do with their health and performance, good or bad. The last 20 years of working with and trying to teach people I'm now starting to believe that the emotions of the people working with animals may have more to do with the animal's health and performance (good or bad) than the emotion of the animals. In most situations it is the emotions of the people that determines the emotions of the animals that they work… The livestock industry keeps thinking that all of the problems (with livestock) *can be cured with more drugs, machines and technology. Like most*

things that cause a problem, these problems can't be stopped with more of what causes it. While the industry will not change and be concerned about the emotion of the animals, the individuals who want to can be concerned and eliminate many of the health and performance problems." –Bud Williams, 2010, www.stockmanship.com.

Bud Williams emphasized that it is not the equipment that we use, but the method and demeanor that we use it in, that can most affect the health and performance of livestock (Williams, 2010). It is the producers' responsibility to their livestock. The benefits for the producer are greater due to this concept than any new expensive equipment could provide to them, especially in the new age of media coverage.

Most of the media attention has been focused on animals in feed yards; therefore, most of the research studies and focus have been on that area. Some agricultural industry leaders have tried to convey the importance of humane treatment of animals in all aspects of the livestock industry. These handling techniques, if employed, could revitalize the beef industry's public appearance. However, this type of change has a steep learning curve that battles tradition (Grandin, 2003). Change is not the easiest accomplishment in an industry governed by a timeless tradition of pushing cattle where we want them to go no matter what the process. People have been more willing to purchase new and expensive equipment rather than learn to employ low stress (LS) handling techniques even when there are clear benefits to cattle welfare and financial return (Grandin, 2003). The industry has demanded the quest for improved production and society has demanded more humane animal treatment. The concept of LS handling may have relevance in helping the beef industry in both aspects.

Low stress handling techniques have been documented in the feedlot setting (Maday, 2013) to reduce the stress of cattle which in turn, can decrease respiratory disease and increase gain, increasing profits in the feedlot stage. If benefits are seen due to increased performance for immune function, feeding efficiency, and at harvest in meat quality of the animals in the feedlot stage, then the cow/calf operation should also benefit in these areas as well as reproduction. Agitation, fear, and excitement during handling is a key stressor for cattle. Stress during a chute handling session is influenced by both genetics and previous handling experiences (Grandin, 1998).

Safety

It is apparent when working in the cattle industry that many injuries can occur to cattle and humans due to the cattle's reactions to equipment and environmental stimulus, such as humans, especially when it causes agitation to the animal (Grandin, 1999). Cattle that have disposition issues, whether by genetics or learned behavior, are a safety hazard to handlers (Grandin, 1993). Detering's article (2006), "Ranch Safety through Low-Stress Cattle Handling", suggests that if we can reduce the stress of cattle while being worked, we can help prevent them from injuring themselves, the facilities, and the handlers. In a thesis written by Shannon Fox of Kansas State University, occurrences of human injuries have been reported and cataloged. Many of the injuries were due to being chased by cattle or traumatized by gates when cattle challenge handlers (Fox, 2003). In Virginia the average age of a farm's principal operator is 59.5 years of age (NASS.USDA.GOV 2013). Running from or avoiding these accidents with agility is more difficult with an aging farming population. Fox suggests that in addition to making sure there are proper facilities to work in, handlers also need to practice safer handling techniques. Conditioning cattle to be calmer while worked can also be accomplished. Not only is human safety an issue, but animal safety should also be addressed. Harsh handling and agitation of cattle can promote scuffing of the toes which will result in toe abscesses (Grandin, T. 1998). Cattle in stressful situations do whatever they can to move away from stress. This can result in cattle breaking bones or receiving lacerations from fencing and other objects. Low stress handling can reduce toe abscesses, lacerations, broken bones, and bruises. The National Beef Quality Audit (Quality Assurance of Market Cows and Bulls, 1999) reports that bruises were the largest quality issue recorded by packers. Cows were five times more likely to have bruising than bulls and that proper animal care is necessary (Mid-Atlantic BQA manual, 2006).

Genetic Selection

Basic temperament differs by an animal's genetics. The disposition of cattle can differ between breeds, within breeds, and between the genders of the calves. Genetics for behavioral traits seem to be low to moderately heritable (Hoppe et al, 2010), and there has been success in identifying the regions on a chromosome that affect cattle temperament (Gutierrez-Gil et al, 2008). Calf temperament is linked to the temperament of its dam (Morris et al, 1994) and sire, as well as environmental conditions. Most breed associations are scoring the temperaments of their bulls and offspring of those bulls to determine docility scores. Docility scores give producers an insight into the temperament of a certain bull's offspring. Scores of 1 (docile) and 2 (restless) are grouped and reported to be more ideal than higher scores of 3 to 6 (nervous to aggressive). This score is then reported as an Expected Progeny Difference (EPD). EPDs are defined as the expectation of how offspring of the listed individual will perform when compared to its constituents (www.angus.org). The Angus breed docility EPD range is from -32 to +42 in current Angus sires (Kirkpatrick, 2011). The most aggressive animal would have an EPD of -32 and the most docile would have an EPD of +42. The average docility EPD is +9. The docility EPD is a percentage. If we chose a bull with a docility EPD of +19, it would have 10% more offspring that score a 1 or 2 on the docility scale than the average Angus bull of +9 (Church, 2011). Therefore, assuming that there are three major factors that influence an animal's temperament, genetics from both the sire and the dam, physical observation of the surrounding cattle's reactions to stimuli, and direct experiences with stimuli, producers can use the docility EPD to assist in breeding calmer cattle and compliment low stress handling techniques.

One study (Vann et al, 2008) shows that assessing temperament and culling for disposition at the cow-calf operation level can increase value of the animals throughout the production system. By looking at chute behavior scores and the speed of the cattle coming out of the chute (flight speed) producers can estimate stress levels on cattle during handling experiences. These factors are negatively correlated with daily body weight gain, regardless of the breed (Hoppe et al, 2010). Additionally, this study concluded that cattle's dispositions can be rated by using these factors on the farm and that proper genetic selection for temperament traits will not decrease production. Another study found that calm temperament cattle, indicated by chute exit scores and gait scores, will become pregnant earlier and will be less likely to experience pregnancy loss (Kasimanickam et al, 2014). Flight scores can be used as a predictor of genetic predisposition to be more excitable, therefore having some value in the predictor of productivity (Petherick et al, 2009) and reproduction (Kasimanickam et al, 2014). Selection for a calm temperament can improve animal and handler safety as well as increase average daily gains (Voisinet et al, 1997). As temperament traits are easy to measure, this selection criterion could be used in an evaluation program (Kadel et al, 2006). Ultimately, more excitable cattle have lower weight gain, carcass quality, and immune response (Burdick et al, 2011). The following discussions will show how selecting and training for calm cattle will not decrease profit, but will actually increase profit by increasing reproduction, production, immune response, weight gain, and carcass quality of the calves that show a calmer disposition.

At present, the cattle market is at its best with prices for feeder cattle doubling in the past five years and the highest they have ever been (Gee, 2014). Culling based on disposition alone is not favorable; therefore, looking at other ways to improve herd disposition would be beneficial. In the study by Vann et al. (2008), chute score, pen score, and flight speed were also recorded by farm origin. Trends could be seen in all of the scores depending on the farm from which they originated. Interpreting these trends in the Vann study shows that temperament and behavior are affected by handling experiences. Overall cattle production benefits from positive human-livestock interactions (Hemsworth, 2003). Negative stockperson handling can cause an animal to experience stress. Stress can cause fear. Repetitive negative stockperson handling can train livestock to be fearful of humans. Fear is a condition that can limit production (Hemsworth, 2003). Cows can also become more accustomed to being handled with age (Hearnshaw et al, 1984), showing that a learning or a desensitization process can be achieved, even on those animals that do not have a genetic predisposition for calm temperament.

A study using dairy heifers found that negative handling resulted in acute stress responses, larger flight zones, and increased cortisol concentrations (Breuer et al, 2003). The Breuer article also suggested that due to stimulus generalization, the learned behavior response to those handlers would also be present while being worked by any human. Therefore, handling at the early stages of the calf’s life can carry through to later in its life and other segments of the cattle industry.

Gentle touching prior to slaughter was shown to decrease flight zones and stress, as measured by blood lactate concentrations; however, it did not improve meat quality as much as early-life gentle touching (Probst et al, 2013). Veal calves show reduced emotional responses and fewer detrimental incidents when farmers use positive treatment. It is believed that these reduced emotional responses result in a reduced fear of humans, the willingness to be handled, a reduced heart rate during handling, and fewer carcass quality issues (Lensink et al, 2001).

Waiblinger found that stress reactions of cows during palpations and inseminations can be reduced by previous positive handling experience as well as by a handler giving positive and gentle encouragement during the exam. Simulating social licking behavior of cows, gentle stroking of the neck can calm an animal that is familiar with its gentle handler. The effects that humans have on the animals can also differ in respect to their calming abilities (Waiblinger et al, 2004). Good treatment can reduce stress, and poor treatment can cause stress and will have a negative impact on weight gains (Petherick et al, 2009).

Reproduction

Stress can affect reproduction in cattle. Burdick et al (2011), came to the conclusion that more excitable cattle exhibit greater glucocorticoid and catecholamine levels. It was also determined that cattle experience these raised levels of corticosteroids during periods of stress, such as stressful handling (Breuer et al, 2003). Elevations in corticosteroids may directly inhibit sexual behavior in females (von Borell et al, 2007) affecting reproduction. In this study it was concluded that in times when animals are stressed, a variety of mechanisms are employed to suppress reproductive and maternal performance. Other researchers have found that during cattle working sessions, the more excitable cattle not only took longer to become pregnant, but also had a higher incidence of pregnancy loss (Kasimanickam et al, 2014).

Milk Production

Stress can affect milk production and milk quality in dairy cattle. Milk production at over 30 dairy farms was found to have moderate to high correlations with fear of humans. Fear of humans accounted for 19% of the variation in milk yield between farms (Breuer et al, 2000). Another study on milk yield of dairies that had implemented a low stress handling method compared to conventional handling found that milk yield was 5 % higher during peak lactation on the low stress handling farms and that milk fat and milk protein content also showed similar differences (Hemsworth et al, 2002).

Immune Function

Vann, et al, (2008), have shown that the cattle with the more excitable temperaments incur added treatment costs, which results in lower net profits. Immunization response and overall health can be positively affected by low-stress handling techniques. Weaning stress was found to affect leukocyte levels, and that neutrophil:lymphocyte ratios can be an effective measure of stress response (Kim, 2010). One study looked at the immune function of bulls of different temperament levels to determine if stress can affect health. It found that cattle with certain temperamental phenotypes may be more likely, under stressful situations, to experience microbial invasion due to deficiencies in neutrophil function. In addition to that, these infected individuals with a more excitable temperament may not show symptoms of infection (Hulbert et al, 2011). This is due to their reaction to humans as a threat or predatorial stressor. The weak individual will ultimately become the target of the predator’s hunt. Therefore, their natural instinct is to avoid showing clinical signs of illness or weakness in the presence of a predator. However, since visual identification of sick cattle is the most commonly used method to determine which individuals need treatment, disposition and/or fear of humans can play a key role in the health and identification of unthrifty individuals (Hulbert et al, 2011).

Carcass Quality

Nkrumah (2007) found that differences in behavior may affect overall energy metabolism. This occurs when temperamental animals spend less time with their head lowered for eating (feeding duration), which also affects dry matter intake, feed conversion ratio, and average daily gain. This in turn affected overall quality of the finished product by affecting carcass fat. Therefore, when looking at different measures of performance, it is important to look at genetic variations as well as environmental variations. This study concluded that if a producer was interested in feed conversion ratio, feeding behavior and temperament need to be a part of that program's breeding decisions.

Other investigators (Reinhardt et al, 2009) found that disposition has an effect on performance in feedlots. In a recent study on over 20,000 feedlot cattle in Iowa, various phenotypic traits were compared to feedlot performance and carcass traits (Reinhardt et al, 2009). Disposition due to previous handling prior to the feedlot stage and genetics was found to have an impact. King et al (2006) found that temperament can influence tenderness; however, the direct cause of this remains unclear.

In a study to examine the difference of good, bad, and no handling on feedlot cattle, it was shown that handling may affect plasma cortisol levels as well as live weight (Petherick et al, 2009). Again, temperament can be measured and productivity predicted by simple tests, such as flight speed.

There is evidence that the more excitable cattle on arrival and throughout the feedlot stage had a lower initial body weight, final body weight, average daily gain, hot carcass weight, fat thickness, loin muscle area, yield grade, quality grade, marbling score, percentage of cattle grading choice, and higher mortality. Respiratory morbidity was negatively correlated with initial body weight, average daily gain, yield grade, hot carcass weight, and marbling score. The degree of the effect on average daily gain, final body weight and hot carcass weight was dependent on the sex of the animal (Reinhardt et al, 2009).

Dark cutting beef results in large economic losses in the United States. Dark cutting meat results when pre-harvest stress depletes glycogen stores in the muscle. Reduced glycogen prevents lactic acid from being produced, which lowers the pH of the meat producing a dark, firm, and dry product. Disposition, handling and management practices pre-harverst can be causes of dark cutters (Mid-Atlantic BQA manual, 2010). Low Stress techniques and more humane handling methods are being employed at the feedlot level due to the observed benefits to animal health and weight gain, as well as public perception. Grandin (2003) determined that to reduce stress in feedlot and processing plants there needs to be efficient working facilities as well as properly trained handlers. Beginning with low-stress handling techniques at the cow/calf operation level will benefit the beef industry as a whole in product quality and public perception, as well, and have added benefits at the producer level.

The Weaning Process

Weaning can be a very stressful time for livestock. Fordyce (1998) reported that selection and training of cattle, especially at weaning was important in improving temperament to produce quiet and manageable cattle. It was determined that weaning into a pen with initial training to a feed bunk did not improve feed efficiency after a few days compared to the pen weaned group that was not trained (Walker et al, 2007). The same trial did, however, find that pen weaning improved weight gain in calves, when compared to pasture weaning. This research also looked at vaccination for respiratory disease which also increased weight gain. The greatest weight gain was observed in the pen of weaned calves that were vaccinated. The bunk training process consisted of grain being distributed into an adjacent empty pen. The gate between the pens was kept open for 45 minutes with the handler standing quietly on one side of the gateway. At the end of the 45 minutes the handler would quietly herd the remaining cattle into the feed pen (Walker et al, 2007). The handling technique required calves to pass closer to a human than their previous flight distances allowed, which allowed calmer disposition cattle to obtain 45 minutes more feed bunk time than the less calm cattle. The technique did show increased weight gains over pen weaned, untrained calves for the first couple of days. The cattle were taught that they could move past a handler without having a negative experience. They appeared to learn this process and each day more animals would pass through the gate on their own (Walker et al, 2007), showing that flight zones can be positively affected by continued calm handling.

The above described process was similar to the "weaning training" practiced in the current study. The current study uses the concept of training cattle to walk past a handler and that doing so will not result in a negative experience. This concept seems to be the most effective and important aspect for positive results.

Other research done at weaning time has shown that calves can be trained at certain tasks for improved efficiency in the future and reduce stress. In one such study, calves were trained at weaning to load onto a trailer. At a later date the calves were again loaded onto the trailer. The trained calves showed less adverse effects measured by heart rate, plasma cortisol levels, non-esterified fatty acids, and creatinine phosphokinase activity. The trained calves also loaded onto the trailer in less time with less protest (Fukasawa, 2012).

III. Purpose and Objectives:

Purpose

The purpose of the study was to determine the benefits of LS cattle handling used in conjunction with weaning training to the cow/calf producer in central Virginia. The study was important as it employed LS cattle handing techniques and determined its benefit during the most critical time in a calf's growth and development as well as the most critical time for the cow's reproductive success, synchronization and breeding time. This trial will attempt to determine if the LS techniques have an economic impact on the producer's operation by lowering the stress response in the calves during the weaning process, increasing weight gain and/or decreasing weight loss post-weaning. This research, if proven effective, will help to encourage producers at the heart of the beef industry to not only use genetic selection for calmer temperaments, but to also handle their livestock with methods which promote calmer temperaments for the benefit of the whole beef industry and final beef product.

Objectives

The objective of this study was to define the benefits and assist in finding successful ways of implementing LS handling techniques at the roots of the beef industry. This will benefit all segments of the beef industry by improving gain and product quality, as well as animal welfare and public perception of the beef industry. It will also potentially affect reproductive success in cows.

IV. Materials and Methods

Materials

The locations being used for the research and collection of data were Brunswick Women's Correctional Center in Lawrenceville, Virginia, and James River Correctional Center in Maidens, Virginia. There were two designated groups of handlers from each correctional center. One handler group was the control (C) and handled cattle as they had always handled cattle. The C group handlers only handled the C group of cattle and were not present in the pen area during the times when the experimental (low stress, LS) group was being worked, in order to decrease potential bias. The person working the head chute was randomly assigned and not from any particular group, as they had little interaction with the cattle. Another group of handlers were assigned to working the LS group of cattle. They were trained by watching disk one of the Bud Williams, Stockmanship 4 disk DVD set as well as participating in a two hour hands-on handling training session demonstrating weaning training and LS techniques discussed in the Stockmanship DVD. At Brunswick this training occurred on November 5, 2013, from 9:30 am to 1:00 pm. At James River this training was scheduled for September 30, 2013, to prepare for a short independent study examining calf activity after subjecting calves to the LS handling and weaning training on the day of weaning. Due to unforeseen circumstances this training had to be postponed. The video was viewed at their convenience and the hands-on session was postponed and discussed during the independent study. Following the independent study, there was a change in work force and the LS group was diminished to two people for Day -166. A third handler was added and viewed the video and a short hands on session was conducted with the low stress group on Day -159.

Each time the cattle were worked handlers were scored by Virginia Cooperative Extension professionals to evaluate noise level, contact with the livestock, arm movement, and speed of movement (Table 1:1). Scoring took place each time cattle were worked from November 26, 2013, to June 10, 2014, for James River cattle and from November 26, 2013, until June 4, 2014, for Brunswick.

Table 1:1 Descriptions of Scoring of the Behavior of the Cattle Handlers.

Score	*Description of handler's behavior*
1	walks slowly, no voice, no hand or arm movements
2	walks slowly, some low voice, some hand and/or arm movements, some brisk paced movements
3	fast and slow movement, hand and arm movement, raised voice
4	fast movement, hand and arms flailing, yelling, beating on animals

Cattle were of Angus cross breeding from two separate herds in Virginia. The Brunswick herd was separated into four groups, two C groups and two LS handled groups. The James River herd was separated into two groups, one C and one LS group. Numbers are represented in Table 1.

Table 1:2 Trial Cattle Numbers

Group	Pasture	Cow Numbers	Calf Numbers
Brunswick C 1	Pasture 1	21	19
Brunswick C 2	Pasture 2	36	35
Brunswick LS 1	Pasture 3	37	36
Brunswick LS 2	Pasture 4	21	18
James River C (A1)	Pasture S1	58	56
James River LS (A2)	Pasture S2	60	60
Trial C		115	110
Trial LS		118	114

Each time the calves were worked, activity scores were observed and recorded by Virginia Cooperative Extension professionals on the group of calves, as well as on three randomly selected calves. Scoring emphasized noise level, pacing activity, speed of movement, and mouth panting or foaming (Table 1:3). Weights were taken at normal recording times with one additional weight being taken on Day 4 post-weaning to allow for weaning week loss/gain and weaning month loss/gain calculations to be taken.

Table 1:3 Descriptions of Scoring of Calf Behavior in the Pen.

