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THE EFFECTS OF TEMPERATURE AND PRECIPITATION ON GROWTH IN BEEF CATTLE FOR THE SOUTHERN ILLINOIS REGION

by

Cameron Helderman

B.S., Southern Illinois University- Carbondale, 2019

A Research Paper
Submitted in Partial Fulfillment of the Requirements for the
Master of Science

Department of Agribusiness Economics
in the Graduate School
Southern Illinois University Carbondale
May 2020

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RESEARCH PAPER APPROVAL

THE EFFECTS OF TEMPERATURE AND PRECIPITATION ON GROWTH IN BEEF CATTLE FOR THE SOUTHERN ILLINOIS REGION

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A Research Paper Submitted in Partial

Fulfillment of the Requirements

For the Degree of

Master of Science

in the field of Agribusiness Economics

Approved by:

Dr. Dwight Sanders, Chair

Graduate School
Southern Illinois University Carbondale
February 28, 2020

AN ABSTRACT OF THE RESEARCH PAPER OF

Cameron Helderman, for the Master of Science degree in Agricultural Services, presented on March 25, 2020, at Southern Illinois University.

TITLE: THE EFFECTS OF TEMPERATURE AND PRECIPITATION ON GROWTH IN BEEF CATTLE FOR THE SOUTHERN ILLINOIS REGION

MAJOR PROFESSOR: Dr. Dwight Sanders

The demand for beef around the United States has been growing exponentially over the years because of our growing population. This means that producers must maximize the growth and development of their cattle and herds in total so that they can meet that growing demand. Many factors come into consideration when making decisions on increasing the turnover rate on the farm, but one of those big decisions is weather, especially temperature and precipitation. These two variables can have a direct effect on the growth and development of cattle. If conditions are harsh, their feed intake could decrease because of sickness, and then take longer to meet the weight requirement for slaughter. This costs producers time and money because of having to keep them longer, feed them more, and pay for certain vaccinations in order to nurse them back to health.

This research takes a closer look at temperature and precipitation and how they affect the average daily gain of cattle. The region that I decided to focus on is Southern Illinois, because of the availability of data provided by the Bull Test Facility at Southern Illinois University Carbondale. My other source of information about weather variable is from the National Centers for Environmental Information. During the Fall of 2019, I started compiling all necessary information to complete the research project. The data I used was from 2001 through 2009.

My hope for this project is to find valuable information that will help producers manage their herds better and maximize their profits. Weather can be a very important factor when growing livestock and this could lead to a very important discovery. If the research is linked to lower average daily gains, then producers could justify building additional buildings or cover for animals to get under in order to escape the weather. This will help them increase their turnover rate for cattle and also maximize their overall profits.

ACKNOWLEDGEMENTS

This research paper was completed with the help of many professors, managers, and interns from the Southern Illinois University Bull Test Facility and College of Agricultural Sciences. Their previous work to collect data has been very useful in the research that I have conducted. They have done a great job of giving an accurate representation of each individual bull's growth characteristics such as average daily gain and feed to gain ratios. I'm very thankful to be a part of such a great College and University with such caring and intelligent faculty and staff members.

Secondly, I would like to sincerely thank Dr. Dwight Sanders for always being a great friend and mentor throughout my time at Southern Illinois University Carbondale and especially in this research project and master's program. He has always pushed me to do my best and keep me on track, while giving very valuable life advice and instruction. His knowledge of Agribusiness Economics has had an impact on the lives of hundreds of students and especially mine. I would not be where I am today without his guidance.

Lastly, I would like to thank my family and friends for always keeping me motivated and on a path to success. Especially my parents (Brian and Michelle Helderman), and my grandparents/great-grandparents (Max and Wanda Hartman, Betty Pierson). Without their continued support throughout the years, this would not have been possible. I owe them so much for the love, motivation, and encouragement they have shown me throughout my entire life.

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CHAPTER 1

INTRODUCTION

One of the biggest decisions that cattle producers can make is which bull they will use to introduce new genetics into their herds. This decision comes with a lot of research and understanding of expected progeny differences, carcass characteristics, and sometimes test figures that come from a certified testing facility. If producers can introduce the correct genetics from their bulls to the herd, this can increase their overall herd value, profitability, and success in the long run. Herd valuation will experience growth if the producer can select the correct traits for the overall production goal. Profitability can increase if the structure of a farm is achieved accurately. A herd can be structured for different traits depending on the region in which the farm is placed and the goal of production. Some producers are raising cattle that are bred to display better mothering traits such as calving ease, birth weight, weaning weight, yearling weight, and maternal milk. Other cattle are produced to send directly to feedlots. These are bred to display carcass characteristics and average daily gain characteristics. This research could also affect the price for meat that people pay in stores and restaurants. Temperature and precipitation could cause variable changes in the monetary value of beef that consumers wish to purchase. If temperature and precipitation are both high, gain might not be as good which could then cause the price to raise the bull to be increased with the cost of feed and hay. This could then lead to an increase in the market price knowing that the cost of production was increased.