Score	Description of calf behavior
1	lying down, eating, drinking, relaxed
2	walks slowly around pen, occasional bawling, not at fence, visits bunk occasionally
3	walking along fence with occasional bawling
4	running fence line, bawling constantly, agitated, mouth foaming, not visiting feed bunk
5	excited, runs fence line, continuous bawling, foaming at mouth, running into or jumping fence, not visiting feed bunk

Brunswick Treatment

For the LS cattle handling and weaning training research at Brunswick Correctional Center there were four Groups, Mixed group A (field 1), AI group 1 (field 2), AI group 2 (field 3), Mixed group B (field 4). Cows were randomly assigned to each, taking into account the mixed groups that needed to have an equal number of bull bred cows and heifers. Fields 1 and 2 were the C groups with no special parameters and handlers that had not gone through any special handling training. Fields 3 and 4 were the LS groups and handlers completed a short training session in LS cattle handling techniques and calves were trained for weaning. The four groups remained separate until the bulls were removed in the spring. At this time the C groups were combined and the LS groups were combined for efficiency purposes. The same handlers were used for the groups each time they were worked. This included pen and alley work, but chute work was performed by a handler from the other group due to workforce availability and their minimal contact with the cattle. The C group consisted of the farm manager and three female offenders. The assistant farm manager was the leader of the LS group which consisted of two female offenders.

Each time a group was worked multiple designated observers, local Virginia Cooperative Extension professionals, scored cattle activity and handler activity according to scales described in Tables 1:1 and 1:3. Prior to scoring, three calves were randomly identified and scored separately. A group score was assigned at the same time. All record keeping on cattle was done as usual and according to management standards for the farm. At weaning time (Day 0) the three randomly selected calves from each group were fitted with pedometers (Fitbit Zip™; Fitbit, Inc., San Francisco, CA) on their right front leg. All cattle were weighed on this day. Daily recordings were obtained from the equipment as described in a separate paragraph under devices and technology. On the following Friday, May 9, 2014 (Day 4), the pedometers were removed and all cattle were reweighed. Calves were then reweighed a third time at one month post-weaning to determine weight loss/gain at one week and at one month.

Brunswick calves were weaned by complete separation from the cows and moved to a pen not adjacent to the cows. They could slightly hear each other, but were not in sight of the cows. The pens were less than an acre in size and adjacent to the working facility. Upon weaning, the Brunswick calves were fed free choice hay and water, had access to limited grass and were fed ground corn from the Agribusiness Department's own mill. During the first week post-weaning (Day 0 through Day 4), calves were fed ground corn at a rate of approximately 3 lbs/hd/day. During the subsequent two weeks, this amount was increased 1.5 lb/hd/day for a total of 4.5lbs/hd/day. After this time, they were maintained at a rate of 6.25 lb/hd/day.

Brunswick Observations

The Brunswick LS group was able to keep the same personnel each time. The LS handlers did take some time to discuss their situation. Once they had some practice the cows and calves moved along more smoothly. They were quiet and kept hands in their pockets, at their side, or even on their coffee cups. The group did forget in the beginning to move the whole group between pens to train cattle to walk past the handler. However, they were reminded and each time thereafter completed the process entirely. The LS handlers tried hard and worked calmly and quietly and it transferred to both the cows and the calves. It seems the Brunswick LS handlers did understand the concept and completed the tasks efficiently.

There was some confusion on the part of the handlers that were to work the alleyway. Therefore, the first few times the alleyway was worked by the farm manager, who was part of the C group. This issue was remedied on the day of breeding. The LS group calmly worked the alleyway on breeding day and the cows from this point on worked more smoothly through the alleyway and ceased to balk at the chute, as they had previously done and as the C herd continued to do.

When calves were waiting on the cows to be processed, there was some bawling. The calves seemed fairly calm, however, and occasionally played and grazed.

The C group handlers used cattle sticks and rattle paddles. They used loud voices and flailed their arms at the cattle. The speed of movement of the cattle was noticeably faster and the cattle were more agitated during the process. There was more bawling of the cows and the calves. When the calves were waiting for the cows to be processed, it was observed that more calves bawled and stood at the gate, than in the LS group. There did seem to be a lot of yelling and unnecessary hitting of cattle in the alleyway as they entered the chute. Cows tended to balk at the chute or back up in the alleyway.

James River Treatment

For the LS cattle handling and weaning training research done at James River Correctional, there was a main artificially bred cow group, James River A, that was split into two groups for this study, James River A1 and James River A2. Cows were assigned to each group by the farm manager due to a timing issue with the herd records being submitted. Both groups were in close proximity to the same facilities through which both herds were worked. The LS and C were worked by two separate groups of handlers. Herd A1 was selected to be the C group, which was worked conventionally with no special parameters, and handlers had not gone through any special handling training. Herd A2 was chosen as the LS group and was worked by handlers that had completed the LS cattle handling training, and this LS group was trained for weaning. The same handlers were used with their groups each time that group was worked. This included pen and alley work, although chute work was performed by a handler from the opposite group due to workforce availability and their minimal contact with the cattle. The C group consisted of the assistant farm manager and three to four male offenders. The farm manager was the head of the LS group and it consisted of an assistant farm manager and zero to one male offender.   It is important to note here that the farm manager at James River correctional center, prior to this study, had attended educational sessions with Bud Williams and was familiar with LS handling techniques; therefore, most of the handlers at James River correctional were already implementing subtle LS handling techniques, such as slow movement, and not using raised voices.

Each time a group of cattle was worked, local Virginia Cooperative Extension professionals scored cattle activity and handler activity according to the scales in Tables 1 and 2. Prior to scoring, three calves were randomly identified and scored separately. A group score was assigned at the same time. All recordkeeping on cattle was done as usual and according to management standards for the farm.

At weaning time (Day 0) the three calves randomly selected calves from each group were fitted with pedometers (Fitbit Zip™; Fitbit, Inc., San Francisco, CA) on their left front leg. All calves were weighed on this day. On Day 4, the pedometers were removed. Daily recordings were obtained from equipment as described in a separate paragraph under devices and technology. All calves were then reweighed on Day 4 as well. Calves were then reweighed a third time at one month post-weaning to determine the weight loss/gain at one week and at one month.

The calves were fence-line weaned. Cows from both groups were moved to a field adjacent to two similar lots where the calves were then moved. This allowed the calves to be weaned with the cows being present, but restricted the calves from nursing, as the cows were on the other side of the fence from the calves. The calf lots were a couple acres large with lush forage. Upon weaning (day 0), the James River calves were fed a creep feed consisting of soybean meal and chlortetracycline. No hay was provided due to the abundance of grass forage in their lots. They were fed at a rate of approximately 1.7 lbs/hd/day on day 0, and approximately 3.4 lbs/hd on day 1 through day 4. After this time they were maintained at an amount of approximately 6.8 lbs/hd/day.

James River Observations

There were a few notable observations made on particular days at James River Correctional Center, mostly due to loss of LS handlers. On Day -166, observations were that the LS group was worked first and the crew was late getting them up. When the group was pinched for time they were less able to remain calm and consistent with LS methods due to the fact they felt the need to rush through the training. Cows and calves were not put through the weaning training process, but were separated more calmly than the C group. The lack of assistance on the LS group due to personnel changes also affected the way the group worked. Cows were loaded into the alleyway with the crowd gate and tub and continuously balked in the alleyway and resulted in force being used.

The C group was worked and even though the lead for the C group was not involved that day, the cattle were brought in, sorted, and worked fairly calmly. The sorting process was noticeably the most stressful process. Cows and calves were quick paced and gates hit cows and calves during sorting. Some panting of the cows and calves was observed. While the calves were waiting for their dams to be worked, there was slightly more agitation due to the harsher sorting conditions. Overall, both groups were similarly treated and had similar reactions to the treatments. With the addition of another handler to the LS handling group, a short demonstration of LS handling techniques was scheduled for the next research day, Day -159.

On Day -159, the researcher assisted with the gathering of the cows for instructional purposes. The cows were then put through the weaning training protocol and sorted after moving the whole group between the pens three times. Calves were then turned back out in the field. The tub and crowd gate were not used during processing of the cows. The researcher stayed with the handler working cows into the alleyway. Cows did not balk nearly as much in the alleyway on this day. Upon review of the calves in the field, about half were lying down. The other half seemed to be interested in the mineral tub. There were approximately four standing along the fence bawling. Others were stirred up during the observations by the scorers getting too close and the calves stood up and took notice, but did not seem agitated.

This procedure was not followed every time the cattle in the LS group were worked. In a few instances the cattle were immediately sorted; however, sorting was quiet and smooth. Reminders were given to move the whole group between pens first to teach cattle to walk past a handler and by the end of the study the LS handlers were working their group to protocol standards.

The C group baited their cows in using a tractor, honking horns, and sacks of feed. Some calves, including two of the randomly chosen calves were left in the field. Those calves, approximately eight, seemed to not be bothered by the commotion and continued to graze. The sorting process seemed to be the most stressful time for the cows, calves, and handlers. Yelling, arms flailing and even striking of the cows and calves did occur. Upon processing of the cows, a paddle was used, but stayed fairly quiet. The handler loading the alleyway was calm and quiet. However, he did always move to the back of the group to push cows towards the tub, which proved to be more of a challenge than that experienced with the LS handlers filling the alleyway from the front of the group. Three cows were put back in with the C calves before individual calves were examined. The one randomly chosen calf present in the pen seemed to be very calm. The two remaining random calves were left in the field and scored ones. All randomly chosen calves had a purple tag put in their ear for quick identification so scorers would not have to disturb the group.

On Day -157, the LS group cows were gathered with three handlers and the cows responded quickly to the process. The group was brought into the first pen, then moved to the second pen where some of the cows had already ventured. The group was then moved back to the original pen and calves were sorted to remain in the second pen. This shortened the procedure slightly. The handlers wanted to determine if loading the cows into the holding pen from the first pen would be easier. It was determined it was not, and during the next handling experience the cows were loaded from the second pen. Cows and calves were worked calmly and there was a slight hold up in loading the holding pen. Otherwise, the handling went very smoothly. One calf was noticeably lethargic and was treated. Another calf that had been noted earlier in the week to look lethargic was treated as well, but seemed to have recovered.

The C group was worked and again the most agitated time was during the sorting process. Cows and calves were bawling more often and some cows were visibly breathing hard due to the stress. The three randomly chosen calves in this group seemed to be the calmest calves in the group. Even though they scored 1's, the group scored higher.

On Day -156, it was not quite light yet when the LS handlers went to retrieve their group. The group was more spread out in the field and therefore took slightly longer to bring in, but still responded at a fairly quick rate. The group was moved between the pens and then calves were sorted. Each time a few calves did get through with the cows and were sorted off when putting the cows in the holding pen, with no incidences. One LS handler was missing due to a class. Therefore, some assistance was needed. The researcher assisted by bringing cows to the loading chute. The scorers did work a cut gate on the alleyway, which was necessary this time due to the fact that ear tag numbers were required prior to cows being in the squeeze chutes for breeding. An untrained student was standing on the catwalk with paper flapping, disturbing flow, and a scorer that was assisting with obtaining ear tag numbers began leaning over the alley way and grabbing cow's ears, disrupting the flow of the LS group and resulted in handling techniques that were harsher than the control groups methods. This will most likely affect the results of cow conception rates, as the cows were bred on this day. This proves that alleyway techniques are extremely important in the flow of cattle through the working system.

Devices and Technology

The pedometers used were the Fitbit Zip™ (Fitbit Zip™; Fitbit, Inc., San Francisco, CA). They can be found and purchased at many locations as well as online. The Fitbit Zip™ is a human pedometer, therefore step measurements were skewed slightly due to the cattle having four legs instead of two. However, skewed data would be similar for all Fitbit Zip™ pedometers and for all calves. Therefore, it was determined that the data would be sufficient. The Fitbit Zip™ was placed into a plastic bag and then put into a pouch that had been sewn onto a velcro leg band. The pedometers kept track of the steps taken in each 24 hour period until removed on Day 4. The Fitbit Zips™ also stored these daily steps for the five days the calves wore them. Fitbit Zips™ are able to store daily steps for up to 14 days. They were connected to their own separate Ipad® (Ipad®, Apple, Inc., Cupertino, CA), either an Ipad Mini® (4) or an Ipad 4® (1) via bluetooth for recording purposes. One Fitbit Zip™ was connected via Bluetooth to a Samsung Galaxy S4® smartphone (Samsung Electronics Co., Ltd, Ridgefield Park, NJ) due to the inability to locate and use a sixth iPad® without additional costs. Data was downloaded into the software program provided by the Fitbit Zip™; Fitbit, Inc., San Francisco, CA.

The calves at the two facilities were weaned on separate weeks in order for the same devices to be used at both facilities. The leg bands and pedometers were used on the Brunswick calves first. During this week, the LS calves seemed to be so calm immediately after weaning that they noticed the leg bands on the three chosen calves and began to lick the bands. Two of these bands were licked off on Day 0 and reapplied on Day 2. Times were recorded when the pedometers were reapplied and steps per hour were able to be recorded for Day 2 through Day 4 on those two LS calves. Due to this negative event, the James River calves were fitted with leg bands and then wrapped with a material that clings to itself (Vetwrap, 3M, St. Paul, MN) to prevent licking and loss of their leg bands.

All cattle at James River were weighed using Tru-Test scales (Tru-Test ®, Tru-Test Limited, Auckland, New Zealand) that were mounted under a Foremost Squeeze chute, Model 450W, with 30T manual headgate (For-Most Livestock Equipment, Hawarden, Iowa). All cattle at Brunswick were weighed using single animal chute weigh Tronix scales (Avery Weigh-Tronix©, Fairmont, MN) The squeeze chute the scales were mounted under was a W&W Beefmaster chute with manual scissor headgate (W&W Livestock Systems ©, W&W Manufacturing, Thomas, OK).

Methodology

A description of Low-Stress handling techniques that were employed in this research study:

Key Concepts to be followed:

- Use of the edge of the cattles' natural flight zones for movement
- Observe cattle's movement in reaction to handler and adjust as necessary
- No use of voice, cattle sticks, or prods
- Hands kept at the handler's side
- No use of direct eye contact unless necessary
- When line of sight is available, begin in front of the animal and walk past it to the rear of the animal.

When moving cattle through the chute:

- No use of voice, cattle sticks, or prods
- When line of sight is available, begin in front of the animal and walk past it to the rear of the animal
- Hand contact at the shoulder and stroke toward the distal end of the animal
- Last resort is to curl the tail and release pressure immediately upon movement in the correct direction

LS handling of cows and weaning training is explained in the following paragraphs. Also reference the video files. Links are supplied in appendix III of this thesis.

Weaning training consisted of an exercise performed each time the cows and calves were sorted for normal scheduled management work sessions. Weaning being day 0, for Brunswick this consisted of six handling experiences on day -159, day -152, day -150, day -

149, day -89, and day -34. For James River this consisted of six handling experiences on day -166, day -159, day -157, day -156, day -95, and day -37. The cow/calf pairs were quietly brought in from the field to a holding pen. Then they were quietly moved into a pen that was adjacent to the current holding pen by working the front of the herd from the exit gate. The whole group was quietly moved from the first pen to the second pen with the key concept being to teach the cattle to walk past the handler. If an animal moved too quickly the handler would back up with that animal, using parallel movement to slow the animal down. If the cattle were not calm, the whole group would then be moved back to the first pen following the same procedure with the same concept. Finally, if calm, the cows would be allowed to move to the second pen again, and the calves would remain in the first pen, gently stepping in front of each calf that tried to exit. If any calves mistakenly were let by during the sorting process, there was no attempt to stop the calf, unless easily done at the walk. The handler or another handler would go retrieve the calf and bring it back to the original pen at a walk at a later time.

The cows and calves would remain separate until the cows were finished being processed. The calves would either be returned to the original pasture or held in a separate pen prior to the cows being returned. This process was done each time the cows were worked prior to weaning. This included artificial insemination synchronization, breeding, and pregnancy checking. Throughout the study, cattle working sessions only occurred at times when normal working sessions would have occurred. The treatment LS cow/calf pairs were not worked more days than the control for the weaning training process.

Statistical Analysis

Data were entered into Microsoft Excel ® (Version 2010, Microsoft Office, Microsoft, Inc., Redmond, WA) to organize and figure results. Statistical analysis and figuring was done using JMP Pro® software (Version 11, SAS Institute, Cary, NC). Analysis of variance was performed on the data recovered from weight measurements using the means of the LS and C groups. A regression model was run on the weight measurements using least square means for comparison, which included parameters for treatment, location, weaning weight, and the gender of the calves. Days at weaning and the different fields were originally run in the model and were found to have no statistical significance, so were removed from the model. Initially, weaning weight was not in the model which resulted in a difference in location and gender. However, once weaning weight was added it rendered the difference in location and gender insignificant. Location and gender remained in the model. Significance level was $p < 0.0001$.

Multivariate analysis of variance with repeated measures was performed on the pedometer readings as the twelve individual calves' average steps per day were used as multiple variables in the population analysis. Significance level was set at $p < 0.01$.

Limitations and Extraneous Variables

The turnover of offenders working in each group was an issue for this study at James River Correctional. The LS group lost handlers a few times and required this group to either work understaffed or with new people that had to be trained again and left an inconsistency in the LS workforce. However, this did not interfere with the calves being handled as desired and the calves' response to the weaning training. There was some interference with the way the cows were handled on the day of breeding, Day -156, due to the turnover of staff at James River, which is explained in the AICR results. There was also a certain amount of bias at both facilities due to the C handlers gravitating towards more quiet working conditions due simply to the concept of the study.

The most difficult aspect of this research project was the instruction of LS handling techniques to Virginia Department of Corrections Agribusiness workers and their successful implementation of those techniques on a consistent basis each time the cattle were worked. There was a frequent rushed feeling the handlers felt, which resulted in an inadequate process, and/or technique. The handlers did, after some practice, become efficient in the LS handling techniques and weaning training process.

Extraneous variables might include, but are not limited to, the docility scores of bulls used that affected the genetic predisposition of the calves in the study. The docility of the cows also affected the genetic predisposition of the calves and created a circumstance of "learn by example" for the calves. Weather conditions could have affected the activity levels of the cows and calves on certain days. Some days were cooler and rainy and there was noticeably more activity and playfulness on these days. The same facilities and similar fields with similar distances from the facility were used for each group at the correctional centers and, therefore, should not have had a significant impact on the study.

V. Results and Discussion

There were differences in weight changes for the C and LS treated calves for the week and the month post-weaning ($p < 0.001$). Raw data is provided for handler scores, calf scores, AICR, weight gain, and pedometer readings for each location as well as for the combined trial.

Statistical analysis was done on the trial using the combined data from both locations for weaning week and weaning month weights and pedometer readings. Tables and plots of the statistical data are provided in appendix II of this thesis and explained on the following pages. Scoring is as described in Tables 1:1 and 1:3.

Brunswick Results

Figure 2:1 includes the handler scores that were given by the Virginia Cooperative Extension professionals over the course of the treatment from November 2013 to June 2014. The C group handlers are represented by burgundy and the LS group handlers are represented by blue. The LS group handler scores received considerably more 1s and had some 2s, whereas the C group handlers scored more 3s and covered a range of 2 through 4.

Calf activity scores are displayed in figure 2:2. The C calves are represented in shades of burgundy and the LS calves are represented in shades of blue. In response to the handler activity scores, the LS individual calves and group as a whole scored more 1s and 2s, than the C group calves which were more spread out but predominantly scored 3s and 4s.

Figure 2:1 Brunswick Handler Scores

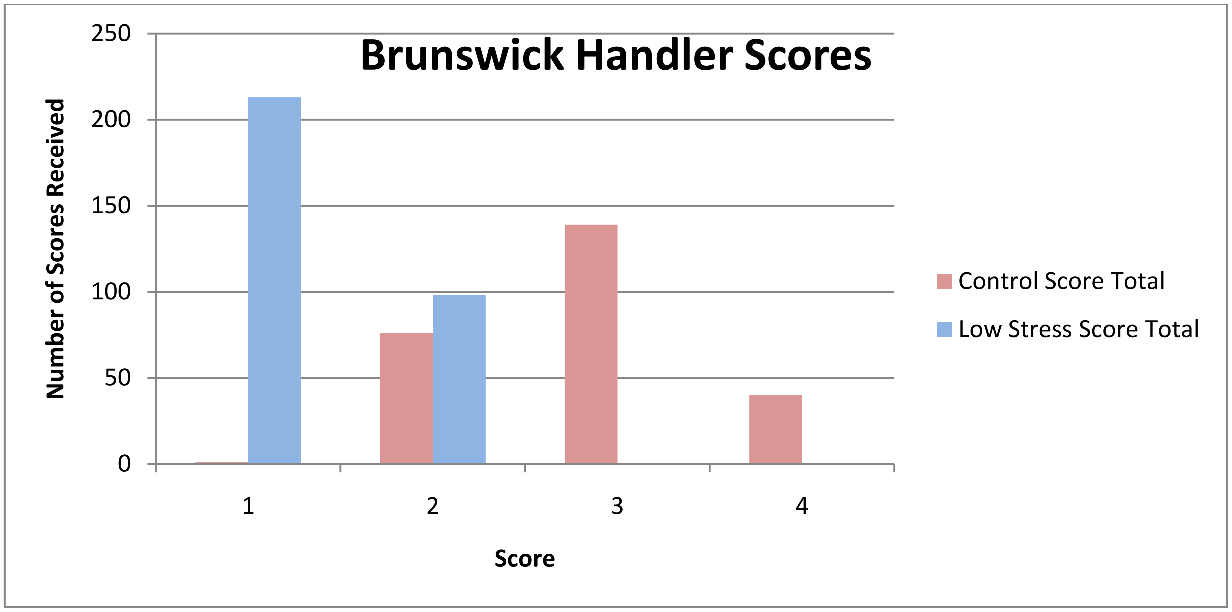
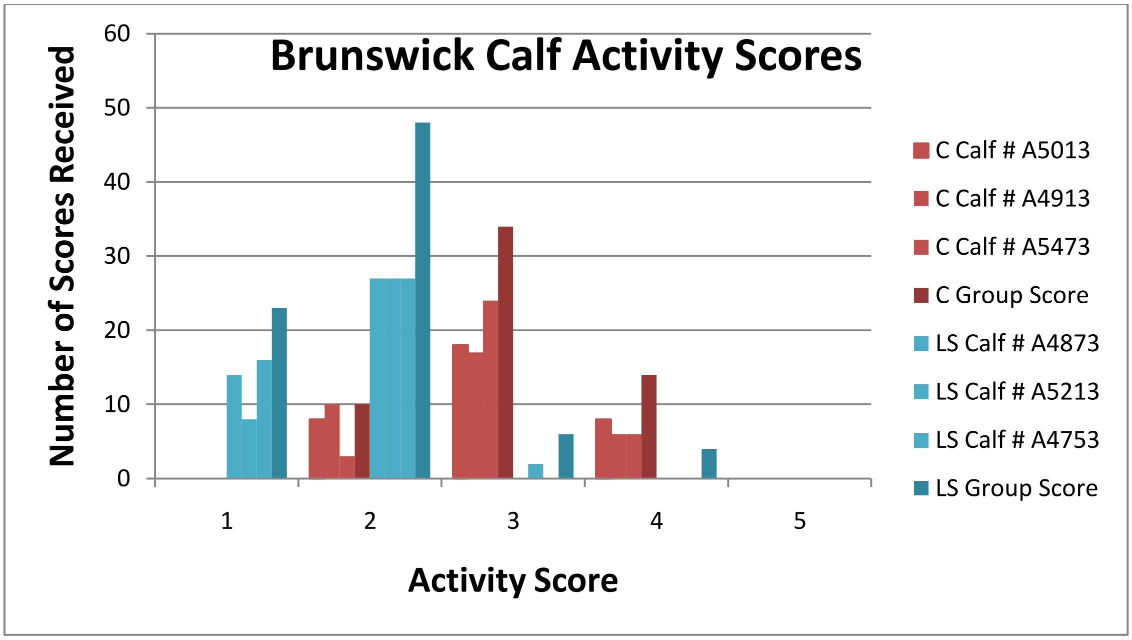
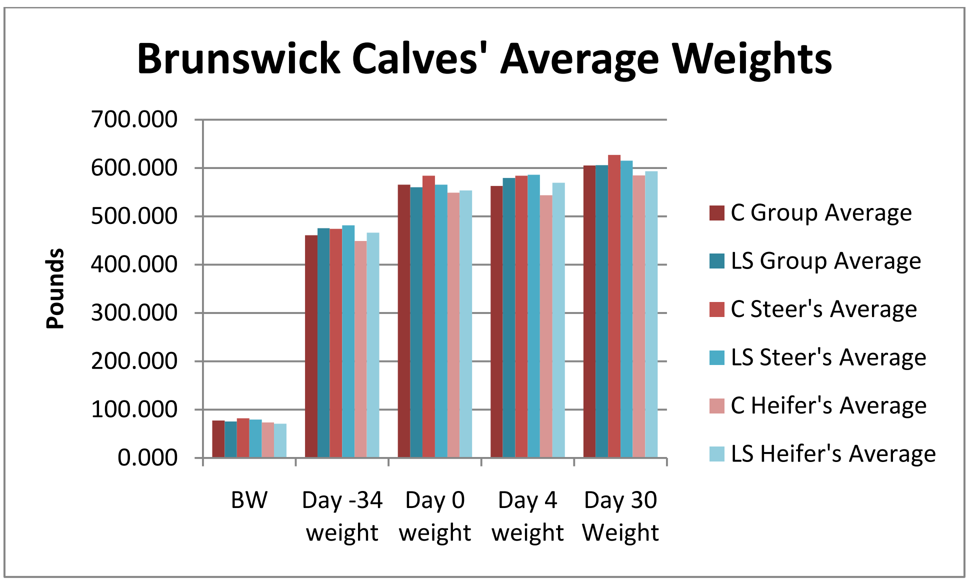


Figure 2:2 Brunswick Calf Activity Scores



The average weights for the steers, heifers, and as a whole group, each time the calves were weighed throughout the study are represented in Figure 2:3. The C calves are represented in shades of burgundy and the LS calves are represented in shades of blue. The average weights at birth are numerically similar; however, the C (Burgundy) groups are slightly higher, which continued at similar numerical values throughout the study. However, from Day 0 to Day 4 the LS group showed an observable weight increase over the C group. The C group steers compensated slightly after the first week post-weaning. This could be due to the weaning stress wearing off with time and those calves regaining at a faster rate due to compensatory gains, as those steers were initially at a higher weight upon weaning, explaining why the C group closes the weight gap on the LS group. The heifers demonstrated the most benefit as the LS heifers were initially lower in weight; however, they finished the month post-weaning with a numerically higher average weight.

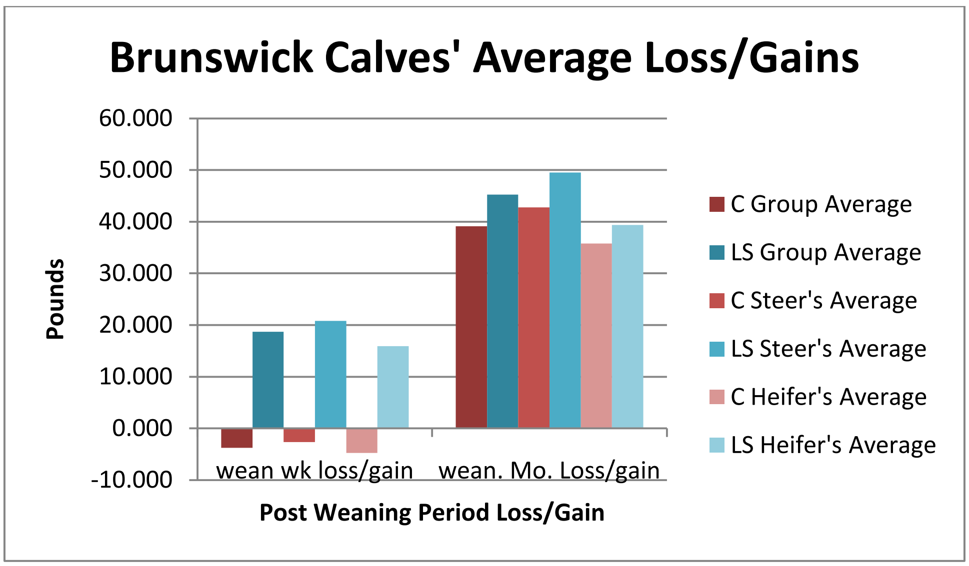
Figure 2:3 Brunswick Calves' Average Weights



Group (# of individuals)		BW	Day -34 weight	Day 0 weight	Day 4 weight	Day 30 Weight
C Group (54) Average		77.26	461.00	565.59	562.57	604.74
LS Group (54) Average		75.46	474.96	560.33	579.04	605.56
C Steer's (26) Average		81.81	474.08	583.92	583.60	626.69
LS Steer's (31) Average		79.26	481.42	565.36	586.13	614.90
C Heifer's (28) Average		73.04	448.86	548.57	543.79	584.36
LS Heifer's (23) Average		70.35	466.26	553.57	569.48	592.96

Figure 2:4 illustrates the average weight loss and/or gain for the steers, heifers, and the whole group for first week post-weaning and then also for the whole month post-weaning. The C calves are represented in shades of burgundy and the LS calves are represented in shades of blue. The first week shows that there is a weight loss associated with the C group and the opposite in the LS group, which gained well during the post-weaning stress response period. The C group calves averaged an almost 4 lb. loss over the first week post-weaning, where the LS calves averaged an 18 lb. gain. Observations during the week can explain these results.

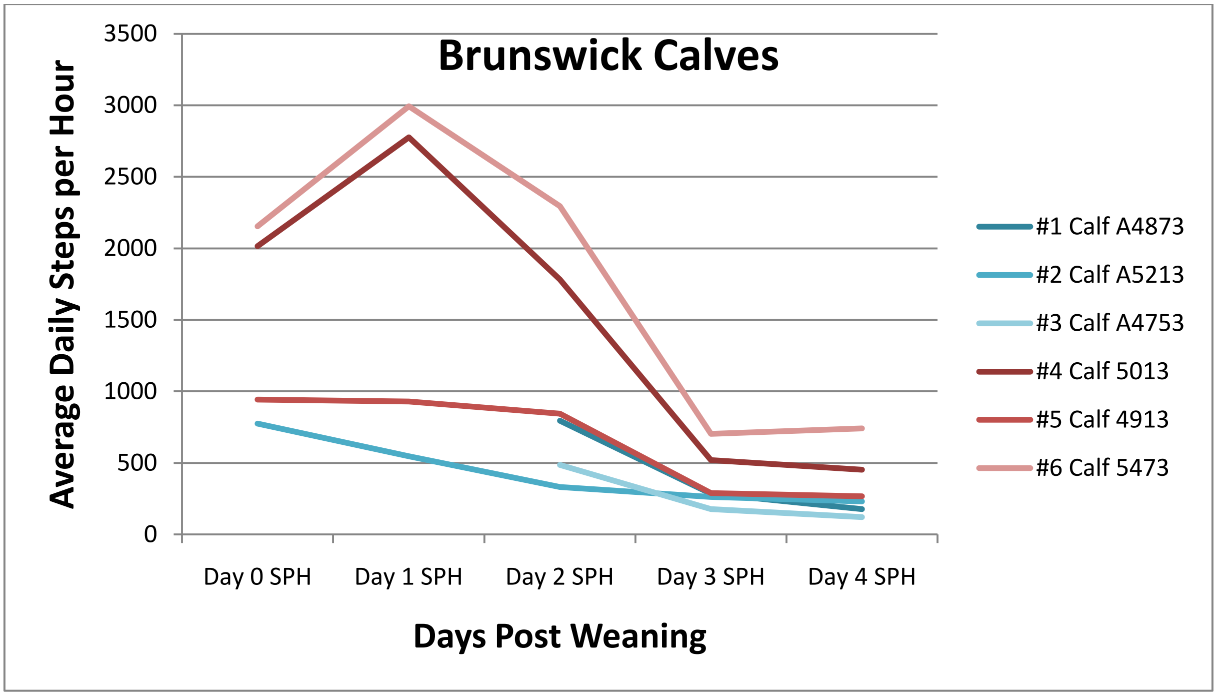
Figure 2:4 Brunswick Calves' Average Weight Loss/Gains



Group (# of individuals)	wean wk loss/gain	wean. Mo. Loss/gain
C Group (54) Average	-3.77	39.15
LS Group (54) Average	18.70	45.22
C Steer's (26) Average	-2.64	42.77
LS Steer's (31) Average	20.77	49.55
C Heifer's (28) Average	-4.79	35.79
LS Heifer's (23) Average	15.91	39.39

The C group calves were constantly moving, pacing from one end of the lot to the other and then back again. Some were at the hay bales, but the majority of the calves were participating in energy consuming behaviors during this week. The LS group calves were all eating at hay bales resulting in optimal gut fill, drinking water or standing at the fence-line curious about the scorers. The LS calves were observed showing less signs of a stress response due to weaning.

Figure 2:5 Brunswick Calves' Pedometer Readings in Steps Per Hour



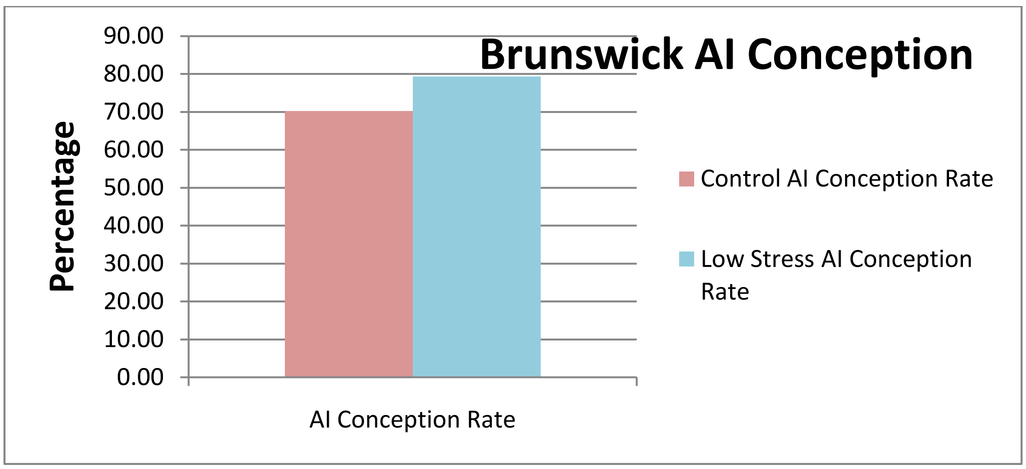
Brunswick Low Stress	Day 0 SPH	Day 1 SPH	Day 2 SPH	Day 3 SPH	Day 4 SPH
#1 Calf A4873			795.31	284.46	178.17
#2 Calf A5213	774.36	547.21	332.88	263.42	231.77
#3 Calf A4753			486.39	176.75	122.06
Brunswick Control					
#4 Calf 5013	2014.15	2776.79	1782.42	519.67	453.41
#5 Calf 4913	943.62	930.04	843.46	290.42	266.38
#6 Calf 5473	2152.69	2992.46	2294.71	704.54	740.94

Figure 2:5 represents the three randomly chosen calves' pedometer readings from each group, calculated in steps per hour (SPH) per day. The LS calves are in shades of blue and the C calves in shades of burgundy. This Figure is missing data, due to the fact that the LS calves were so calm after being weaned and put in the field that they were curious about the leg bands on the other calves. They began licking the Velcro and ultimately they licked off two of the leg bands. On Day 2, the two leg bands were found and fitted back to the calves at a recorded time so that SPH could be calculated on these two calves for Day 2. The activity level on the LS group calves and also one of the C calves was fairly quiet for the first four days and then all of the selected calves were much less active for the last two days. However, the LS calves still logged less SPH on these days as well. Two of the C calves had considerably more steps the first two days and represented what was observed for the entire group. One observation to note in the Brunswick calves' activity scores, was that during the week of weaning, when attempting to sync the pedometer data, the calves were so agitated and were pacing so rapidly, it took a considerably longer time to sync the pedometers with the Ipads® because the calves constantly came into range and then would move out of range before synching was complete. The constant pacing and movement corroborates information in the studies that indicated increased activity such as walking and/or pacing were indications of post-weaning stress (Weary Chua, 2000; Flowers and Weary, 2003; Price et al, 2003, Solano, 2007). The LS calves when being observed, scored, and pedometers synched, simply walked to the fence-line where the scorers were and stood there, curious about the scorers. They did not pace at all.

These calves were not fence-lined weaned. The LS calves were observed to walk less. It was also observed that at least two of the C calves, as well as most of that group, still experienced stress and were more inclined to move around and pace. This could explain the average weight loss of the entire C group, as this requires additional energy (Ribeiro, et al 1977) and left considerably less time for the calves to have their head down eating. Further study is necessary using additional pedometers to determine if this data statistically viable.

Figure 2:6 illustrates that the AI conception rate of the LS group is slightly higher than the C group. The AI conception rate at Brunswick Correctional Center was exceptional at 70%. However, the LS group was able to result in a conception rate of 79%. These are promising observations and more research is needed in the field of LS handling and its effects on reproduction in beef cattle to prove statistically viable results.

Figure 2:6 Brunswick Artificial Insemination Conception Rates



There was a slight negative energy balance resulting in lower BCS for the C group, shown in Figure 2:7; however, the BCS was still in a suitable range to produce exceptional AI conception rates. Figure 2:8 shows the LS groups' BCS. The LS group shows a more pronounced negative energy balance between the AI synchronization dates and pregnancy exams, yet it did not affect the AICR. Therefore, even with the lower BCS scores when compared to the C group cows, the LS group Cows resulted in a 9% higher AI conception rate. More research is needed in this area of reproduction due to handling techniques.

Figure 2:7 Brunswick Control Cows' Body Condition Scores

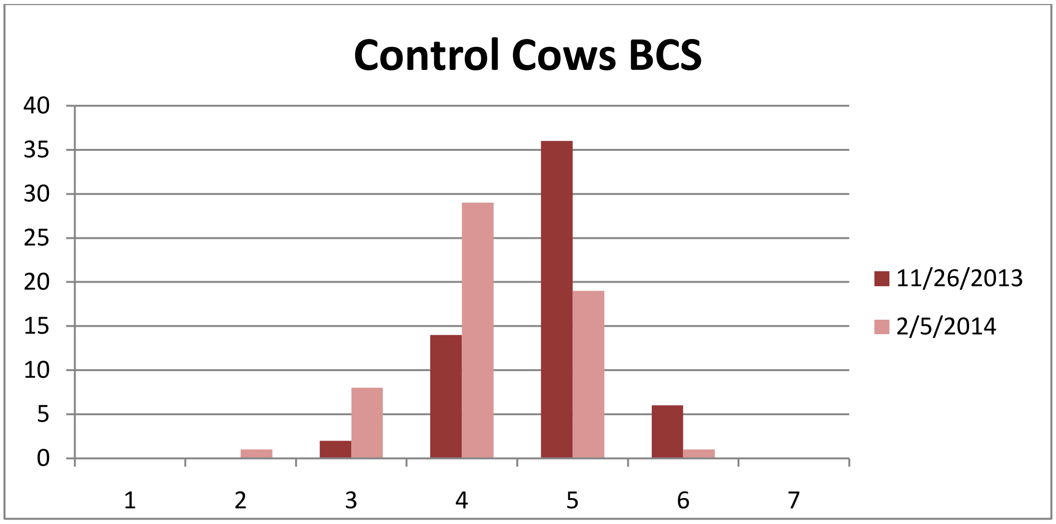
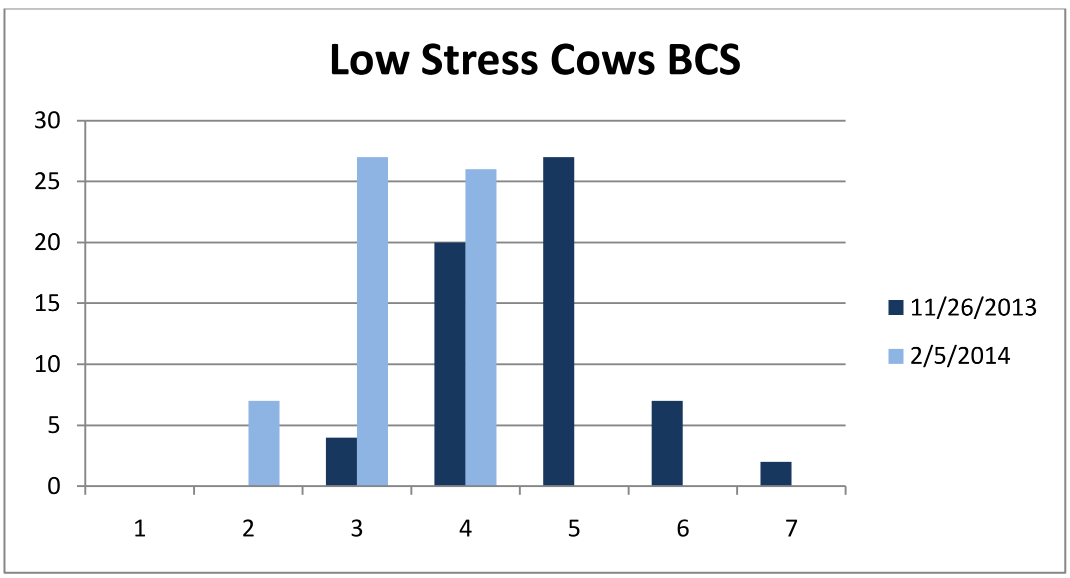


Figure 2:8 Brunswick Low Stress Cows' Body Condition Scores



James River Results

Figure 3:1 depicts the scores that were given by the Virginia Cooperative Extension professionals over the course of the treatment from November 2013 to June 2014 at James River Correctional. The C group handlers are represented by burgundy and the LS group handlers are represented by blue. The LS group handlers scored considerably more 1s and the C group handlers were more spread out, ranging from 2 through 4.