The Southern Illinois University Bull Test Sale is widely known from beef cattle producers around the area. It provides performance tested bulls to production farms in order

to introduce quality genetics into their respective herds. The bull test facility has been in operation since 1975 and provides an excellent data source for researchers looking for bull information, especially certain traits. The point of the bull test sale is to calculate average daily gain and feed/gain ratios for the bulls in the trial. My research will focus on the monthly temperatures and precipitation while the bulls are on trial, and the impact they have on overall average daily gain for each individual bull. This data is very important in understanding which weather characteristics are preferred in raising bulls and if they have an impact on overall performance in the test centers. If found that they have an impact, this could alter the overall value of the bulls when they sell in the auction. Weather has been known to have an impact on the overall performance of animals that are housed outside and have a direct contact with it (Atkinson, Sanders, Jones, Altman, 2010). My data is from the National Centers for Environmental Information and includes the monthly average of precipitation and temperature through the months of August through April in the years 2001 – 2009. This data is sourced from the Carbondale Sewage Treatment Plant, which is 6.3 miles away from the SIU Bull Test Facility at the Southern Illinois University Farms.

I approached the problem by researching if precipitation and temperature have a direct effect on the performance of the bulls at the SIU Bull Test Facility. I especially looked at average daily gain to see how the data changed depending on the temperature and precipitation. This research is based off of previous research done by a team of faculty members at SIU in 2010 (Atkinson, et al., 2010). The data will be the same, but they did not look at temperature and precipitation compared to average daily gain. They focused more on the expected progeny differences that were displayed in the bulls that were on test and evaluated the monetary value

of those characteristics. This will be a simple twist on the work that they have already completed. Also, this will add a different variable into the equation that might have a large effect on the data in their research. If so, this will give a more precise and accurate representation of their data and the conclusions in which they found.

CHAPTER 2

REVIEW OF LITERATURE

A team of researchers from Western Illinois University put together data from their annual Performance Tested Bull Sale during the time frame of 2006 through 2016 (Bacon, Cunningham, Franken, 2017). The bulls underwent a 112-day testing period where they were evaluated for important performance data such as Expected Progeny Differences (EPD's), feed/gain ratios, and average daily gain. They were also tested on ultrasound measurements for ribeye area and pelvic width and scrotal circumferences. The researchers were very interested in finding out the value that producers put on herd bull characteristics and the monetary importance they have on the buyers.

The conclusion of the study showed that cow/calf producers' value phenotypic characteristics of the bulls they purchased from the bull sale, such as appearance, frame scores, birth weights, and average daily gain. It was found that a one-pound lower birth weight for a bull increases its value by $14, and a birth weight expected progeny difference of one pound lower than the breed average increases its value $63. The ultrasound scores and measurements also played a very large role in the value of bulls, especially intramuscular fat and ribeye area. These statistics appeal mostly to cow-calf producers and show that an additional square inch of ribeye area is worth $168 and an additional degree on the marbling score is worth about $73. This proves that the characteristics attributed to bulls do have an impact on the overall value of bulls in the eyes of buyers.

Holt, Fields, Prevatt, Kriese-Anderson (2004) was written in order to determine which characteristics in a bull are the most important to consumers purchasing bulls from a bull test

sale. The data that was examined on each bull includes the sire and dam of each bull, their EPD's, average daily gains, birth weight, frame scores, feed efficiency, and height. 260 buyers and 370 bulls were examined in this process. This data is very valuable to the industry so that producers can better implement certain genetics into their herd, thus resulting in more profits. This data was evaluated from the Auburn University Bull Test Sale and a survey was sent out to all buyers asking them questions that relate to the expected progeny differences (EPD) that they look for when purchasing from the sale. The results showed a great difference on the value that each producer placed on certain EPD's and characteristics. The results showed that breed and EPD's were two of the major characteristics that every buyer in the survey valued the most. Other characteristics mentioned was temperament, performance, price, and seller reputation. The EPD's that were most significant were adjusted weaning weight, average yearling weight, breed, yearling weight, and maternal milk. Birth weight was mentioned but less valued than the rest of the EPD's. Also, out of the seven breeds showcased at the Auburn University Bull Test Sale, angus was the preferred breed and Simmental was the second preferred breed of the buyers.

Atkinson, Sanders, Jones, and Altman (2010) performed research on the Southern Illinois University Carbondale Annual Bull Test Sale. The researchers evaluated 353 bulls from 2001-2009 using hedonic pricing models to determine the price that the buyers put on the characteristics that the bulls displayed. This is very important in order to place a value on the bull. The large majority of the buyers are cow/calf producers that will market their calves after weaning (500-600 pounds) or yearlings (700-800 pounds) to feedlots.

The characteristics that generated the highest price was yearling weight, frame scores, and average daily gain. One of the characteristics that I found most intriguing is that a lower birth weight EPD and a high yearling weight EPD would generate an increase in value of $1,164. Also, a one-pound increase in yearling weight increased the value by $13. The SIU Bull Test values express that the buyers value characteristics that impact their production specifically like weaning weight and average daily gain. They do not receive any benefit for carcass characteristics like the feedlots will when the calves go to market.

In comparison to the data from Bacon, Cunningham, and Franken, overall the desired characteristics were very comparable, but the prices were different. The research from Atkinson, Sanders, Jones, and Altman included a hedonic pricing model because of the many years of data, while the WIU Bull Test was using the present markets to evaluate producer value (Bacon, Cunningham, Franken, 2017). Another large difference is that the buyers at the WIU Bull Test Sale placed a high value on ultrasound characteristics, and the SIU Bull Test data did not show a very noticeable difference. In comparison, the SIU and WIU Bull Test Sale proved that the desired characteristics were yearling weight, average daily gain, and frame scores. This is because both are selling to a similar customer base of cow/calf producers that are marketing their calf crops to feedlots.

Tejada, Glaze, and Jensen (2008) evaluated the expected progeny differences in bulls and their actual performance data that resulted from the test. They did this work based on the perspective of Idaho Beef Cattle Producers. In the research, a price was attached to certain EPD's in order to find what traits are desirable when purchasing their bulls from a sale. This offers a unique perspective of region-specific traits that may not be desirable in other places

around the United States and World. A hedonic model of pricing was used in the research and samples were taken from two different regions in Idaho.