Figure 3:1 James River Handler Scores

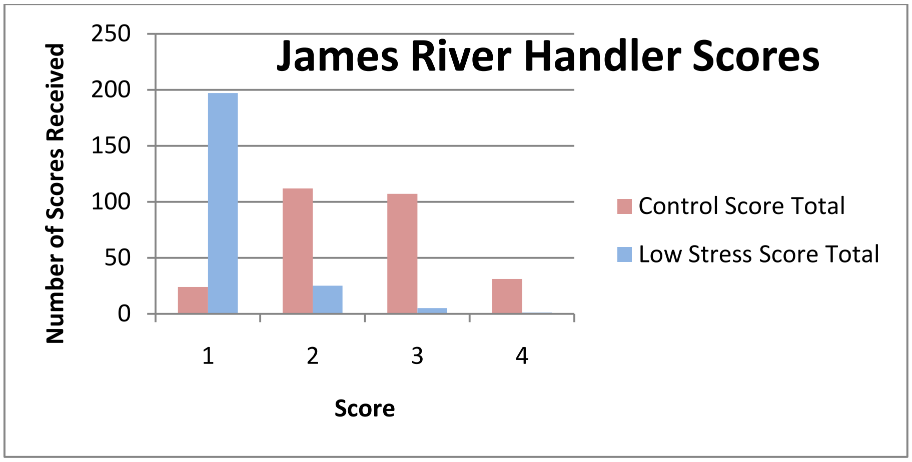
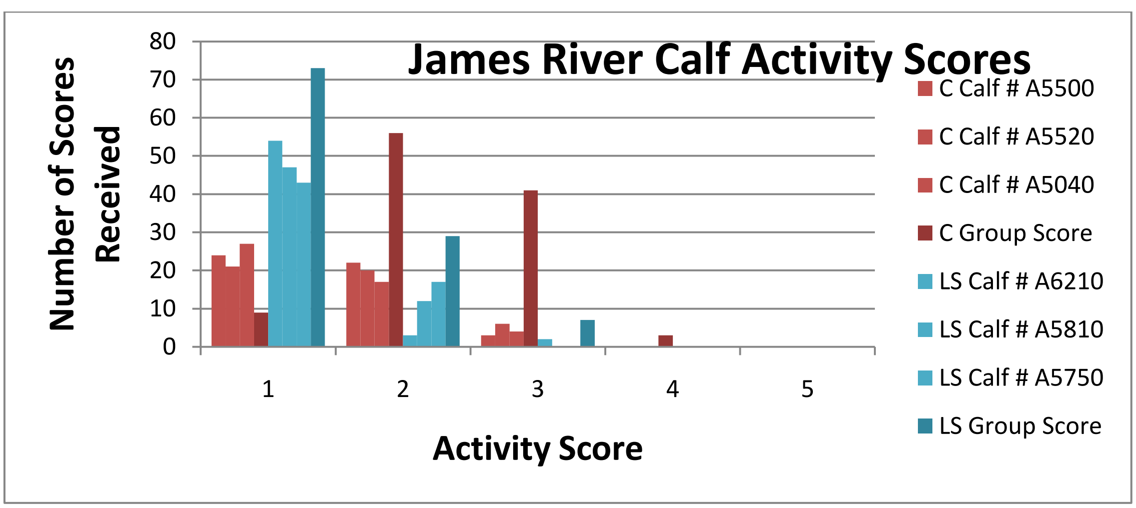


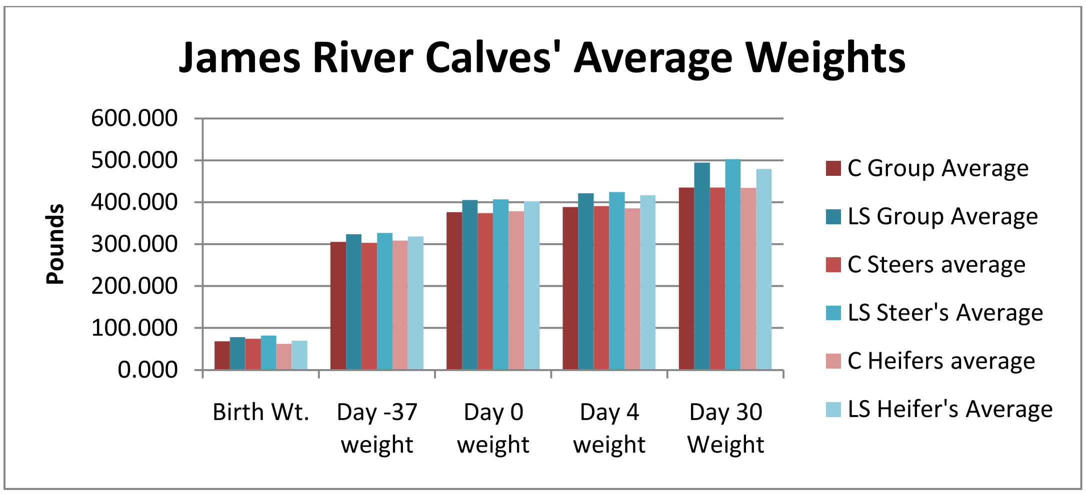
Figure 3:2 depicts the calf activity scores. The C calves are represented in shades of burgundy and the LS calves are represented in shades of blue. In response to the handler activity scores the individual LS calves and group as a whole scored more 1s, than the C group calves which were more spread out but predominantly scored 1s, 2s, and 3s. This can be explained by the fact that the James River Farm manager had previous training and initially all handlers at this facility worked more quietly and calmly. However, there was still an observable difference in the handling of the two groups, especially during the sorting process.

Figure 3:2 James River Calf Activity Scores



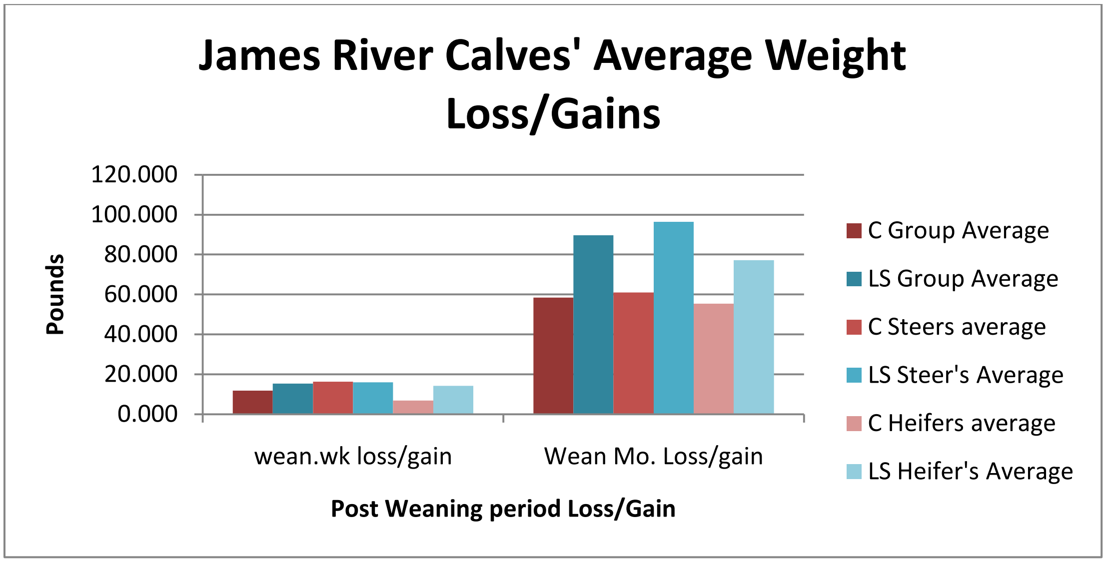
Figures 3:3 includes the graph and table of the average weights for the steers, heifers, and the group as a whole each time the calves were weighed throughout the study. The C calves are represented in shades of burgundy and the LS calves are represented in shades of blue. The average weights at birth are similar; although the LS (blue) group weights are numerically higher. Progressively throughout the study the LS group was observed to achieve higher gains, with the month after weaning being the time when the LS calves displayed the most noticeable increased gains when compared to the C group calves.

Figure 3:3 James River Calves' Average Weights



Group (# of individuals)	Birth Wt (lbs)	Day -37 weight (lbs)	Day 0 weight (lbs)	Day 4 weight (lbs)	Day 30 weight (lbs)
C Group (56) Average	68.53	305.71	376.30	388.18	434.71
LS Group (60) Average	77.93	323.72	405.07	421.39	494.70
C Steers (30) Average	74.38	303.50	374.17	390.47	435.13
LS Steer's (39) Average	82.13	326.74	406.49	424.03	502.85
C Heifers (26) Average	62.00	308.27	378.77	385.54	434.23
LS Heifer's (21) Average	70.14	318.10	402.43	416.62	479.57

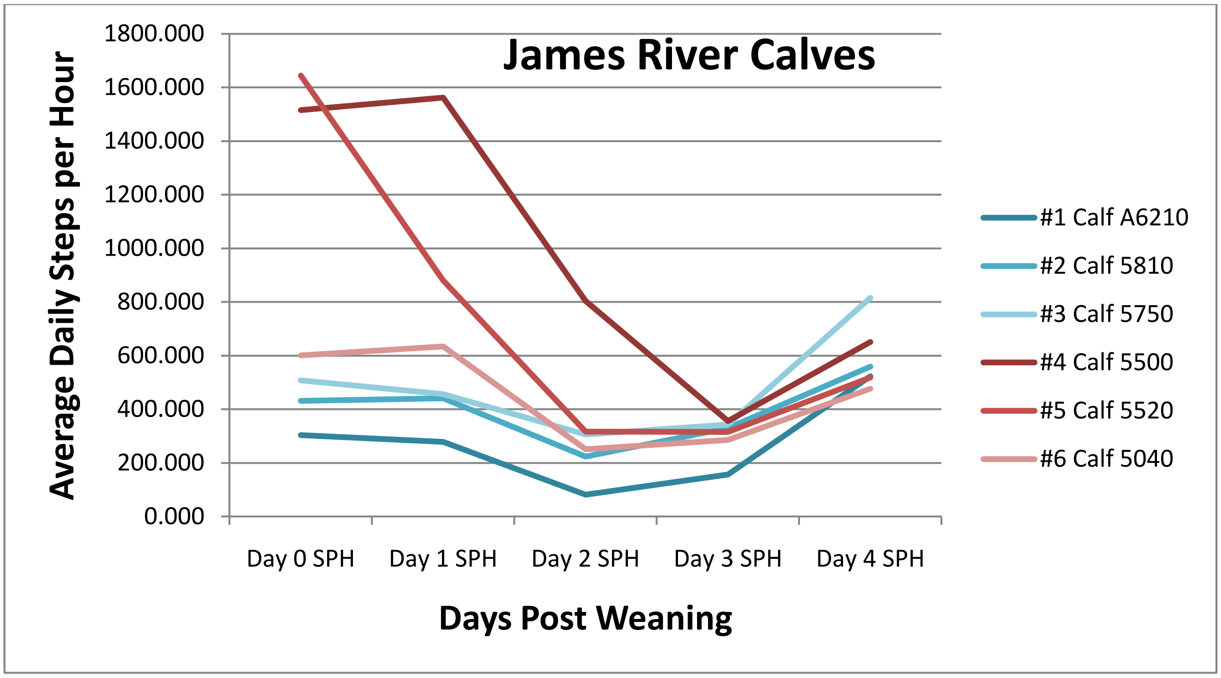
Figure 3:4 James River Calves' Average Weight Loss/Gains



Group (# of individuals)	wean.wk loss/gain	Wean Mo. Loss/gain
C Group (56) Average	11.88	58.41
LS Group (60) Average	15.32	89.63
C Steers (30) Average	16.30	60.97
LS Steer's (39) Average	15.95	96.36
C Heifers (26) Average	6.77	55.46
LS Heifer's (21) Average	14.19	77.14

Figure 3:4 depicts the observed average weight loss or gain for the steers, heifers, and the whole group over the first week post-weaning and then also for the month post-weaning. The C calves are represented in shades of burgundy and the LS calves are represented in shades of blue. The raw data shows that during the week post-weaning the C calves displayed a reduced average weight gain, where the LS calves showed higher average gains. This continued and was more pronounced through the month post-weaning.

Figure 3:5 James River Pedometer Readings in Steps per Hour



James River LS	Day 0 SPH	Day 1 SPH	Day 2 SPH	Day 3 SPH	Day 4 SPH
#1 Calf A6210	302.857	278.125	80.833	155.958	523.556
#2 Calf 5810	431.333	440.292	223.917	329.000	558.486
#3 Calf 5750	506.929	455.583	305.875	342.958	815.784
James River C					
#4 Calf 5500	1515.23	1561.83	804.13	355.42	650.80
#5 Calf 5520	1643.91	880.04	316.46	315.17	518.20
#6 Calf 5040	600.75	634.08	250.79	284.88	476.51

Figure 3:5 represents the three randomly chosen calves' pedometer readings from each group, calculated in SPH per day. The LS calves are in shades of blue and the C calves in shades of burgundy. The activity level on the LS group calves and also one of the C calves is fairly quiet for the first four days and then increases on the fifth day. The fifth day spike can be attributed to the gathering of the calves and bringing them back to the working facility to be weighed and pedometers removed. At this point the calves were about half a mile from the

working facility. Two of the C calves had considerably more steps the first two days, which may indicate that they experienced more stress immediately after the weaning process than the others. Since these calves were fence-line weaned and also expected to graze a large field, we would have assumed there to be less of an observable difference in steps taken between the groups; however, it was observed that at least two of the C calves still experienced stress and were more inclined to move around. This could explain the reduced weight gain of the C group calves as a whole.

At James River Correctional center the AICR variable did not have the hypothesized results. This can be explained by the drop in body condition scores observed from the time of calving and AI synchronization to pregnancy exams, as well as the rough handling and distractions in the alleyway on breeding day.

Figure 3:6 depicts the reduced AICR in the LS group cows, represented by the blue. The C group is represented by the burgundy. Figures 3:7 and 3:8, show that the body condition scores, which were also monitored, dropped considerably in the LS group. Additionally, on the day of breeding, the LS group handlers experienced a loss in workforce and had to depend on a few untrained handlers that unfortunately handled the LS group more severely than the C group was handled. A student untrained in LS handling was standing on the catwalk with paper flapping, disturbing flow and a scorer that was assisting with obtaining ear tag numbers began leaning over the alleyway and grabbing cow's ears, again disrupting the calm handling of the LS group more so than that which the C group was handled. This negative handling experience at the time of breeding coupled with a negative energy swing during the most critical time for reproduction could have impacted the AICR and reduced it considerably.

Figure 3:6 James River Artificial Insemination Conception Rates

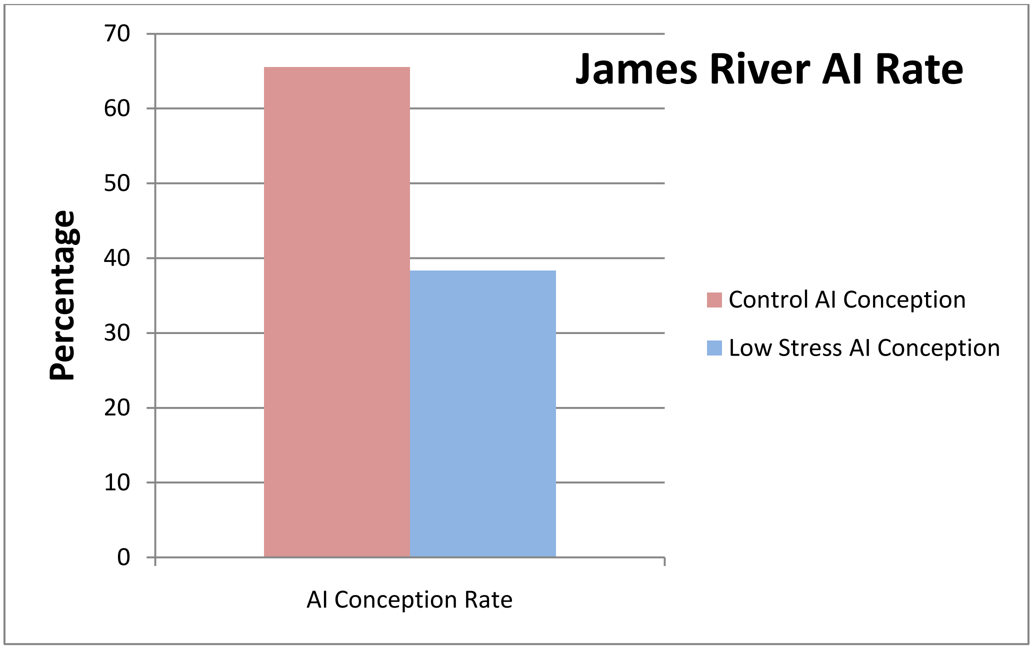


Figure 3:7 includes the BCS scores from 11/26/13 at the start of AI Synchronization, represented in the dark burgundy and then what the BCS was on 2/5/2014 upon pregnancy exam for the C cows, represented in the light Burgundy. The C cows did lose body condition, but were still a majority of 4s and 5s.

Figure 3:7 James River Control Cows' Body Condition Scores

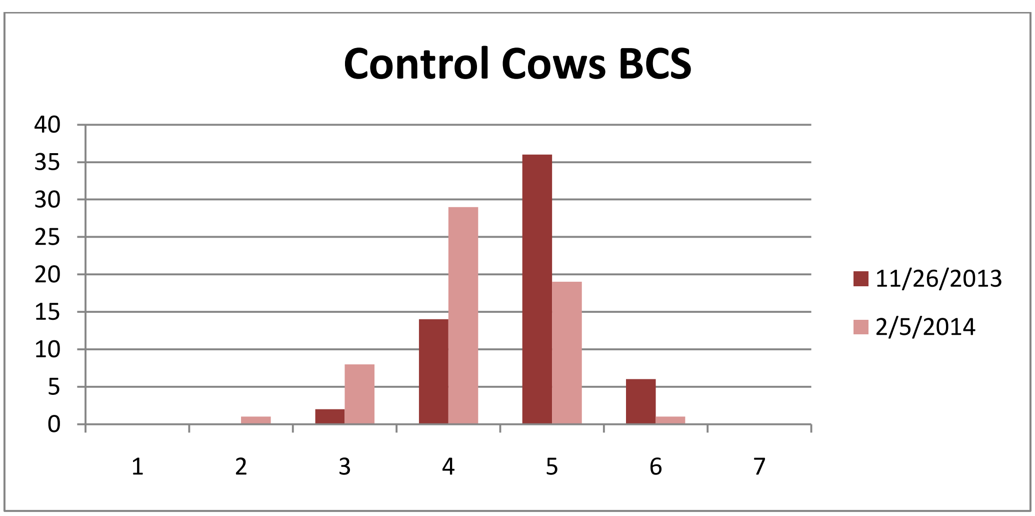


Figure 3:8 James River Low Stress Cows' Body Condition Scores

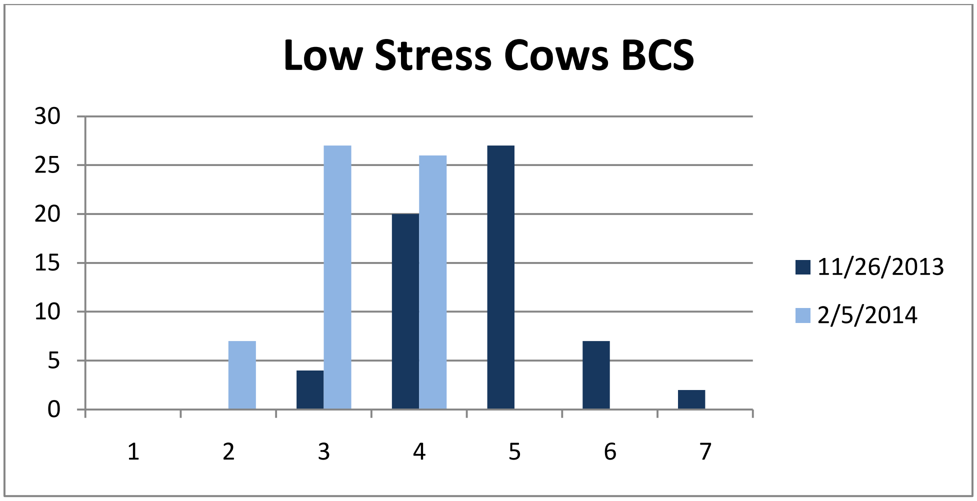


Figure 3:8 includes the BCS scores from 11/26/13 at the start of AI Synchronization, represented in the dark blue and then what the BCS was on 2/5/2014, pregnancy exam for the LS cows, represented in the light blue. These cows lost body condition scores of two to three scores within the span of just over two months. The majority of BCS scores at pregnancy exams were 3s and 4s, with a considerable amount of 2s.

Working Time Results

The time it took to work the calf groups on Day 4 of the study is represented in Figure 4:1. This does not include the weaning training process time for the LS calves or sorting process time for the C group. It does reveal that working cattle with LS techniques that may appear to take more time due to the slow, calm, and quiet movement is not the case and that tasks can actually be accomplished at a faster rate due to the cattle's willingness to cooperate when using their natural instincts to move them. The links to LS handling videos in Appendix III, Weaning Training 1, 2, and 3 demonstrates the amount of time it takes to do the training on a herd of cattle just being introduced to the method. The training and sorting process took approximately 40 minutes. This time would most likely be reduced with the cow herd being familiar with the process and can be compared to the time it takes to sort the calves from the cows. This time difference may be the cost the producers need to evaluate in determining the benefits of LS handling on their operation.

Figure 4:1 Day 4 Calf Weigh Times

Location, Group	Time Readings	Working Time
Brunswick C	8:02 to 8:36	34 minutes
Brunswick LS	8:40 to 9:12	32 minutes
James River C	9:25 to 9:57	32 minutes
James River LS	8:50 to 9:16	26 minutes

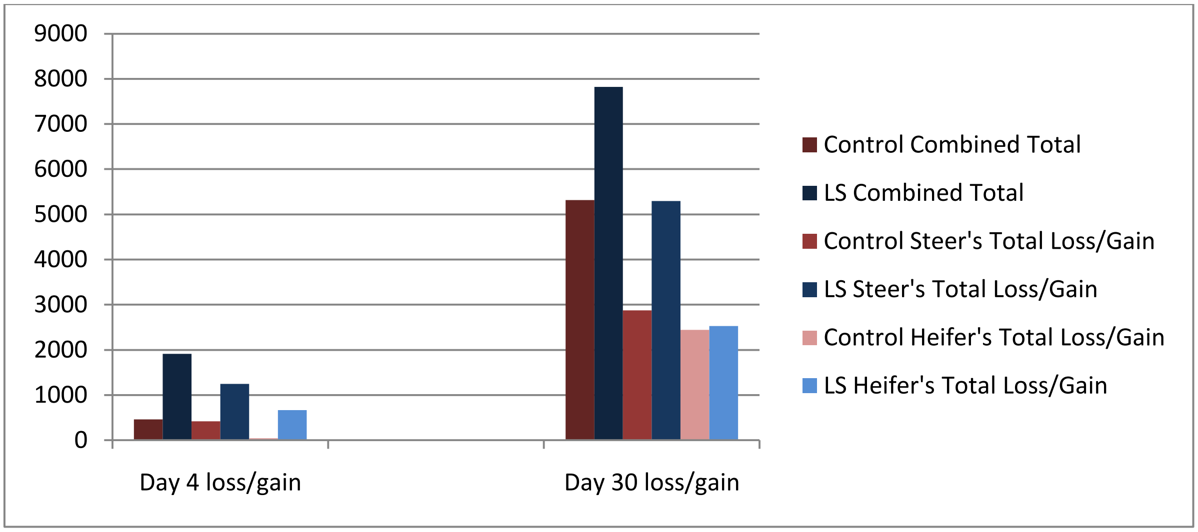
Statistical Analysis on the Combined Trial Data

Weight Results

The two locations were combined for statistical analysis. Doing so gave a total of 110 calves in the C group and 114 calves in the LS treatment group. The statistics were analyzed using JMP Pro® 11 software. Analysis of variance was performed on the post-weaning weight data and a regression model was run for comparison of the weaning week loss/gain and the weaning month loss/gain between treatment groups. In doing so parameters such as treatment, location, weaning weight, and the gender of the calves we used in order to minimize bias. Days at weaning, start weight, and field were also initially included in the regression analysis, however were found to have no significant affect, and removed from the model during further analysis.

Figure 4:1 and 4:2 represents the data found from the Day 4 and Day 30 weights that were analyzed using the treatment, location, weaning weight, and gender parameters. After one week of being weaned there was a difference in the weights of the two treatment groups at a P-value of < 0.0001. The C group had a minimal average gain of 4.38 lbs. from Day 0 through Day 4, where the LS group averaged a gain of 13.75 lbs. per head. This provides evidence that the experimental treatment of LS handling can have a positive effect on weight gain due to its ability to reduce the stress response during the weaning process. From weaning through Day 30 the LS group (68.6 lbs.) averaged a 20 lb. gain over those individuals in the C group (49 lbs.). This provides more evidence that the experimental treatment of LS handling can have a positive effect on weight gain due to the reduced stress experienced by the LS calves over the weaning process. This benefit can also extend not only through the first week, when stress response is at its greatest, but it also continues through 30 days post-weaning to a time when most producers participating in Virginia marketing programs are beginning to market their calves. The LS handling techniques and weaning training can effectively and efficiently compliment genetic selection and these marketing programs to increase gain and result in more pounds sold as weaned, preconditioned feeder calves.

Figure 5:1 Combined Trial Total Weights Post-Weaning



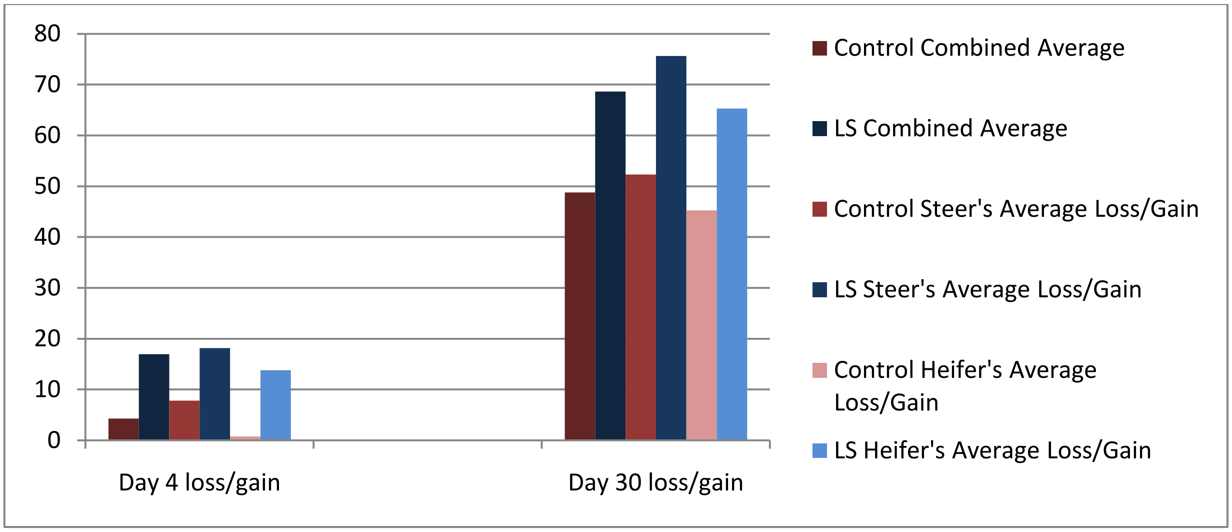
Group		Day 4 loss/gain		Day 30 loss/gain
Control Combined Total (110)		**463**		**5319**
LS Combined Total (114)		**1914**		**7820**
Control Steer's Total Loss/Gain (56)		**421**		**2875**
LS Steer's Total Loss/Gain (70)		**1250**		**5294**
Control Heifer's Total Loss/Gain (54)		**42**		**2444**
LS Heifer's Total Loss/Gain (44)		**664**		**2526**

Location had a significant difference at the $P < 0.0001$. However, this was due to the weaning weight differences. Therefore, when weaning weight was included as a parameter to the statistical model, it rendered location insignificant. Brunswick averaged a weaning weight of 550.26 lbs. for the C group and 559.8 lbs. for the LS group, for an average of 554.92 for this location. James River averaged a weaning weight of 376.3 lbs. for the C group and 405.07 lbs. for the LS group. This calculated to an average of 390.69 lbs. weaning weight for the James River calves. This can partially be attributed to the lack of nutrition at James River that was evident in the declining body condition scores of the cows represented in Figures 3.7 and 3.8.

The Brunswick groups gained an average of 7.57 lbs. in the week post-weaning and 41.86 lbs. in the month post-weaning, and the James River groups gained an average of 13.83lbs. in the week post-weaning and 73.46 lbs. in the month post-weaning. This weight difference in gains between locations can be partially attributed the James River calves being able to take advantage of increased compensatory gains due to lower BCS at weaning as well as the weaning methods. Brunswick calves were weaned by complete separation, where James River calves were fence-line weaned. Another factor that attributed to the weight gain differences is the comparison between the weaning environments at the two locations. The James River calves had access to lush pasture and grain, where the Brunswick calves were fed free-choice hay of varying quality, and grain.

The heifers did not observably gain as efficiently as steers as represented in Figures 4.1 and 4.2. There was a difference in the weight gain of the heifers compared to the steers at the $P<0.0001$ value on Day 4 and Day 30, which agrees with the Reinhardt (2009) study where average daily gain and final body weight was sex dependent. The heifers gained an average of 55.29 lbs. in the month after weaning. The steers gained an average of 63.95 lbs. in the month after weaning. The heifers gained 13.54% less than the steers. In the Zinn study (2008), it was found that steers' mean average daily gain was 1.57 kg. and heifers' mean average daily gain was 1.36 kg. Over one month this would calculate out to an approximate 13.8 lbs. difference when converted to pounds (1.36 kg. is approximately 3 lbs. and 1.57 kg. is approximately 3.46 lbs.). This is approximately a 13.3% less gain in heifers. This study agrees with past research that heifers will gain less than steers as a rule (Keane et al, 1990; Zinn, 2008) and did in both studies by approximate 13%. Once the weaning weight parameter was added to the statistical model, it rendered gender insignificant.

Figure 5:2 Combined Trial Average Weights Post-Weaning

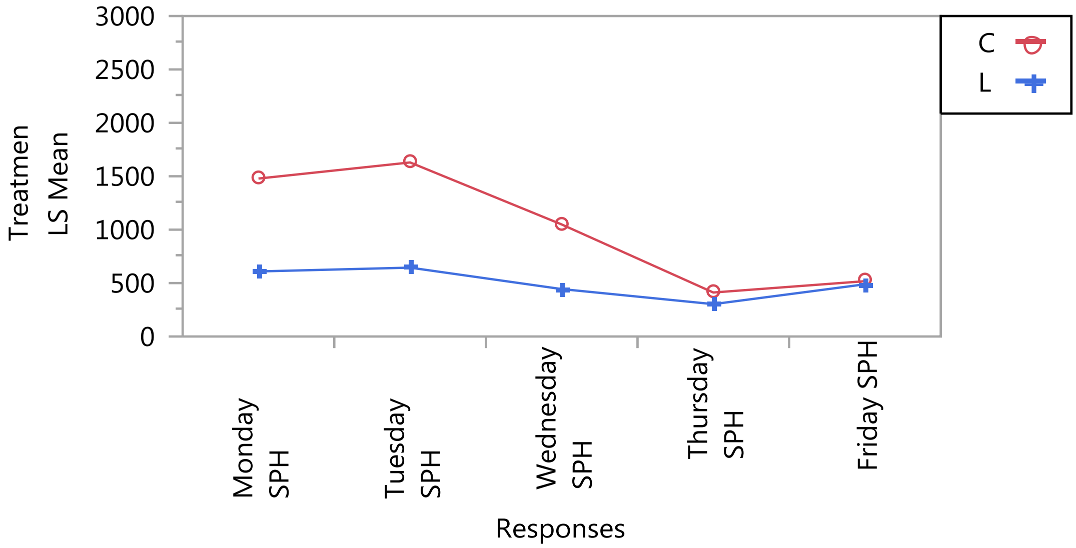


Group		Day 4 loss/gain		Day 30 loss/gain
Control Combined Total (110)		**4.29**		**48.80**
LS Combined Total (114)		**16.94**		**68.60**
Control Steer's Total Loss/Gain (56)		**7.80**		**52.27**
LS Steer's Total Loss/Gain (70)		**18.12**		**75.63**
Control Heifer's Total Loss/Gain (54)		**0.78**		**45.26**
LS Heifer's Total Loss/Gain (44)		**13.82**		**65.32**

Pedometer Reading Results

The statistical analysis that was performed on the pedometer readings was multivariate analysis of variance with repeated measures. The twelve individual calves' average SPH were used as multiple variants in the population analysis. Analysis was done over a linear scale from Day 0 to Day 4. To construct the linear combinations across responses the values of (N) = 10 for population, and degrees of freedom (DFE) = 7 were used. The significance level was set at $p < 0.01$.

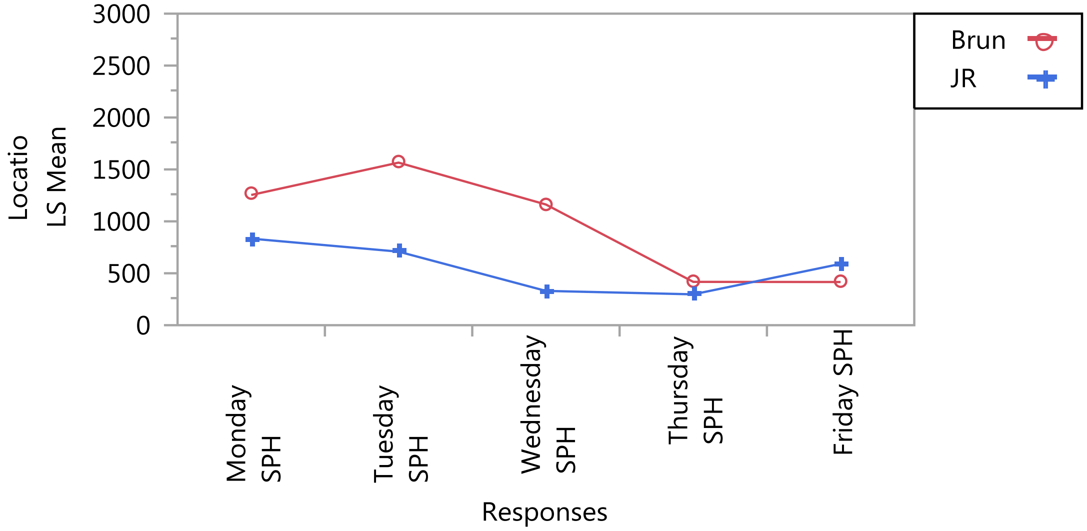
Figure 5:3 Treatment Effects on Pedometer Readings



Treatment	Monday SPH	Tuesday SPH	Wednesday SPH	Thursday SPH	Friday SPH
C	1478.39	1629.21	1048.66	411.68	517.71
LS	608.95	644.59	443.83	302.85	488.73

Figure 4:3 represents the graph and table of the results of SPH, determined by the pedometer readings for the calves by treatment. SPH for the week post-weaning was numerically higher for those calves handled conventionally and not trained for weaning. The C calves averaged 1048 to 1629 SPH for the first three days, where the LS calves averaged 443 to 644 SPH for the first three days. The fourth and fifth days the C calves slowed to 411 and 517 SPH and the LS calves 302 to 488 SPH. The fifth day saw an increase in SPH across all calves due to the calves being gathered, worked, and weighed.

Figure 5:4 Location Effects on Pedometer Readings



Location	Monday SPH	Tuesday SPH	Wednesday SPH	Thursday SPH	Friday SPH
Bruns	1253.85	1565.47	1162.16	417.30	415.88
JR	833.50	708.33	330.33	297.23	590.56

Figure 4:4 shows the results of SPH, determined by the pedometer readings for the calves by location. It was observed that the Brunswick calves took more steps than the James River calves, even though the Brunswick calves were penned in a smaller lot. This could be explained by James River practicing fence-line weaning, rather than complete separation, as Brunswick practiced. The last day showed a spike in SPH for James River calves. This resulted from gathering the calves from their few acre lots and bringing them the half mile back to the working facility for weighing.

Statistical analysis of the pedometer results shows a trend for the model to be significant; however, due to the limited number of pedometers, the sample size was not large enough to provide significant results for the current trial.

VI. Conclusions

This study shows that LS handling techniques and weaning training, even when mistakes are made and a cow herd is just being introduced to the techniques, can have a positive impact on weight gain in calves after weaning. It corroborates the behavior stress response of calves after weaning, through increased vocalizations and increased activity such as walking and/or pacing (Weary and Chua, 2000; Loberg et al, 2008; Price et al, 2003; Solano et al, 2007). The pedometer results had an observable difference in the activity level between the two treatments and suggests that the LS calves did not participate in a similar level of stress response, as the C calves did. These stress responses, experienced by the C calves require additional energy over maintenance (Ribeiro et al, 1977) and caused the C calves to experience significant, at the $P < 0.0001$ value, reduced weight gain one week and one month post-weaning when compared to the LS calves. There was a clear difference in post-weaning calf performance, measured by weight gain, between the C and LS handled groups. Therefore, the hypothesis that calmer cattle due to LS handling and weaning training can have a positive impact on weight gain performance is supported by the results of this study.

LS handling methods do have a financial impact on the cow/calf producer when price is calculated for the additional weight of the LS group. It is important to note that both the LS treatment group and the C group were fed the same amount of grain each time. The difference in weight gain can be attributed to the LS calves utilizing all the grain fed to them where there may have been some grain waste in the C group. The LS group at Brunswick may have consumed more hay than the C group and the LS group at James River may have consumed more forage than the C group. Producers must account for the additional feed costs due to increased hay/forage consumption.

Financial gains were calculated based on the numbers of the least square mean calculations for the month post-weaning loss/gain. The C group gained an average of 49 lbs. and the LS group gained an average of 69 lbs. per calf. In this example 25 lbs. will be used to match actual numbers from the local market and actual loads from the Buckingham Cattlemen's Association (BCA) VQA 2014 Tel-O-Auction. The fall of 2014 saw the most impressive cattle prices on record. The local market in central Virginia on August 5, 2014, received an average price of $2.0975/ lb. for calves averaging 727 lbs. A $0.04 slide was used in the BCA's 2014 Tel-O-Auction and is being used in this example. An extra 25 lbs. on the LS calves would calculate out to a reduction in price by $1.00 per hundred weight or $0.01 per lb. Therefore, for cattle that average 752 lbs. (25 lbs. over reported average market 700 weight cattle) would be sold for $2.0875/ lb. That is an increase of $44.9175/calf with the calculated slide taken into account. On 100 head that would be $4,491.75 more in the producers' hand with minimal additional input costs.