Bacon, Cunningham, and Franken (2017) found that in the north-central region in Idaho, consumers were mainly concerned with the following characteristics: birth weight, 205-day weight, 365-day weight, milking ability, and docility. These characteristics were found to establish an increase in the price of the bulls and the value that the consumer placed on each bull. Alternatively, in the southwest regions in Idaho, the yearling weight EPD was found to cause an increase in the price of the bull along with birth weight, weaned calf value, and cow energy value.

In conclusion, it was found that the two regions in Idaho were very different because of factors including the climate, altitude, and moisture. Some of the desired EPD's from the regions were very different and some were similar. In comparison with other areas in the United States including the Midwest, South, and Plains, the only EPD's that were desirable across all of those regions was birth weight, weaning weight, and yearling weight. It was determined that the same factors had an influence on the producer valuations across the United States.

Lillywhite and Simonsen (2008) evaluated material from New Mexico's Tucumcari Bull Test and Sale in order to figure out why producers market their bulls through a registered testing site. This research found that there are many very valuable tests that are performed on the bulls throughout the 114-day trial that will give consumers a better understanding of their purchases and what kind of genetics that will be thrown into their herd. Along with evaluating the bull's EPDs', two performance tests that have a major impact on the bull's worth are average daily gain and feed to gain ratios. These tests, which are performed by the registered

bull test provide the consumer with very important information on how quickly their bull and his progeny's will grow and develop. The research found that these two characteristics are very valuable to a consumer when bidding on a bull. Likewise, the bull test also provides information such as scrotal circumference, back-fat thickness, and pelvic area which are important characteristics for bulls that will be producing feedlot calves. Another benefit of a bull test facility is to increase the docility of the bull. They are constantly getting worked with and moved from pen to pen which allows them to be worked easier when they arrive at their new farm. Another important aspect of the research was when a producer should remove their bull from the sale and try an alternative way of selling. This is determined by their performance and the reputation of the seller. Some producers value their reputation rather than putting a bull in the sale that did not perform well while on test. Every bull in the bull test was evaluated based on a performance index. If their performance index was not sufficient, then they would be recommended to go as a "No-Sale". Overall, the bull test is a great marketing strategy for most producers if their bulls perform well while on test. The bull test offers a wealth of information that consumers need in order to make the right purchasing decisions to better their farms and operations.

Bekkerman, Brester, and McDonald (2013) looked at products in the agricultural world that can be analyzed and evaluated based on their differentiation by consumers. Consumers in the agricultural world are known for evaluating and purchasing differentiated products such as feed, seed, livestock, etc. This research evaluates the effects of quality perceptions on consumers' marginal valuations of genetic beef cattle seedstock using quantile regressions. It compiles information from the Midland Bull Test in Montana and uses it to track consumer

behavior and evaluate the factors that cause them to behave in that way. The quantile regression model used to evaluate this information may provide producers with a more in-depth analyses of why the consumers made the decisions they did more so than traditional parametric, conditional-mean estimation techniques.

Bekkerman, Brester, and McDonald (2013) concluded that the most reliable way to evaluate the bulls is coming from a heterogeneous set of bulls and a heterogeneous set of buyers. The exact desirable traits are tough to measure because of non-observable traits such as producer reputation, differing knowledge of bull trait heritability, and the differing visual appearance preferences from each buyer. The other factor that causes the data to be skewed is the buyer preference. An overall high-quality bull may not be desirable for some producers who are selecting for a specific trait to improve the offspring of their own cows. Cost efficiency is another factor that affects the valuation of observable traits. In other words, a buyer that selects a bull for his personal highly valued characteristics is cost efficient and can decrease production costs in the long run.

Smith (2007) looked at statistics from bull sales over time to determine what characteristics are valuable to consumers using the hedonic pricing method. This method was used to estimate the data by giving actual transaction data while revealing the value buyers of bulls implicitly place on specific traits. The three types of traits that were evaluated were productive, consumptive, and physical. Each was estimated using the same model and showed a great deal of variance between them.

The data showed that buyers place the most value on ribeye area, rib fat, intramuscular fat, average daily gain, yearling weight, and birth weight. This shows that most of the research

was done on cattle that will be going to a feedlot. The data that are the most important are vital for feedlots to achieve the premium for their cattle. It was found that a buyer is willing to pay a smaller amount more for each additional unit of the traits listed above (Smith, 2007). Another important finding in the research was that buyers are willing to pay more for a bull that possesses angus genetics. The data also expresses the strategy used by producers to market their animals. If a bull producer knows their individual marginal cost for producing a unit increase of a bull trait, they can compare their implicit price for that specific trait in their cattle. Improving the genetic makeup of the cattle that producers take to a bull test will in turn pay out. Their bulls will have a higher value and they will build a reputation for selling good quality livestock. If improvements are made on the specific genetics listed in this article, then the overall value of the bull will go up.