Figure 6:1 Calf Weight Economic Comparison

	C handled market sold	LS handled market sold with $0.04 slide	C handled VQA sold	LS handled VQA sold with $0.04 slide	LS handled VQA sold
Average weight	727	752	720	745	745
Price per pound	$2.0975	$2.0875	$2.60	$2.59	$2.5850
Price per calf	$1,524.8825	$1,569.80	$1,872	$1,929.55	$1,925.825
Price difference (C market)	0	$44.9175	$347.1175	$404.6675	$400.9425
Price difference (C VQA)			0	$57.55	$53.825

Using the prices received from the BCA's VQA Tel-O-Auction, which utilizes all the programs available in Virginia to market cattle and weans their cattle to receive premium prices, a load of 69 head of cattle that averaged 720 lbs. sold for $2.60/ lb. That calculates to $1,872 per calf. A calculation of the additional weight gain of the LS handled calves can be done using the $0.04 slide or it can be shown by an actual example from the BCA's sale where a load of 67 head of cattle averaging 745 lbs. sold for $2.5850/ lb. Using the slide the additional weight incurred a drop in price of $0.01/ lb. Using the example from the BCA Tel-O-Auction the additional weight incurred a drop in price of $0.015/ lb. However, with the additional weight the price still calculates to $1,929.55/calf with the slide and $1,925.825/calf if the calf was put on the load that averaged 25 more lbs. This is an additional $57.55 or $53.825/ head. LS handling increased the income on each calf by $45 in the local livestock market and approximately $55 in VQA marketed cattle.

On 100 head of cattle, the benefits equal $4,500 to $5,500 more in the producer's hand by using LS handling techniques over conventional handling and minimal input costs of slightly more hay or forage. If you combine the use of LS handling techniques with the marketing programs available to Virginia producers, the potential income increases can be $40,000 per 100 head of cattle. These prices demonstrate that utilizing LS handling techniques has the potential to increase producer profits with minimal added input costs of additional hay/forage.

It was also documented that the LS group usually worked with one to two fewer handlers and once they were familiar with the weaning training protocol, still managed to accomplish the tasks in a similar amount of time as the C group. This would be two fewer employees needed to accomplish these particular tasks that could be working elsewhere on the operation or not needed, saving in labor costs and production efficiency.

Implementing these handling techniques can also re-establish the beef industry's public appearance as good, wholesome, and family oriented. It will assist in giving farming and beef production a positive image and make it more acceptable for consumers. It is understandable that people have been more willing to purchase new and expensive equipment rather than learn to employ low-stress handling techniques even when there are clear benefits to cattle welfare and financial return (Grandin, 2003). The mindset and freedom to accomplish tasks without being judged or forced to change is important to the traditional farming community. The industry continues to be judged and society demands more, even though the farming community provides food for the world and the world cannot live without food. Producers still want to be free to work as they see fit and to seek increased production in their livestock. The concept of LS handling has relevance in helping the beef industry and producers in all aspects.

VII. Implications

It is important to understand the added benefits of LS handling techniques in the cow/calf operation. Not only will producers be creating an environment that is safer for the handler and the animal, but it also creates a better working relationship with society, the media, and ultimately the consumer. LS handling techniques can assist in increasing gain in cattle at the most crucial point in the cow/calf operation - weaning, bringing more dollars back to the producer with minimal additional input costs. LS handling techniques that are applied at the cow/calf operation can also enhance reproduction, health, and immunity. It can reduce stress and provide a calmer, more manageable animal for other segments of the beef industry to work with, as well as help to ensure better meat quality of the finished product. Producer profits, consumer perception, and consumer satisfaction will benefit from LS handling techniques when applied early in the life of cattle.

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Appendices

A. Combined Trial Raw Data

Pedo-meter	Calf ID	Dam ID	Calf Birth Date	Sex	Birth Wt.	4/4/14 weight	5/12/14 weight	5/16/14 weight	wean wk. loss/gain	6/10/140 Weight	Wean Mo. Loss/gain	Location Group
	A5460	N0143	9/10/2013	H	72	356	403	417	14	476	73	JR C-F1
	A5220	N0513	9/4/2013	H	62	428	512	516	4	540	28	JR C-F1
	A5210	N1421	9/4/2013	H	65	372	445	443	-2	482	37	JR C-F1
	A5320	O667	9/7/2013	H	64	307	369	385	16	418	49	JR C-F1
	A5590	P7100	9/12/2013	H	57	264	338	347	9	403	65	JR C-F1
	A5280	R0919	9/6/2013	H	54	382	480	476	-4	536	56	JR C-F1
	A5570	S1	9/12/2013	H	76	360	461	444	-17	502	41	JR C-F1
	A5240	T1	9/5/2013	H	52	359	455	456	1	532	77	JR C-F1
	A5470	T3109	9/10/2013	H	61	355	392	426	34	458	66	JR C-F1
	A5410	T5903	9/9/2013	H	85	401	468	469	1	520	52	JR C-F1
	A5310	W4670	9/6/2013	H	65	379	475	475	0	518	43	JR C-F1
	A5510	W4770	9/10/2013	H	83	398	483	489	6	586	103	JR C-F1
	A5620	X0738	9/12/2013	H	72	199	230	254	24	275	45	JR C-F1
#4	A5500	X1033	9/10/2013	H	56	205	280	300	20	344	64	JR C-F1
	A5390	X1183	9/8/2013	H	58	322	388	379	-9	411	23	JR C-F1
	A5430	X248G	9/9/2013	H	54	270	362	378	16	415	53	JR C-F1
	A5550	X5229	9/11/2013	H	76	329	417	395	-22	473	56	JR C-F1
	A5370	XX090	9/6/2013	H	56	297	372	387	15	438	66	JR C-F1
	A5480	XX590	9/10/2013	H	74	268	350	357	7	436	86	JR C-F1
	A5090	YY1130	8/24/2013	H	62	225	263	272	9	303	40	JR C-F1
	A5140	YY200	8/27/2013	H	42	216	280	285	5	312	32	JR C-F1
	A5010	YY320	8/18/2013	H	60	322	361	387	26	444	83	JR C-F1
	A5110	YY610	8/26/2013	H	50	291	357	348	-9	410	53	JR C-F1
	A5070	YY660	8/23/2013	H	65	225	293	289	-4	335	42	JR C-F1
	A5200	YY710	9/4/2013	H	53	236	302	316	14	361	59	JR C-F1
	A5180	YY750	8/28/2013	H	38	249	312	334	22	362	50	JR C-F1
	A5003	Y1066	8/23/2013	H	72	404	516	528	12	576	60	B C-F1
	A4993	Y1246	8/21/2013	H	83	380	490	480	-10	536	46	B C-F1
	A5033	Y2103	9/4/2013	H	56	350	466	456	-10	520	54	B C-F1
	A5023	Y229B	8/23/2013	H	83	376	472	488	16	536	64	B C-F1
	A4963	Y2703	8/19/2013	H	78	334	460	432	-28	502	42	B C-F1
	A5013	YY930	8/23/2013	H	56	388	510	498	-12	538	28	B C-F1
	A5853	U1610	10/10/2013	H	78	458	562	554	-8	590	28	B C-F1
	A5843	U3579	10/7/2013	H	61	248	310	324	14	374	64	B C-F1
	A5673	U8412	9/24/2013	H	67	478	564	578	14	610	46	B C-F1

	A5683	N0303	10/4/2013	H	72	460	550	548	-2	568	18	B C-F1
	A5443	U1690	9/12/2013	H	51	498	600	592	-8	614	14	B C-F1
	A5593	U3419	9/16/2013	H	61	414	502	486	-16	532	30	B C-F1
	A5493	U8502	9/13/2013	H	89	514	628	616	-12	630	2	B C-F1
	A5473	W8993	9/13/2013	H	77	544	654	638	-16	666	12	B C-F1
	A5573	W9063	9/15/13	H	77	456	558	568	10	600	42	B C-F1
	A5653	119	9/21/2013	H	72	368	490	470	-20	608	118	B C-F1
	A5563	2836	9/15/13	H	67	236	294	306	12	344	50	B C-F1
	A5603	3425	9/16/2013	H	73	490	572	564	-8	606	34	B C-F1
#5	A5523	3472	9/14/2013	H	61	496	594	590	-4	608	14	B C-F1
#6	A5533	3485	9/14/2013	H	83	528	620	636	16	632	12	B C-F1
	A5633	N0323	9/18/2013	H	73	506	594	590	-4	622	28	B C-F1
	A5513	R6790	9/14/2013	H	72	516	640	614	-26	664	24	B C-F1
	A5613	R9275	9/17/2013	H	94	560	658	640	-18	680	22	B C-F1
	A5663	T1300	9/21/2013	H	89	450	546	546	0	598	52	B C-F1
	A5123	T1859	9/10/2013	H	61	526	614	608	-6	632	18	B C-F1
	A5503	T1869	9/14/2013	H	61	488	590	580	-10	620	30	B C-F1
	A5623	T3500	9/17/2013	H	105	558	670	668	-2	690	20	B C-F1
	A5063	T6793	9/9/2013	H	73	544	636	628	-8	666	30	B C-F1
	A5600	8020	9/12/2013	S	100	349	465	462	-3	524	59	JR C-F1
	A5330	N0360	9/7/2013	S	58	353	453	448	-5	512	59	JR C-F1
	A5270	N0883	9/6/2013	S	68	364	454	463	9	496	42	JR C-F1
	A5560	N1191	9/12/2013	S	68	376	481	512	31	546	65	JR C-F1
	A5340	R2643	9/7/2013	S	83	392	480	502	22	556	76	JR C-F1
	A5190	R5630	9/1/2013	S	79	358	443	463	20	528	85	JR C-F1
	A5260	S70	9/5/2013	S	80	368	464	470	6	534	70	JR C-F1
	A5300	W4880	9/6/2013	S	68	353	433	438	5	493	60	JR C-F1
	A5490	X1486	9/10/2013	S	68	323	373	415	42	457	84	JR C-F1
#5	A5520	X255G	9/10/2013	S	92	308	418	417	-1	508	90	JR C-F1
	A5530	XX040	9/10/2013	S	87	328	407	414	7	456	49	JR C-F1
	A5360	XX270	9/3/2013	S	83	354	378	406	28	443	65	JR C-F1
	A5540	XX980	9/11/2013	S	80	303	361	405	44	421	60	JR C-F1
	A5400	Y2233	9/9/2013	S	59	296	361	379	18	402	41	JR C-F1
	A5150	YY1050	8/27/2013	S	55	202	258	283	25	321	63	JR C-F1
	A5050	YY1190	8/22/2013	S	71	303	381	381	0	434	53	JR C-F1
	A5060	YY1210	8/23/2013	S	89	293	388	395	7	467	79	JR C-F1
	A5380	YY1340	9/8/2013	S	82	237	300	332	32	378	78	JR C-F1
	A5170	YY160	8/27/2013	S	68	290	331	367	36	395	64	JR C-F1
	A5030	YY250	8/22/2013	S	72	256	313	338	25	357	44	JR C-F1
#6	A5040	YY270	8/22/2013	S	77	284	382	389	7	434	52	JR C-F1
	A5020	YY380	8/21/2013	S	71	313	361	377	16	409	48	JR C-F1
	A5080	YY390	8/24/2013	S	77	289	363	379	16	450	87	JR C-F1
	A5100	YY460	8/24/2013	S	75	290	357	362	5	399	42	JR C-F1

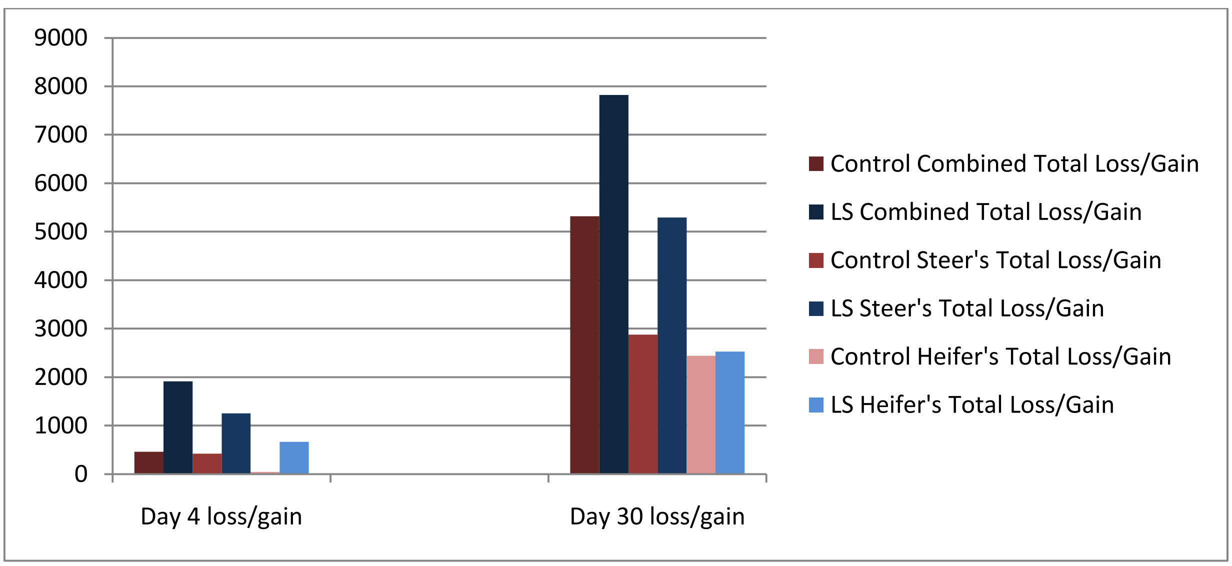
	A5230	YY500	9/5/2013	S	48	222	270	279	9	326	56	JR C-F1
	A5120	YY560	8/26/2013	S	70	331	393	414	21	436	43	JR C-F1
	A5420	YY860	9/9/2013	S	59	250	300	338	38	357	57	JR C-F1
	A5450	YY930A	9/10/2013	S	92	219	232	243	11	282	50	JR C-F1
	A5130	YY950	8/27/2013	S	78	238	285	311	26	350	65	JR C-F1
	A6110	R6800		S		263	340	332	-8	383	43	JR C-F1
	A4713	Y1044	8/20/2013	S	71	384	488	482	-6	530	42	B C-F1
#4	A4703	Y1286	8/17/2013	S	71	414	526	???		560	34	B C-F1
	A4723	Y1704	8/23/2013	S	59	410	520	496	-24	586	66	B C-F1
	A4893	Y2173	9/12/2013	S	77	234	302	298	-4	312	10	B C-F1
	A4743	Y222B	8/24/2013	S	71	348	456	454	-2	520	64	B C-F1
	A4783	Y378B	9/4/2013	S	77	382	480	492	12	566	86	B C-F1
	A5733	W8633	10/6/2013	S	77	494	620	614	-6	648	28	B C-F1
	A5693	152	9/30/2013	S	95	406	504	518	14	546	42	B C-F1
	A5193	T3149	9/13/2013	S	83	562	676	666	-10	716	40	B C-F1
	A5343	U0426	9/17/13	S	83	376	478	494	16	572	94	B C-F2
	A5313	U1280	9/16/2013	S	71	568	652	646	-6	706	54	B C-F2
	A5423	U8393	9/22/2013	S	114	522	620	630	10	646	26	B C-F2
	A5403	W4010	9/21/2013	S	73	466	590	574	-16	592	2	B C-F2
	A4833	W8683	9/9/2013	S	65	554	652	662	10	708	56	B C-F2
	A4913	W8973	9/12/13	S	102	526	632	616	-16	656	24	B C-F2
	A5323	66	9/16/2013	S	65	424	522	530	8	554	32	B C-F2
	A5393	144	9/21/2013	S	89	488	614	604	-10	654	40	B C-F2
	A5383	3535	9/19/13	S	95	392	514	508	-6	560	46	B C-F2
	A5183	8530	9/12/2013	S	61	520	646	648	2	664	18	B C-F2
	A4863	9060	9/10/2013	S	77	576	692	698	6	746	54	B C-F2
	A5333	L321	9/17/13	S	89	550	665	652	-13	694	29	B C-F2
	A5433	R7130	9/25/13	S	95	538	626	612	-14	674	48	B C-F2
	A4883	T1580	9/11/13	S	91	610	730	738	8	770	40	B C-F2
	A4903	T1676	9/12/13	S	79	552	656	664	8	698	42	B C-F2
	A5363	T7174	9/18/2013	S	95	468	633	604	-29	662	29	B C-F2
	A5413	X219G	9/21/13	S	102	562	688	690	2	754	66	B C-F2
					BW	Day -34	Day 0	Day 4	Day 4 loss/gain	Day 30	Day 30 loss/gain	
		C Total			7839	41452	50927	50864	463	56246	5319	
		C Average			72.58	380.29	467.22	470.96	4.29	516.02	48.80	
		C Steer's Total			4182	20869	25719	25614	421	28594	2875	
		C Steer's Average			77.44	379.44	467.62	474.33	7.80	519.89	52.27	
		C Heifer's Total			3657	20583	25208	25250	42	27652	2444	
		C Heifer's Average			67.72	381.17	466.81	467.59	0.78	512.07	45.26	

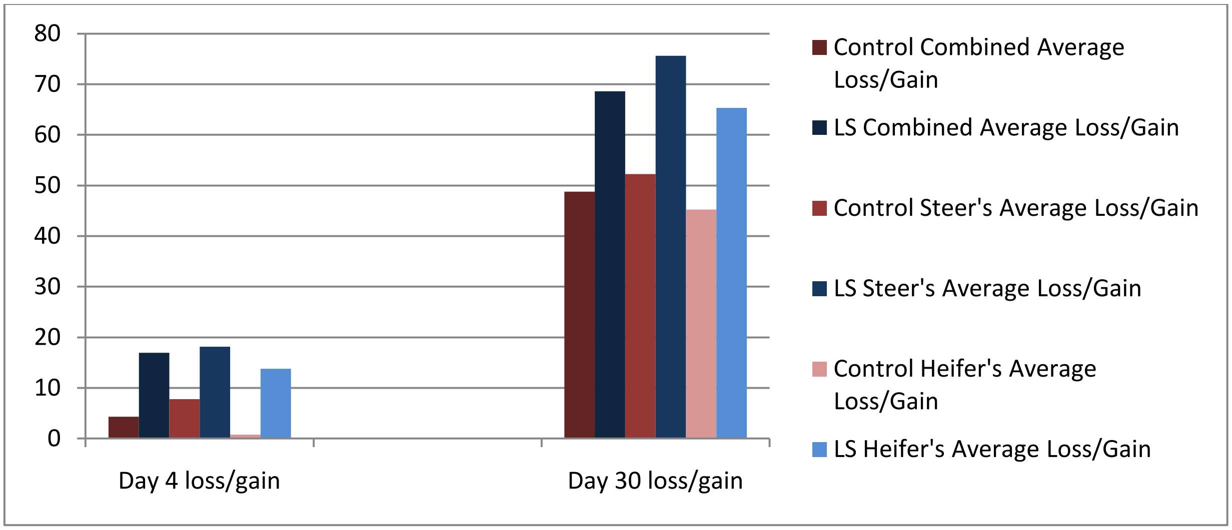
Pedo meter	Calf ID	Dam ID	Calf Birth Date	Sex	Birth Wt.	4/14/14 weight	5/12/14 weight	5/16/14 weight	wean.wk loss/gain	6/10/14 Weight	Wean Mo. Loss/gain	Group
	A6220	3430	9/22/2013	H	83	229	285	304	19	335	50	JR LS-F2
	A5940	N7502	9/17/2013	H	55	287	347	373	26	451	104	JR LS-F2
	A5970	R2023	9/17/2013	H	67	270	345	374	29	445	100	JR LS-F2
	A5800	R2153	9/15/2013	H	82	340	420	431	11	512	92	JR LS-F2
	A5870	R2633	9/16/2013	H	70	337	395	418	23	475	80	JR LS-F2
	A5880	R5170	9/16/2013	H	80	311	384	400	16	461	77	JR LS-F2
	A6090	R5488	9/19/2013	H	78	385	493	514	21	552	59	JR LS-F2
	A5740	R6720	9/14/2013	H	38	248	319	331	12	361	42	JR LS-F2
	A5610	R6760	9/12/2013	H	67	356	441	464	23	542	101	JR LS-F2
	A6020	S2992	9/18/2013	H	67	352	437	443	6	542	105	JR LS-F2
	A5700	T1696	9/14/2013	H	65	335	426	417	-9	489	63	JR LS-F2
	A5630	T6403	9/13/2013	H	72	381	491	499	8	600	109	JR LS-F2
	A5670	W4000	9/13/2013	H	80	320	406	422	16	488	82	JR LS-F2
	A5840	W5430	9/16/2013	H	92	433	518	524	6	584	66	JR LS-F2
	A5660	W8364	9/13/2013	H	65	374	428	478	50	504	76	JR LS-F2
	A5950	W8484	9/17/2013	H	58	264	472	478	6	532	60	JR LS-F2
	A6030	X0998	9/18/2013	H	72	248	294	311	17	400	106	JR LS-F2
	A5770	X5299	9/14/2013	H	67	304	447	406	-41	472	25	JR LS-F2
	A5850	X6957	9/16/2013	H	61	339	427	443	16	514	87	JR LS-F2
	A6050	Y5579	9/19/2013	H	76	314	385	407	22	455	70	JR LS-F2
	A6180	YY240	9/22/2013	H	78	253	291	312	21	357	66	JR LS-F2
	A5583	U2420	9/15/2013	H	72	528	626	632	6	660	34	B LS-F3
	A5643	U2425	9/18/2013	H	94	468	574	592	18	614	40	B LS-F3
	A5173	U6400	9/11/2013	H	61	542	614	640	26	660	46	B LS-F3
	A5143	U7763	9/11/2013	H	72	504	610	620	10	624	14	B LS-F3
	A5543	2866	9/14/13	H	72	460	540	560	20	594	54	B LS-F3
	A5553	3672	9/14/13	H	67	406	478	508	30	510	32	B LS-F3
	A5133	N0133	9/11/2013	H	83	470	556	552	-4	574	18	B LS-F3
	A5153	N0473	9/11/2013	H	67	486	592	590	-2	608	16	B LS-F3
	5093	N5965	9/10/2013	H	89	546	648	652	4	668	20	B LS-F3
	A5083	R9055	9/9/2013	H	71	504	586	602	16	618	32	B LS-F3
	A5163	T1516	9/11/13	H	61	530	624	622	-2	664	40	B LS-F3
	A5463	T1566	9/12/2013	H	72	490	572	584	12	614	42	B LS-F3
	A5483	T3079	9/13/2013	H	78	358	420	448	28	480	60	B LS-F3
	A5453	T6373	9/12/2013	H	61	410	492	506	14	540	48	B LS-F3
	A5043	X1133	9/6/2013	H	72	446	522	522	0	582	60	B LS-F3
	A5113	X1163	9/10/2013	H	78	418	490	530	40	514	24	B LS-F3
	A5073	X1223	9/8/2013	H	83	376	460	482	22	504	44	B LS-F3
	A5053	XX1010	9/6/2013	H	72	468	574	592	18	622	48	B LS-F3

	A5103	X385B	9/10/2013	H	83	538	620	642	22	656	36	B LS-F4
	A4983	Y2673	8/20/2013	H	45	442	520	552	32	584	64	B LS-F4
	A4943	Y2723	8/17/2013	H	61	416	508	528	20	556	48	B LS-F4
	A4953	YY1680	8/18/2013	H	51	500	582	606	24	632	50	B LS-F4
	A4973	YY1730	8/20/2013	H	53	418	524	536	12	560	36	B LS-F4
	A5930	73	9/17/2013	S	90	326	407	428	21	522	115	JR LS-F2
	A6040	1465	9/14/2012	S	93	242	306	321	15	411	105	JR LS-F2
	A6140	3165	9/14/2013	S	95	280	372	394	22	480	108	JR LS-F2
	A6100	3702	9/19/2013	S	97	346	425	437	12	516	91	JR LS-F2
	A6120	3992	9/20/2013	S	82	251	289	297	8	338	49	JR LS-F2
	A6080	L126	9/19/2013	S	102	362	432	460	28	491	59	JR LS-F2
	A6070	N0953	9/19/2013	S	93	325	434	446	12	554	120	JR LS-F2
	A5790	N191B	9/15/2013	S	101	400	480	512	32	578	98	JR LS-F2
	A6200	N290B	9/23/2013	S	91	370	446	455	9	564	118	JR LS-F2
	A6000	N416B	9/17/2013	S	78	259	356	364	8	465	109	JR LS-F2
#1	A6210	O643	9/23/2013	S	90	250	311	318	7	400	89	JR LS-F2
	A5710	O780	9/14/2013	S	71	305	384	346	-38	476	92	JR LS-F2
	A5650	P9552	9/13/2013	S	65	301	383	391	8	460	77	JR LS-F2
	A5900	R281B	9/16/2013	S	80	361	457	480	23	574	117	JR LS-F2
	A5890	R332B	9/16/2013	S	70	337	406	426	20	496	90	JR LS-F2
	A5720	R5560	9/14/2013	S	82	296	385	405	20	489	104	JR LS-F2
	A5980	R6710	9/16/2013	S	72	270	328	335	7	401	73	JR LS-F2
#2	A5810	R9545	9/15/2013	S	89	352	437	461	24	554	117	JR LS-F2
	A5730	S1850	9/14/2013	S	72	365	457	495	38	570	113	JR LS-F2
	A6130	S2862	9/20/2013	S	83	334	409	409	0	473	64	JR LS-F2
	A5960	T1536	9/15/2013	S	83	389	492	514	22	588	96	JR LS-F2
	A5860	T2490	9/16/2013	S	83	406	486	518	32	588	102	JR LS-F2
	A5990	T4982	9/16/2013	S	87	411	510	542	32	616	106	JR LS-F2
	A5640	T7050	9/13/2013	S	77	264	324	350	26	432	108	JR LS-F2
	A5760	W227B	9/14/2013	S	93	388	492	522	30	608	116	JR LS-F2
	A5680	W5020	9/13/2013	S	95	421	488	502	14	570	82	JR LS-F2
	A5820	W5490	9/15/2013	S	87	417	500	524	24	604	104	JR LS-F2
	A6060	X1626	9/19/2013	S	89	366	461	476	15	578	117	JR LS-F2
	A6160	X5279	9/21/2013	S	95	359	435	458	23	544	109	JR LS-F2
	A5830	X6767	9/15/2013	S	83	398	494	508	14	592	98	JR LS-F2
	A5780	X6917	9/14/2013	S	73	346	447	464	17	550	103	JR LS-F2
	A5690	XX210	9/13/2013	S	70	332	416	441	25	516	100	JR LS-F2
#3	A5750	XX220	9/14/2013	S	85	357	449	459	10	538	89	JR LS-F2
	A6190	Y2263	9/23/2013	S	65	211	270	292	22	378	108	JR LS-F2
	A6010	Y238B	9/11/2013	S	70	167	198	194	-4	249	51	JR LS-F2
	A6170	Y2823	9/22/2013	S	68	291	361	376	15	448	87	JR LS-F2
	A6150	Y5529	9/21/2013	S	77	278	346			435	89	JR LS-F2
	A5920	Y5609	9/16/2013	S	68	270	355	371	16	455	100	JR LS-F2

	A5910	Y5699	9/16/2013	S	59	340	425	422	-3	510	85	JR LS-F2
	A4823	U0066	9/7/2013	S	65	436	518	552	34	580	62	B LS-F3
	A5223	U0096	9/14/13	S	83	576	680	700	20	724	44	B LS-F3
	A5213	U8292	9/14/2013	S	71	392	496	538	42	568	72	B LS-F3
	A5253	W8204	9/15/2013	S	65	446	542	568	26	594	52	B LS-F3
	A5203	W8234	9/14/2013	S	59	510	598	610	12	644	46	B LS-F3
	A5353	4245	9/17/2013	S	95	184	232	248	16	276	44	B LS-F3
	A5303	8270	9/16/13	S	102	502	564	616	52	662	98	B LS-F3
	A4873	29B	9/10/2013	S	83	554	654	668	14	724	70	B LS-F3
	A4933	N2850	9/13/2013	S	108	586	692	708	16	746	54	B LS-F3
	A5293	R7060	9/15/2013	S	53	552	650	658	8	684	34	B LS-F3
	A5233	T1739	9/14/2013	S	65	510	602	626	24	638	36	B LS-F3
	A5243	T6473	9/14/2013	S	77	550	630	654	24	684	54	B LS-F3
	A4803	X1153	9/7/2013	S	71	476	570	582	12	624	54	B LS-F3
	A5283	X1563	9/15/2013	S	95	482	542	564	22	588	46	B LS-F3
	A5373	X1703	9/19/13	S	95	378	466	522	56	552	86	B LS-F3
	A5263	X371B	9/15/2013	S	71	572	602	596	-6	602	0	B LS-F3
	A4843	X6807	9/9/2013	S	65	470	576	590	14	620	44	B LS-F3
	A5273	X6887	9/15/2013	S	89	530	634	646	12	706	72	B LS-F3
	A5743	U1380	10/10/2013	S	102	538	616	632	16	656	40	B LS-F4
	A5723	U7464	10/4/2013	S	77	536	628	640	12	664	36	B LS-F4
	A5753	126	10/12/2013	S	65	454	534	546	12	582	48	B LS-F4
	A5713	T1706	10/3/2013	S	102	586	654	680	26	698	44	B LS-F4
	A5703	T1909	10/2/2013	S	83	570	638	662	24	672	34	B LS-F4
	A4763	Y1036	8/28/2013	S	83	508	576	610	34	622	46	B LS-F4
	A4693	Y2213	8/13/2013	S	53	436	514	526	12	582	68	B LS-F4
	A4923	Y2633	9/13/2013	S	83	428	518	548	30	572	54	B LS-F4
	A4853	Y2773	9/10/2013	S	89	358	446	446	0	488	42	B LS-F4
	A4753	Y349B	8/26/2013	S	83	456	516	550	34	576	60	B LS-F4
	A4793	Y7057	9/7/2013	S	77	360	462	478	16	498	36	B LS-F4
	A4773	YY1060	9/2/2013	S	77	458	556	574	18	564	8	B LS-F4
	A4733	YY1920	8/23/2013	S	71	530	620	632	12	672	52	B LS-F4
		LS Total			**8751**	**45071**	**54562**	**56130**	**1914**	**62382**	**7820**	
		LS Average			**76.763**	**395.36**	**478.61**	**496.73**	**16.938**	**547.21**	**68.596**	
		LS Steer's Total			**5660**	**27667**	**33379**	**34283**	**1250**	**38673**	**5294**	
		LS Steer's Average			**80.857**	**395.24**	**476.84**	**496.86**	**18.116**	**552.47**	**75.629**	
		LS Heifer's Total			**3091**	**17404**	**21183**	**21847**	**664**	**23709**	**2526**	
		LS Heifer's Average			**74.667**	**382.52**	**467.93**	**481.74**	**13.815**	**533.24**	**65.315**	

					Day 4 loss/gain		Day 30 loss/gain
Control Combined Average Loss/Gain					4.287		48.798
LS Combined Average Loss/Gain					16.938		68.596
Control Steer's Average Loss/Gain					7.7963		52.273
LS Steer's Average Loss/Gain					18.116		75.629
Control Heifer's Average Loss/Gain					0.7778		45.259
LS Heifer's Average Loss/Gain					13.815		65.315
					Day 4 loss/gain		Day 30 loss/gain
Control Combined Total Loss/Gain					463		5319
LS Combined Total Loss/Gain					1914		7820
Control Steer's Total Loss/Gain					421		2875
LS Steer's Total Loss/Gain					1250		5294
Control Heifer's Total Loss/Gain					42		2444
LS Heifer's Total Loss/Gain					664		2526



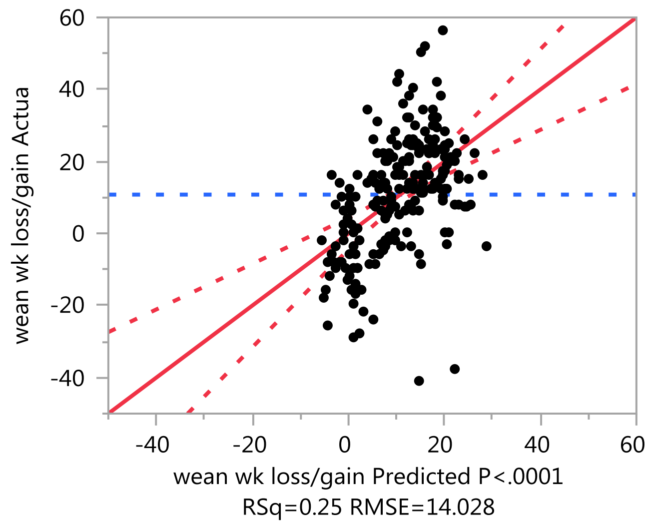


Pedometer Data

Location	Treatment	Pasture	Calf ID	Gender	Monday SPH	Tuesday SPH	Wednesday SPH	Thursday SPH	Friday SPH
Bruns	LS	3	A4873	S			795.31	284.46	178.17
Bruns	LS	3	A5213	S	774.36	547.21	332.88	263.42	231.77
Bruns	LS	4	A4753	S			486.38	176.75	122.06
Bruns	C	1	A5013	H	2014.15	2776.79	1782.42	519.67	453.41
Bruns	C	2	A4913	S	943.62	930.04	843.46	290.42	266.38
Bruns	C	2	A5473	H	2152.69	2992.46	2294.71	704.54	740.94
JR	LS	S2	A6210	S	302.86	278.13	80.83	155.96	523.56
JR	LS	S2	A5810	S	431.33	440.29	223.92	329.00	558.49
JR	LS	S2	A5750	S	506.93	455.58	305.88	342.96	815.78
JR	C	S1	A5500	H	1515.23	1561.83	804.13	355.42	650.80
JR	C	S1	A5520	S	1643.91	880.04	316.46	315.17	518.20
JR	C	S1	A5040	S	600.75	634.08	250.79	284.88	476.51

B. Statistical Analysis

Response wean wk loss/gain
Whole Model
Actual by Predicted Plot



Summary of Fit

RSquare	0.245371
RSquare Adj	0.231397
Root Mean Square Error	14.02761
Mean of Response	10.8009
Observations (or Sum Wgts)	221

Analysis of Variance

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Model	4	13820.108	3455.03	17.5584
Error	216	42503.132	196.77	**Prob > F**
C. Total	220	56323.240		<.0001*

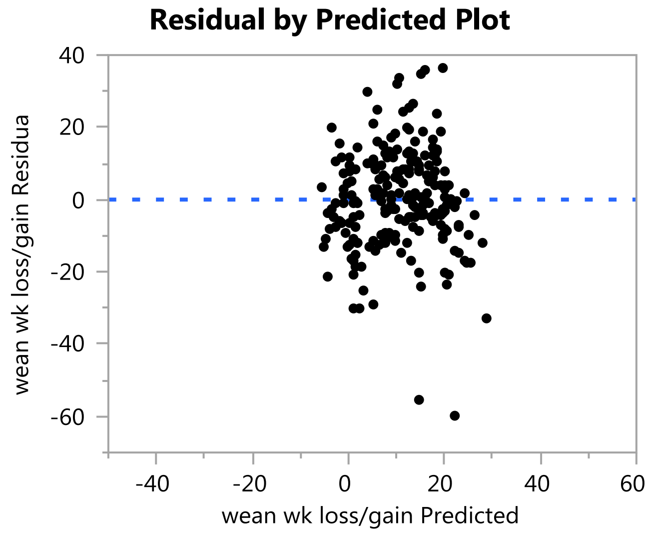
Lack Of Fit

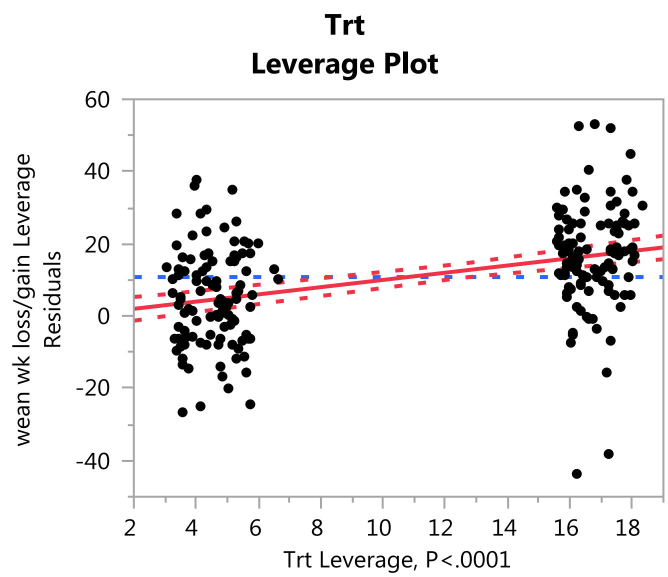
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**
Lack Of Fit	199	40583.632	203.938	1.8062
Pure Error	17	1919.500	112.912	**Prob > F**
Total Error	216	42503.132		0.0782
				Max RSq

Parameter Estimates

Term		**Estimate**	**Std Error**	**t Ratio**	**Prob>|t|**
Intercept		27.681289	5.749592	4.81	<.0001*
Trt[Con]		-6.174072	0.95188	-6.49	<.0001*
Location[Bruns]		0.2363915	1.394279	0.17	0.8655
SEX[H]		-2.606848	0.960624	-2.71	0.0072*

Term		Estimate	Std Error	t Ratio	Prob>|t|
Wean wt weight		-0.03644	0.011892	-3.06	0.0025*

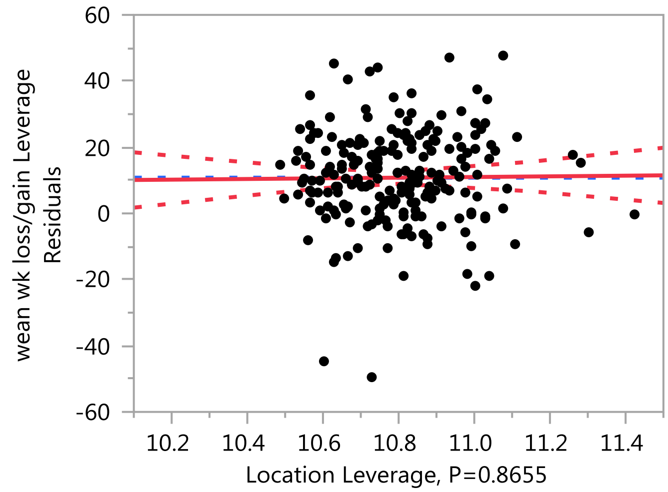




Least Squares Means Table

Level	Least Sq Mean		Std Error	Mean
Con	4.199743		1.3505484	4.3796
LS	16.547887		1.3394926	16.9381

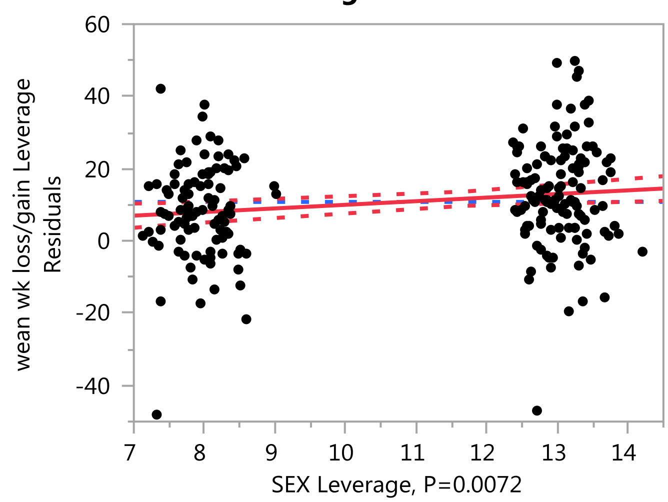
Location
Leverage Plot



Least Squares Means Table

Level	Least Sq Mean		Std Error	Mean
Bruns	10.610207		1.7135505	7.5701
JR	10.137424		1.6606759	13.8333