Diersen and Fausti (2019) is a very interesting project that closely compares small cattle feedlots (<1,000 head) to large cattle feedlots (>1,000 head) in South Dakota. The researchers travelled the state to interview feedlot owners by survey about all of their management practices and strategies. These practices and strategies were very different in most cases and depending on the size of the feedlot. The smaller feedlots tended to use their own calf crop to fill their feedlot, and also relied heavily on the owner to make management decisions relating to veterinary treatment and nutrition. Most of these feedlots were also sole owned and purchase their cattle from auctions. Also, they tend to sell their calves at lighter weights than larger feedlots and use their own crops in feed production. Alternatively, large feedlots are co-owned and purchase their calves directly from producers, while also selling directly to packers when the cattle are finished (Diersen and Fausti, 2019). Larger feedlots tend to use outside

veterinary and nutritional resources for making sure their cattle grow and develop in the right way. These two different types of feedlots do have some similarities. They both are mainly backgrounding lots and contain heifers and steers. Both types of feedlots prefer steers because of their better carcass conditions and price at market.

Jones, Turner, Dhuyvetter, and Marsh (2008) examined the economic values of production expected progeny differences (EPD's) and how they compare to values assigned to actual weights. Also, research was done to evaluate the impact that various carcass trait predictors such as carcass evaluations, ultrasound, and semen analysis had on Angus Bull Prices.

When evaluating the EPD's, Jones, Turner, Dhuyvetter, and Marsh (2008) found that the birth weight of the expected progeny difference was much more desirable than the bulls own birth weight. According to table 8, the most valued characteristics from a consumer standpoint are age, birth weight, adjusted weaning weight, and adjusted yearling weight. The results of the carcass trait predictors found that a significant increase in the price of a bull occurred when the ribeye area was the perfect size and width. The elasticities associated with actual weights also proved to be higher than those associated with production EPD's.

Other factors were used to examine the bulls as well. These factors include marketing premiums or discounts, time of year for the sale, retention of semen rights, pedigree, and the reputation of the producer. It was found that the marketing premiums or discounts were directly related to the EPD's expressed by the bull (Jones, Turner, Dhuyvetter, Marsh, 2008). Bulls that were sold in the spring were consistently discounted compared to bulls sold in the fall. A premium was created for all bulls with retention of semen rights. And lastly, it was found

that the price of a bull was significantly higher based on the bull's pedigree and the reputation of the producer.

Kerr (1984) used a technological model of change to assess the change in the preferable genetic inputs from bull auctions from 1975-1979. The results proved three main conclusions overall. The first conclusion is that commercial cattleman recognizes the important genetic inputs to their production process, and this is reflected in the prices they are willing to pay for bulls. All producers are willing to pay more for traits that will benefit their herd and allow for genetic improvement. This research shows that the producers will evaluate their own herds and prioritize which traits they would like to introduce into their herd. Their decision on purchasing a bull will stem directly from their evaluation of their own herd. The second conclusion is that the prices of bulls reflect the change in the production process expected from the hybrid vigor associated with crossbreeding. Hybrid vigor is the improved performance of offspring compared to the average of their parents. This means that offspring will show more genetic improvements than their parents in most cases, which will add to the overall production of the individual herds. An increased overall production will allow for farmers to have increased profits. The third conclusion mentioned in this article is that the selection of characteristics emphasized in the breeding programs of purebred breeders corresponds, in general, to the choices indicated by the estimated implicit values of characteristics. This states that the opportunity costs associated with the more expensive traits desirable have a direct link to purebred producers. Purebred producers are known for paying more to manage their herds because certain breeds possess different characteristics that are desirable in cattle production (Kerr, 1984). Overall, Kerr proved very successful and found many important conclusions

associated with selective breeding, heritable characteristics, and genetic-based technological changes in the Canadian beef cattle industry.

CHAPTER 3

RESEARCH QUESTION

Beef cattle production has evolved over time and a very large amount of research has been done to improve the efficiency of raising beef cattle. Efficiency is the most important characteristic that a producer values in his herd. The total time on feed from the weaning stage all the way up until they are ready to be slaughtered is vital in production. If the correct growth traits are selected for a herd, producers can cut their production costs and improve their turnover rate. This will allow them to produce more calves than ever before while cutting costs such as veterinary bills and feed costs (Diersen and Fausti, 2019). My research project takes a look at two factors that could have a very drastic importance in the growth rates associated with beef cattle. It is thought that high precipitation and temperatures can cause beef cattle to eat less, thus taking more time to grow and develop. Alternatively, extreme drought and low temperatures are thought to have the same effects on production conditions. This research will show how much significance that temperature and precipitation will have on growing conditions in beef cattle. This is very important to producers in order to cut costs and make a production plan on how to decrease the time their cattle are on feed and increase their growing potential.

CHAPTER 4

DATA AND METHODS

The data for my research included two different sets. The first set is from the Southern Illinois University Bull Test Sale. The second set is from the National Centers for Environmental Information (NCEI). These two sets of data allowed me to perform my research accurately in order to determine whether the temperature and precipitation has an effect on the growth of the bulls that were on test.

The SIU Bull Test Facility has been in operation since 1975. Since that time, the facility has had 45 sales through 2019. Currently, the bull test facility is not in operation this year. Throughout its years of operation, the bull test consigns bulls from producers around the state of Illinois and places them on a 112-day trial period. At the end of the trial, the bulls are placed in an auction that producers can attend and purchase these animals to bring back to their own herds. These bulls are tested for average daily gain (ADG) and feed-to-gain ratios (F/G). Average daily gain is a measure of how much the bulls gain in weight every day over the span of the trial. Feed/gain ratios are a calculation that determines how many pounds of feed it takes for the bull to gain one pound in weight. The barn that houses these animals is open-faced and comprised of a Calan-gate system. The bulls are equipped with a collar that is magnetized and used to let them into their own personal feeder in the Calan-gate system. This is used so that workers can track how much they eat and consume more accurately and precisely (Atkinson, Sanders, Jones, Altman, 2010). When the bulls arrive at the facility, they are introduced to their surroundings and trained to use the Calan-gate system. They are given a very highly

concentrated ration and hay at free choice. This time period is not tested because of the transition period when the bulls are being trained.

The data stretches throughout the years of 2001 through 2009. This information includes data from 436 bulls. The breeds of these bulls include Angus, Charolais, Simmental, Polled Hereford, Limousin, and Red Angus. This data includes individual bull information such as Expected Progeny Differences (EPD's), carcass characteristics, test results, and the price that the bull brought at the sale. Expected Progeny Differences are a measure of the individual bull's overall worth as a parent. The carcass characteristics that are used in this research include scrotal circumference, frame size, pelvic measurements, rib fat, ribeye area, and intramuscular fat. The test results include average daily gain and the feed/gain ratios that the bulls expressed. Other characteristics in the data include date of birth , age, date of sale, and the price that the bull brought in the auction. Also included in the data is the on-test weight and off-test weight.

The expected progeny differences that are included in the research are: calving ease, birth weight, weaning weight, yearling weight, and maternal milk. These expected progeny differences are very important to producers so that they know what characteristics that the offspring of these bulls will display in their herds. Calving ease is the characteristic that displays the percentage of unassisted births. Most producers will value a higher calving ease for first calf heifers. Typically, a medium birth weight and a medium/high weaning weight are attractive to most producers as well. A high yearling weight will also increase the price of the bull. Maternal milk is a measure of mothering/milking ability of a bull's daughters. This characteristic is important for producers looking to add heifers or cows to their herd.

The other data set I used is from the National Centers for Environmental Information (NOAA). This data includes the monthly precipitation and temperature during the years of 2001 – 2009. This data was collected from the Carbondale Sewage Treatment Plant. This data will have allowed me to compare the monthly temperature and precipitation during the months of the trials throughout the nine years and see if they have a direct impact on the overall performance of the bulls. This data could be valuable because if a bull has a lower performance because of a lower temperature and higher precipitation, then it will bring a lower price in the auction. These weather conditions can help producers and buyers better estimate the worth of their animals.

Prior research did not exactly include the variables of precipitation and temperature but estimated the monetary value of the bulls based off of the characteristics such as EPD's, carcass measurements, and the reputation of their producers (Atkinson, Sanders, Jones, Altman, 2010). This research is an extension of Atkinson, Sanders, Jones, and Altman (2010).

CHAPTER 5

RESULTS

After completing the research, the results showed a wide degree of variance. Some of the variables showed good significance, but others did not. When beginning the project, I decided that using the Angus breed of beef cattle would be the best option for a base because of the large volume of bulls that were strictly this breed. So, I based all of my data off of the Angus breed as a comparison. The beta coefficient that I chose was based off of average daily gain. This coefficient showed the change in average daily gain with a one-unit change in the variable I was testing for. The R-squared value for my data set is 0.33 meaning that the variables explain 33% of the variation in ADG. The t-statistic and probability figures show that only eleven of the twenty variables were significant in the research. I split my research into three different groups which included breed variations, expected progeny difference variations, and weather variations.

The breeds that showed a strong significance were Simmental, Gelbvieh, Limousin, Hereford, and Shorthorn. Angus gained the best out of the group of breeds and Gelbvieh had the lowest rate of gain in comparison to Angus. The coefficient associated with the Simmental breed is -0.38, so this means that the Simmental bulls gained 0.38 pounds less than the Angus bulls. Gelbvieh's coefficient was -0.61, so they typically gained 0.61 pounds less than Angus. Limousin bulls had a coefficient of -0.61, so they gained 0.61 pounds less than Angus. Balancer bulls, which is a Gelbvieh and Angus cross showed good significance by displaying a coefficient of -0.51, so they gained 0.51 pounds less than purebred Angus bulls. Hereford and Shorthorn

bulls had coefficients of -0.48 and -0.47 respectively, so they gained 0.48 and 0.47 pounds less than the Angus bulls.

Four of the eight expected progeny differences proved to be significant in my research. These expected progeny differences were frame scoring, scrotal circumference measurements, birth weight, and yearling weight. Frame scoring is measured with a range of 2 through 9. Scrotal circumference is measured in centimeters. The coefficient for frame score was 0.17. This shows that a bull gained 0.17 pounds more with a 1-unit increase in frame score. Scrotal circumference displayed a coefficient of 0.02, so this indicates that the bulls gain 0.02 pounds more with a one-centimeter increase in scrotal circumference. Birthweight displayed a coefficient of 0.009, indicating that a one-pound larger birth weight would translate into the bulls having an average daily gain of 0.009 pounds more. Yearling weight is similar to birth weight, because the coefficient is 0.01, so the bulls that have a 1-pound heavier yearling weight typically have an average daily gain of 0.01 pounds more than the average.

The weather variables were temperature and precipitation. These variables proved significant and had the exact effect on average daily gain that I predicted. Temperature had a coefficient of 0.10, meaning that if the temperature raises by one degree, the bulls will gain 0.10 pounds of their average daily gain. Precipitation had a coefficient of -0.03, meaning that with an increase in precipitation of one inch, the bulls would lose 0.03 pounds of their average daily gain. These coefficients make perfect sense because as temperature rises, bulls require less energy for maintenance and can put more toward weight gain. On the other hand, as precipitation increases, the weather becomes worse and causes the bull's body temperature to decrease due to evaporation. This would in turn take more energy to meet the maintenance

requirement and less energy would be directed to overall gain. This would cause a lack of gain and average daily gain would decrease (Diersen and Fausti, 2019).