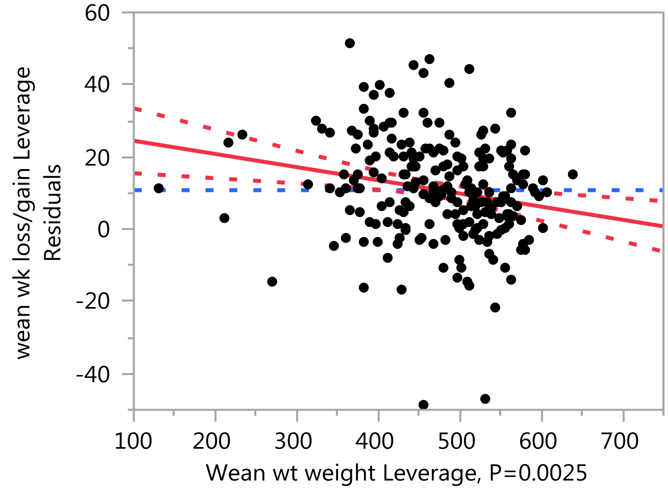
SEX
Leverage Plot



Least Squares Means Table

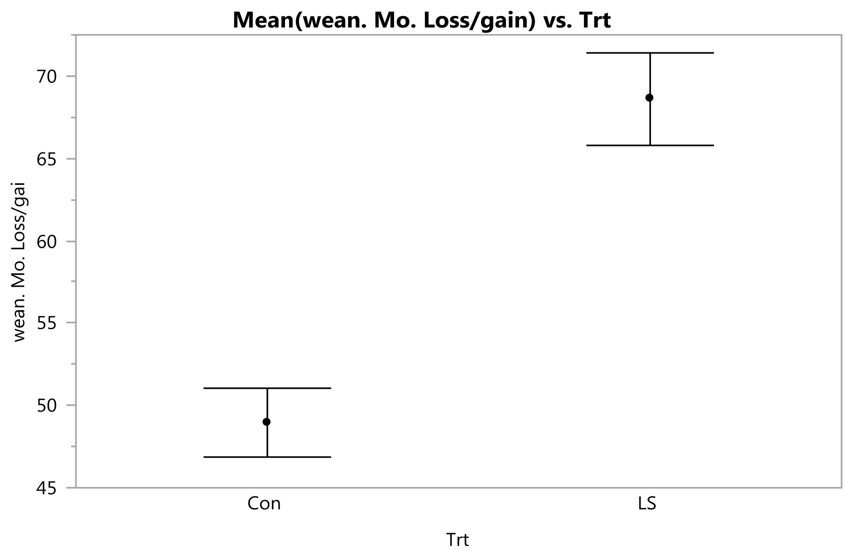
Level	Least Sq Mean		Std Error	Mean
H	7.766967		1.4218511	7.2041
S	12.980664		1.2767177	13.6667

Wean wt weight
Leverage Plot



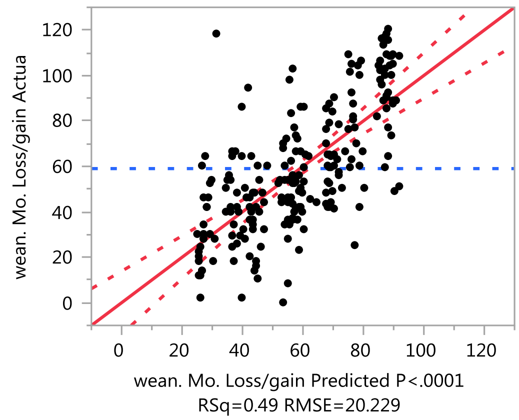
Weaning Month Estimation and Margin of Error

Graph Builder



Each error bar is constructed using 1 standard error from the mean.

Response wean. Mo. Loss/gain
Whole Model
Actual by Predicted Plot



Summary of Fit

RSquare	0.493734
RSquare Adj	0.482069
Root Mean Square Error	20.22928
Mean of Response	59.02242
Observations (or Sum Wgts)	223

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	86603.31	17320.7	42.3256
Error	217	88801.58	409.2	**Prob > F**
C. Total	222	175404.89		<.0001*

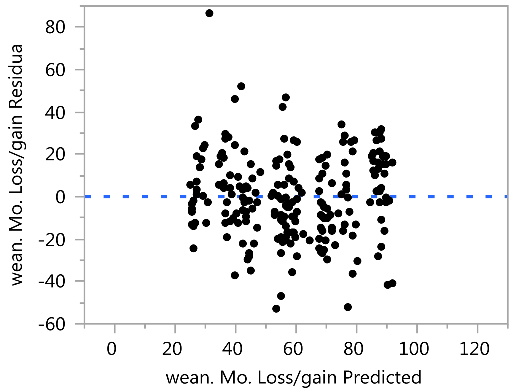
Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	215	88387.079	411.103	1.9836
Pure Error	2	414.500	207.250	**Prob > F**
Total Error	217	88801.579		0.3953
				Max RSq

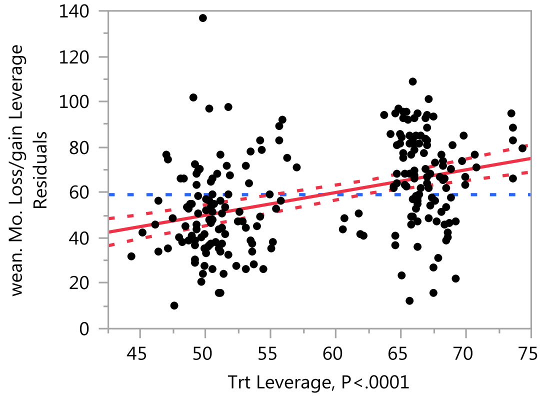
Parameter Estimates

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		97.538101	34.9347	2.79	0.0057*
Trt[Con]		-8.731795	1.416183	-6.17	<.0001*
SEX[H]		-5.506336	1.381257	-3.99	<.0001*
Location[Bruns]		-14.11677	2.04209	-6.91	<.0001*
Days at wean		-0.119641	0.136745	-0.87	0.3826
Start wt weight		-0.028655	0.01964	-1.46	0.1460

Residual by Predicted Plot



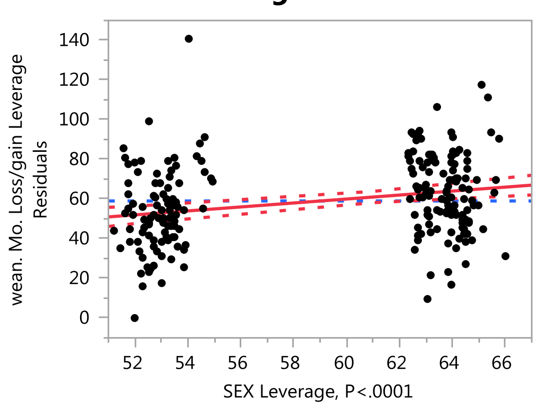
Trt
Leverage Plot



Least Squares Means Table

Level	Least Sq Mean		Std Error	Mean
Con	48.985032		1.9739891	49.0092
LS	66.448623		1.9604783	68.5965

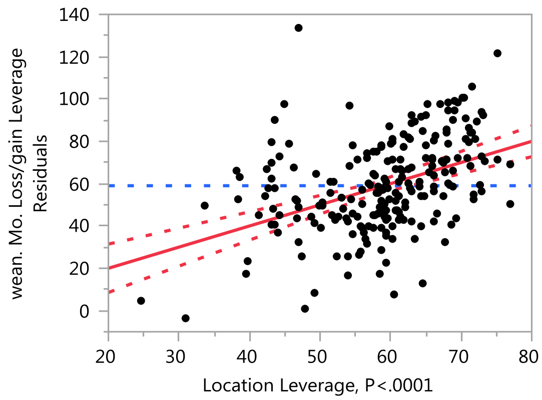
SEX
Leverage Plot



Least Squares Means Table

Level	Least Sq Mean		Std Error	Mean
H	52.210492		2.0513486	50.7143
S	63.223164		1.8266565	65.5360

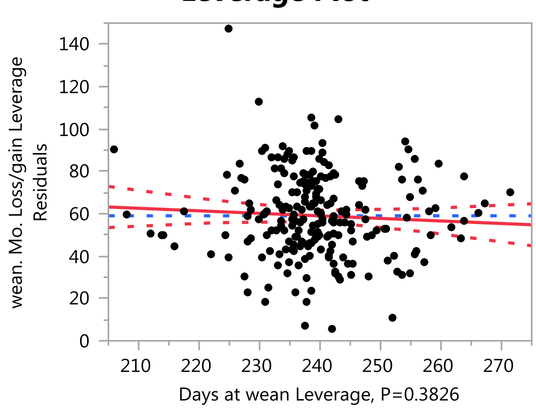
Location
Leverage Plot



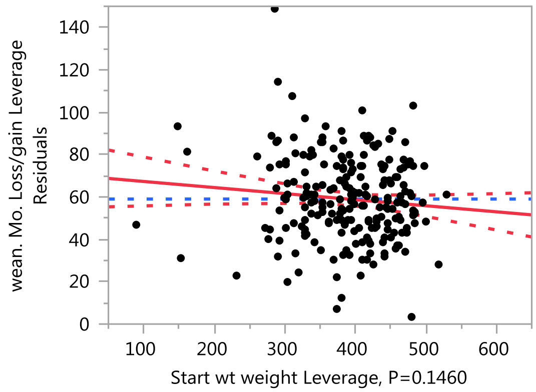
Least Squares Means Table

Level	Least Sq Mean		Std Error	Mean
Bruns	43.600056		2.4916044	42.1852
JR	71.833599		2.4209775	74.8348

Days at wean
Leverage Plot



Start wt weight
Leverage Plot



Manova Fit Response Specification for Pedometer Readings

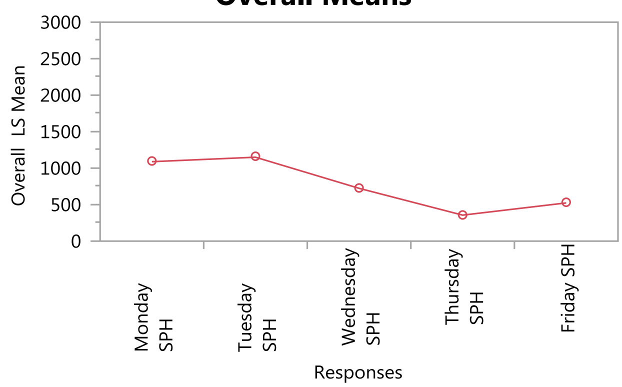
To construct the linear combinations across responses,

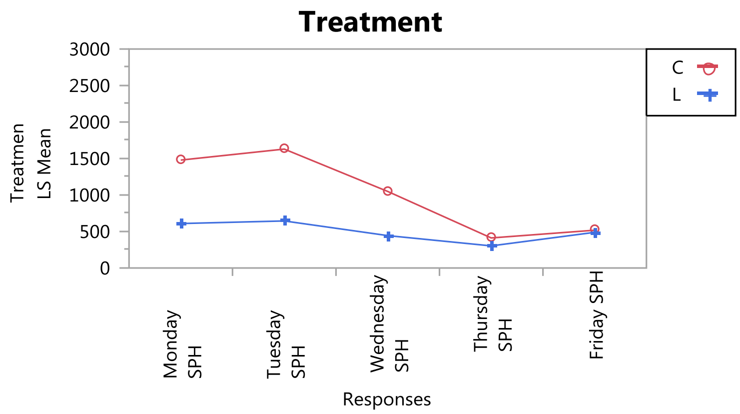
N	10
DFE	7

Parameter Estimates

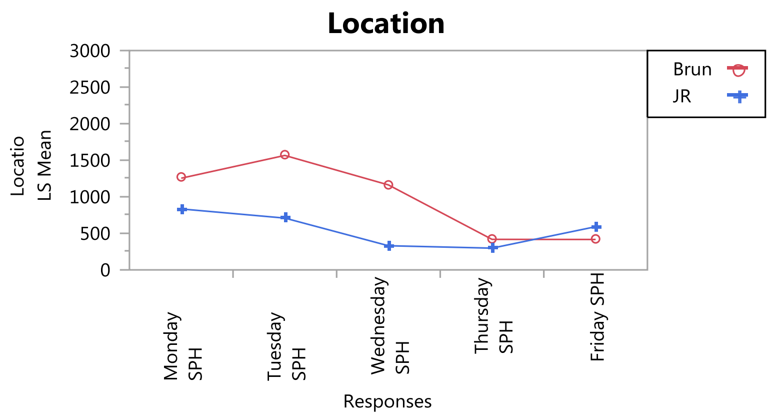
	Monday SPH	Tuesday SPH	Wednesday SPH	Thursday SPH	Friday SPH
Intercept	1043.67387	1136.89815	746.24537	357.266204	503.218591
Treatment[C]	434.719233	492.310185	302.414352	54.4143519	14.4882025
Location[Bruns]	210.171183	428.571759	415.912037	60.037037	-87.33785

Least Squares Means
Overall Means





Treatment	**Monday SPH**	**Tuesday SPH**	**Wednesday SPH**	**Thursday SPH**	**Friday SPH**
C	1478.3931	1629.20833	1048.65972	411.680556	517.706794
LS	608.954639	644.587963	443.831019	302.851852	488.730389



Location	**Monday SPH**	**Tuesday SPH**	**Wednesday SPH**	**Thursday SPH**	**Friday SPH**
Bruns	1253.84505	1565.46991	1162.15741	417.303241	415.880741
JR	833.502689	708.326389	330.333333	297.229167	590.556441

Partial Correlation

P.Cov	**Monday SPH**	**Tuesday SPH**	**Wednesday SPH**	**Thursday SPH**	**Friday SPH**
Monday SPH	221144.396	272250.094	169267.868	45278.0468	53752.0682
Tuesday SPH	272250.094	514970.863	353648.339	85382.8483	106917.137
Wednesday SPH	169267.868	353648.339	263899.723	64478.7813	85882.4126
Thursday SPH	45278.0468	85382.8483	64478.7813	18582.0576	22713.2137
Friday SPH	53752.0682	106917.137	85882.4126	22713.2137	34191.0907

P.Corr	**Monday SPH**	**Tuesday SPH**	**Wednesday SPH**	**Thursday SPH**	**Friday SPH**
Monday SPH	1.0000	0.8067	0.7007	0.7063	0.6182
Tuesday SPH	0.8067	1.0000	0.9593	0.8728	0.8057
Wednesday SPH	0.7007	0.9593	1.0000	0.9208	0.9041
Thursday SPH	0.7063	0.8728	0.9208	1.0000	0.9011
Friday SPH	0.6182	0.8057	0.9041	0.9011	1.0000

Overall E&H Matrices

E	**Monday SPH**	**Tuesday SPH**	**Wednesday SPH**	**Thursday SPH**	**Friday SPH**
Monday SPH	1548010.77	1905750.66	1184875.08	316946.327	376264.478
Tuesday SPH	1905750.66	3604796.04	2475538.37	597679.938	748419.961
Wednesday SPH	1184875.08	2475538.37	1847298.06	451351.469	601176.888
Thursday SPH	316946.327	597679.938	451351.469	130074.403	158992.496
Friday SPH	376264.478	748419.961	601176.888	158992.496	239337.635

Whole Model H	**Monday SPH**	**Tuesday SPH**	**Wednesday SPH**	**Thursday SPH**	**Friday SPH**
Monday SPH	2676820.46	3614732.06	2687702.36	438306.396	-199566.81
Tuesday SPH	3614732.06	5102766.65	3942919.82	631087.133	-379150.71
Wednesday SPH	2687702.36	3942919.82	3142331.01	495578.1	-355584.22
Thursday SPH	438306.396	631087.133	495578.1	78708.5351	-52087.589
Friday SPH	-199566.81	-379150.71	-355584.22	-52087.589	69169.1886

Intercept	**Monday SPH**	**Tuesday SPH**	**Wednesday SPH**	**Thursday SPH**	**Friday SPH**
Monday SPH	9803296.35	10678958	7009531.15	3355824.62	4726764.86
Tuesday SPH	10678958	11632836.6	7635644.82	3655577.57	5148974.56
Wednesday SPH	7009531.15	7635644.82	5011939.38	2399474.25	3379720.9
Thursday SPH	3355824.62	3655577.57	2399474.25	1148752.26	1618046.96
Friday SPH	4726764.86	5148974.56	3379720.9	1618046.96	2279060.55

Treatment	**Monday SPH**	**Tuesday SPH**	**Wednesday SPH**	**Thursday SPH**	**Friday SPH**
Monday SPH	1700827.3	1926150.35	1183188.01	212894.688	56684.7024
Tuesday SPH	1926150.35	2181323.87	1339934.99	241098.657	64194.2068
Wednesday SPH	1183188.01	1339934.99	823089.962	148101.129	39432.9633
Thursday SPH	212894.688	241098.657	148101.129	26648.2952	7095.29533
Friday SPH	56684.7024	64194.2068	39432.9633	7095.29533	1889.1721

Location	**Monday SPH**	**Tuesday SPH**	**Wednesday SPH**	**Thursday SPH**	**Friday SPH**
Monday SPH	397547.334	810660.901	786714.522	113562.496	-165203.09
Tuesday SPH	810660.901	1653063.78	1604233.38	231571.607	-336874.82
Wednesday SPH	786714.522	1604233.38	1556845.4	224731.137	-326923.77
Thursday SPH	113562.496	231571.607	224731.137	32440.0124	-47191.552
Friday SPH	-165203.09	-336874.82	-326923.77	-47191.552	68651.1003

Between Subjects

Sum

All Between

Test	Value	Exact F	NumDF	DenDF	Prob>F
F Test	1.3085231	4.5798	2	7	0.0535

Intercept

Test	Value	Exact F	NumDF	DenDF	Prob>F
F Test	5.1629923	36.1409	1	7	0.0005*

Treatment

Test	Value	Exact F	NumDF	DenDF	Prob>F
F Test	0.606768	4.2474	1	7	0.0783

Location

Test	Value	Exact F	NumDF	DenDF	Prob>F
F Test	0.3799111	2.6594	1	7	0.1470

Within Subjects

Contrast

All Within Interactions

Test	Value	Approx. F	NumDF	DenDF	Prob>F
Wilks' Lambda	0.0198715	6.0939	8	8	0.0097*
Pillai's Trace	1.4044589	2.9479	8	10	0.0563
Hotelling-Lawley	27.969631	13.9848	8	4	0.0111*
Roy's Max Root	27.184108	33.9801	4	5	0.0008*

Day

Test	Value	Exact F	NumDF	DenDF	Prob>F
F Test	9.4917019	9.4917	4	4	0.0255*

Day*Treatment

Test	Value	Exact F	NumDF	DenDF	Prob>F
F Test	2.8758545	2.8759	4	4	0.1654

Day*Location

Test	Value	Exact F	NumDF	DenDF	Prob>F
F Test	20.254195	20.2542	4	4	0.0064*

B. Demonstrational Handling Video Links

1. Low Stress Cattle Handling: Emptying a Pen of Cattle: Weaning Training Part 1 (Teaching cattle to walk passed a handler) http://youtu.be/VzYNf7FaJ6M
2. Low Stress Cattle Handling: Emptying a Pen of Cattle: Weaning Training Part 2 (Teaching cattle to walk passed a handler) http://youtu.be/OFvhwCVEw1I
3. Low Stress Cattle Handling: Sorting Cows and Calves: Weaning Training Part 3 http://youtu.be/YL78RplC32I
4. Low Stress Cattle Handling: Loading an Alleyway http://youtu.be/VE-CIOM8BWI
5. Low Stress Cattle Handling: Moving cattle along an Alleyway http://youtu.be/ipAK3PQw7LA