CHAPTER 6

CONCLUSION

The Southern Illinois University Bull Test Facility data and the weather data from the National Centers for Environmental Information proved to be great sources with very interesting information. Over half of the variables from these two data sets proved to be significant to the average daily gain of the bulls in the trial. For the breed variables, Simmental, Gelbvieh, Limousin, Balancer (Gelbvieh x Angus), Hereford, and Shorthorn all proved to have a significant coefficient in comparison with the base, Angus breed. The Angus bulls had the best average daily gain out of all of the other breeds, with Simmental, Shorthorn, and Hereford not far behind. This information could be very valuable to producers when selecting the type of genetics to introduce into their herds. Selecting purebred Angus or Angus crossbred genetics could mean a higher average daily gain for the entire herd, resulting in less feed purchased and a quicker turnover rate of production.

The expected progeny differences showed great variance with frame scoring, scrotal circumference, birth weight, and yearling weight having significant coefficients. These variables can be important for a producer to consider when deciding on which Bull to purchase. Purchasing a bull that has the expected progeny differences listed above can result in a higher average daily gain of its offspring. This could decrease the time it takes for the calves to grow and develop. Thus, cutting costs associated with producing calves for slaughter, and increasing the turnover rate and profits associated with selling the calves.

Lastly, the weather variables of temperature and precipitation proved to be significant and showed exactly what was expected. This finding is very interesting in the overall production

of calves. When temperature increases by one degree, the average daily gain of the bull increases by 0.10 pounds. The more desirable temperature would cause a heightened gain and better feed conversion because the bull would have less of a maintenance requirement and can put more energy towards overall gain. On the other hand, when precipitation increases by 1 inch, the average daily gain decreases by 0.03 pounds. The less desirable weather with more precipitation could cause a decrease in their overall intake and average daily gain. This is because the evaporation of liquid from their bodies brings down their overall body temperature. This causes the bull to direct more energy towards their maintenance requirements and less energy toward gain.

When making the major decision to install a structure to mitigate the weather effects in a producer's herd, many variables come into play. Assuming that producers have cattle on feed for six months or 180 days, average daily gain is important to minimize production costs. A 50 pound bag of feed roughly costs $10, which is $0.20 per pound. If a calf loses 0.03 pounds of average daily gain over the span of six months because of precipitation, it will lose 5.4 pounds entirely. This will cost the producer $1.08 per head. Alternatively, a calf with a heightened gain because of a one degree increase in temperature will gain 0.10 pounds of average daily gain. Over the span of six months, it will gain 18 pounds more. This will make the producer $3.60 per head. A hoop barn, which is the cheapest structure roughly costs $400 - $600 per head starting out and lasts on average, 10 – 12 years. Given this information, small cattle herds could not justify building a structure to mitigate the impacts of weather on their herd. But, large producers may consider it depending on their overall size. The other factor that needs to be taken into consideration is climate. A producer that is located in a cold climate, for example

North Dakota, would be able to justify a structure compared to producers from the Midwest or South.

In conclusion, the research shows some very important findings dealing with the production of beef calves. The breed characteristics and expected progeny difference variables can assist producers in making the correct management decisions to increase their profits. The main goal in the production of beef cattle is to increase the turnover rate, cut production costs, and ultimately increase the profits made. The agriculture industry is constantly changing and adapting to a growing populations demands and preferences. This research should be helpful in making those decisions that impact the production of beef cattle.

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Table 1: Weight Statistics

	205 Day Weight	Out-Weight	Average Daily Gain	365 Day Weight
Average	681	1329	4.53	1297
Standard Deviation	78	124	0.57	114
Maximum	960	1695	5.96	1601
Minimum	496	1008	2.88	1026

Table 2: Expected Progeny Difference Statistics

	Frame Score	Scrotal Circumference	Birth Weight	Yearling Weight
Average	6.13	39	2	71
Standard Deviation	0.87	3	2	19
Maximum	8.60	49	7	115
Minimum	4.00	32	3	13

Table 3: Muscling Statistics

	Rib Fat	Ribeye Area	Intramuscular Fat
Average	.41	14.98	3.48
Standard Deviation	.15	1.56	1.12
Maximum	.92	19.35	7.11
Minimum	.12	10.40	1.07

Table 4: Regression Analysis Results

Dependent Variable: ADG
Method: Least Squares
Date: 12/17/19 Time: 12:01
Sample (adjusted): 1 436
Included observations: 422 after adjustments

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	2.1930	0.5887	3.7248	0.0002
SIMMENTAL	-0.3821	0.1295	-2.9506	0.0034
CHAROLAIS	-0.1762	0.1330	-1.3243	0.1862
GELBVIEH	-0.6145	0.1672	-3.6748	0.0003
REDANGUS	-0.0389	0.1257	-0.3097	0.7569
LIMOUSIN	-0.6125	0.1309	-4.6777	0.0000
SXA	0.1451	0.1919	0.7564	0.4498
BALANCER	-0.5133	0.2510	-2.0452	0.0415
HEREFORD	-0.4777	0.1213	-3.9366	0.0001
SHORTHORN	-0.4669	0.2698	-1.7304	0.0843
FRAME	0.1745	0.0327	5.3361	0.0000
SCROTAL	0.0231	0.0089	2.5823	0.0102
PELVIC	-0.0004	0.0012	-0.3205	0.7487
BIRTHWT	0.0091	0.0033	2.7544	0.0061
BW	0.0263	0.0203	1.2911	0.1974
WW	-0.0062	0.0069	-0.8982	0.3696
YW	0.0100	0.0043	2.3180	0.0209
MM	-0.0013	0.0051	-0.2608	0.7944
PRECIP	-0.0290	0.0103	-2.8288	0.0049
TEMP	0.1030	0.0406	2.5372	0.0116

R-squared	0.331347
Adjusted R-squared	0.299744
Durbin-Watson stat	1.437222
F-statistic	10.48469

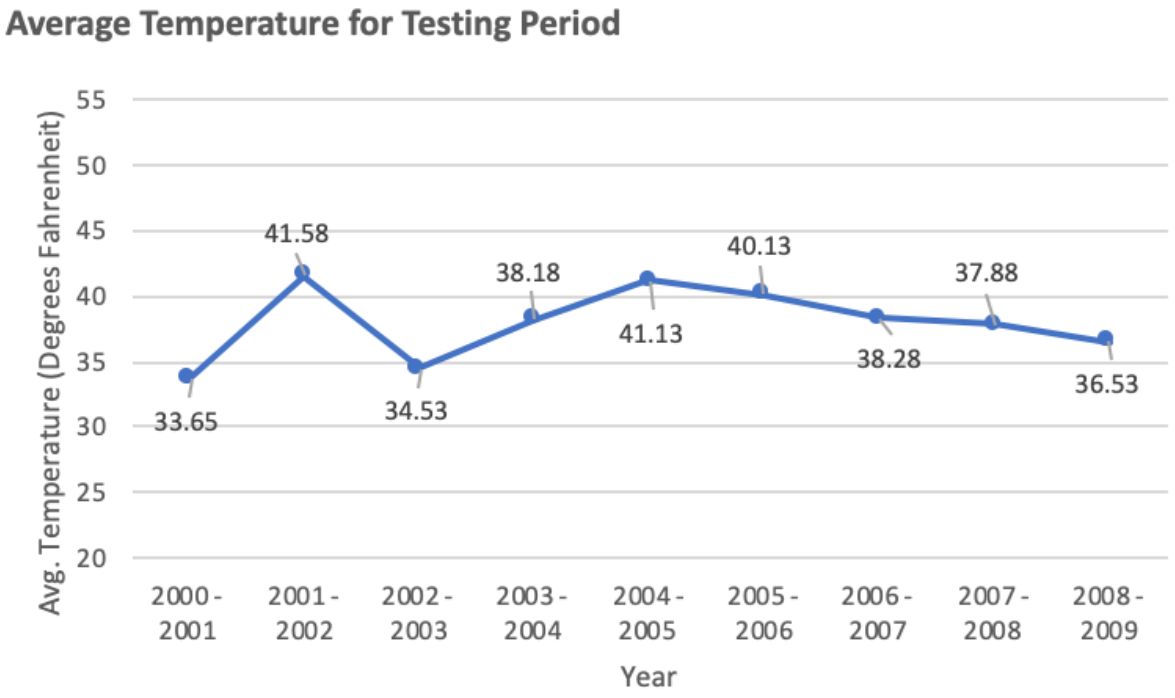

Figure 1: Average Temperature Per Month for Testing Period

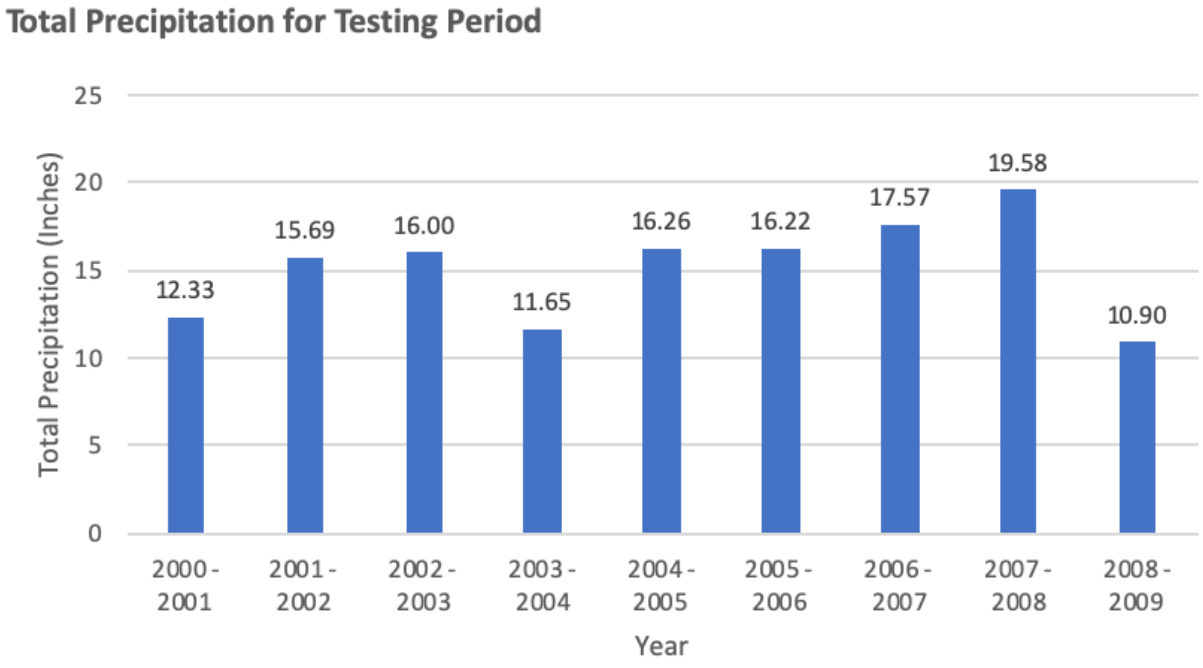

Figure 2: Total Precipitation Per Year for Testing Period

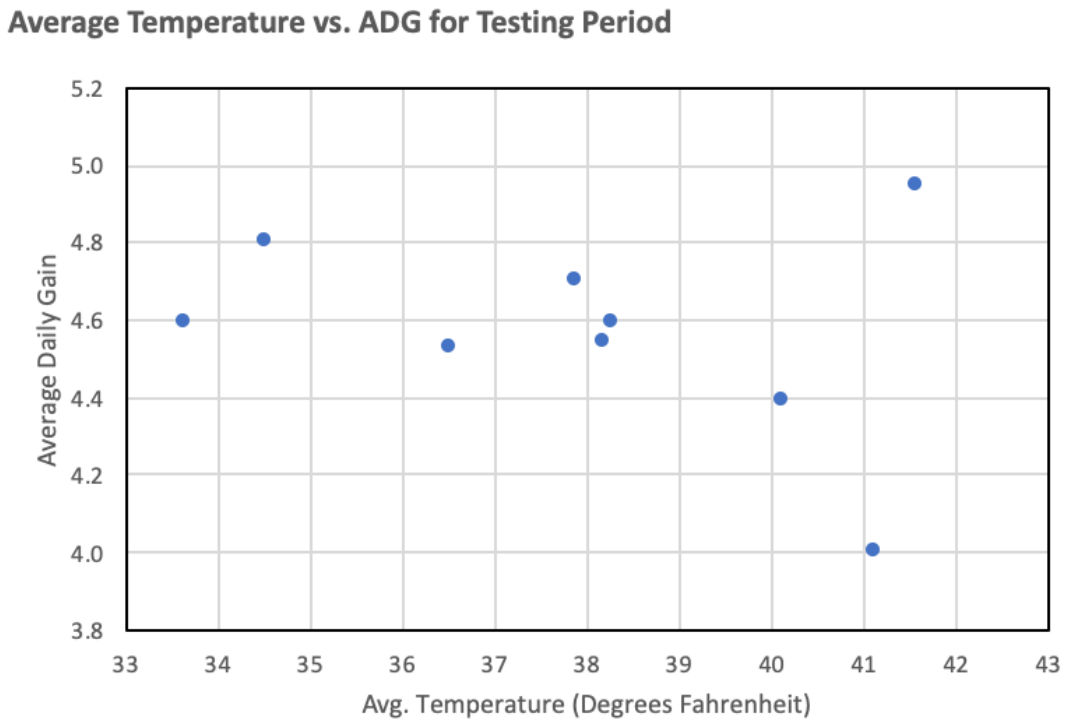

Figure 3: Average Temperature vs. Average Daily Gain

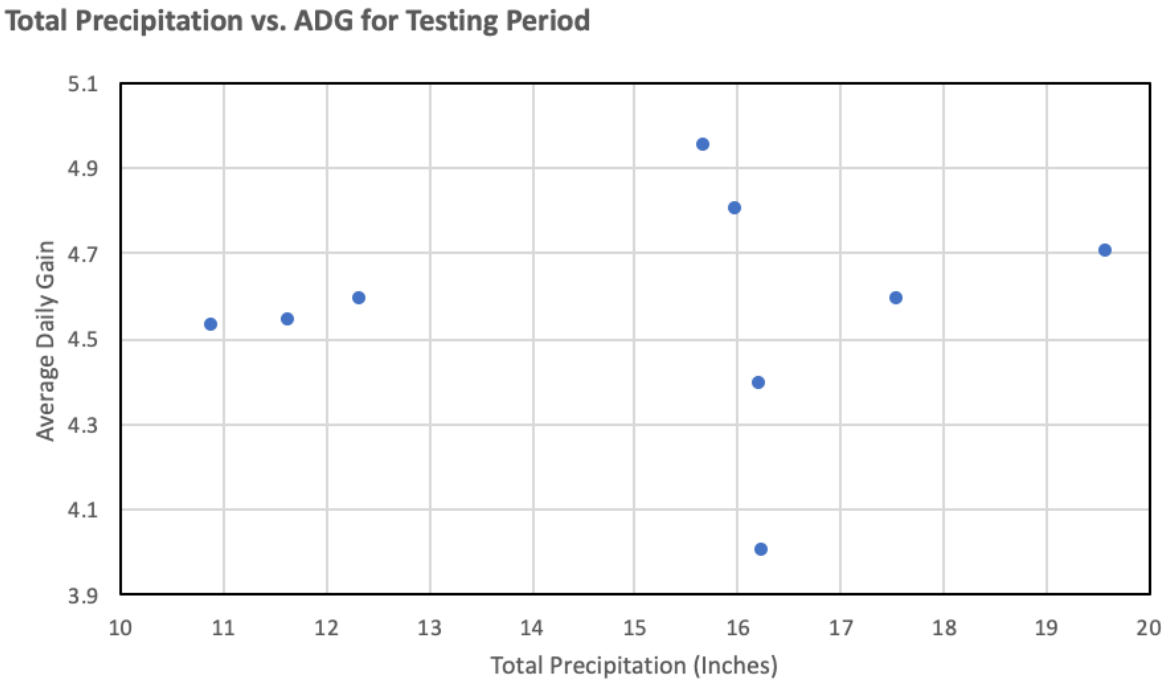

Figure 4: Total Precipitation vs. Average Daily Gain

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Major Professor: Dr. Dwight Sanders