EVALUATION OF USDA FEEDER CALF GRADES AND HEALTH STATUS OF STEERS AND THEIR IMPACT ON LIVE AND CARCASS PERFORMANCE IN SOUTH TEXAS

A Thesis

by

DAVID WAYNE GROSCHKE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2005

Major Subject: Animal Science

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Approved by:

Co-Chairs of Committee,	Andy Herring
	Chris Skaggs
Committee Members,	Jason Sawyer
	Danny Klinefelter
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ABSTRACT

Evaluation of USDA Feeder Calf Grades and Health Status

of Steers and Their Impact on Live and Carcass Performance

in South Texas. (August 2005)

David Wayne Groschke, B.S., Texas A&M University

Co-Chairs of Committee: Dr. Andy Herring
Dr. Chris Skaggs

In 2003-2004, the Texas A&M University Ranch to Rail South program evaluated 430 steers in Edroy, TX. Data were analyzed on several traits, but feeder calf frame and muscle grades and health status were emphasized. Muscle thickness grade (M), frame size grade (F), muscle thickness by frame size interaction (M*F), sire breed type classification (SIRECODE), lung score (LUNG), ranch of origin (RANCH), and level of treatment (LVLTRT) were evaluated as independent variables as affecting ribeye area (REA), marbling score (MARB), fat thickness (FAT), hot carcass weight (HCW), average daily gain (ADG), medicine costs (MED), days on feed (DOF), initial value (VALUE), carcass value (CARVAL), and initial weight (INWT). M ($P < .0001$), F ($P < .0001$), M*F ($P < .0001$), SIRECODE ($P < .0001$), RANCH ($P < .0001$), LVLTRT ($P = .0016$), and INWT ($P < .0001$) were all significant influences on initial value upon arrival. SIRECODE ($P = .0344$), RANCH ($P = .0571$), and INWT ($P < .0001$) were significant in impacting carcass value. RANCH ($P = .0045$) and INWT ($P < .0001$) were very significant influences upon ribeye area when the steers were harvested. RANCH ($P < .0001$) was also influential on marbling score, and LVLTRT ($P = .1096$)

was slightly significant for MARB. M (P = .0659), F (P = .0721), and M*F (P = .0722) were moderately significant in influencing fat thickness. However, SIRECODE (P = .0148) and RANCH (P < .0001) were significant in impacting FAT. HCW was significantly affected by SIRECODE (P = .0056), RANCH (P < .0001), and INWT (P < .0001). For live performance, SIRECODE (P = .0120) and RANCH (P < .0001) were significant influences upon average daily gain. SIRECODE (P < .0001), RANCH (P < .0001), LVLTRT (P < .0001), and INWT (P < .0001) were significant influences on days on feed for the steers. Finally, RANCH (P < .0001) and LVLTRT (P < .0001) were significant in affecting medicine costs. These findings suggest ranch of origin and breed type play major roles in affecting live and carcass performance.

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INTRODUCTION

With the increased use of crossbreeding and producers altering their breeding decisions to fit the current trends of the beef industry, variability in cattle size and body type has been prevalent. These differences in cattle size and type have put many extremes through the market phase. Many beef producers want to know what type of cattle to produce to capture the highest value for their product, and what type of cattle generate the performance and carcass results that will maximize profit. The USDA specifies feeder cattle grades to describe muscle thickness and frame size of young cattle. Cattle frame size is thought to impact growth response and influence numerous profit or loss factors at the end of the feeding period prior to harvest. Muscle score is also thought to indicate positive or negative effects on carcass data and end value. However, the impact of feeder calf grade on these traits has not been widely reported. Past studies have shown that large framed cattle can have increased carcass weights, higher daily gains, and heaviest slaughter weights but can be the least efficient in converting feed to gain, have lower quality grades, and require the most days on feed. Smaller framed cattle are expected to be the most efficient in certain scenarios and be more apt to reach higher quality grades. Heavier muscled cattle are estimated to have an advantage in daily gain and carcass weight but a disadvantage in fat accretion.

Furthermore, another very important factor in determining profitability is the health of the cattle, which can show definite dividends to live performance, cost of gain, and final carcass traits. Many beef industry specialists stress the need for a sound and

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This thesis follows the style and format of Animal Science.

thorough vaccination program at the ranch of origin for cattle to maximize performance and remain healthy. Morbidity and mortality figures can greatly influence a producer's margin of profit. Mortality is certainly meant to be avoided and results in zero return for that individual animal, but morbidity can cost producers even more with the expenses of treatment, labor, and loss of performance. It is also important to determine how these morbid cattle perform on the rail and from profit or loss perspective. This information can be utilized to send the message to producers and feeders that a sound vaccination program will allow them to enhance profit potential and reflect differences on end value characteristics. Producers may wonder if this adds value to their cattle or just adds more expenses to their product. Additionally, how related clinical diagnosis of disease is to the presence or absence of lung lesions at harvest is a question that is unknown. Past research has suggested that cattle that remain healthy tend to outperform calves that require treatment from a weight gain basis. These non-treated calves also show to be more apt to deposit more fat internally and externally, and then reach higher quality grades. Studies have also shown calves that require treatment more than once have major and significant decreased live and carcass performance compared to non-treated calves.

The main objectives of this study were to determine the effects of clinical diagnosis of disease on live performance and carcass traits. Pathological measures of lung lesions were investigated to monitor their relationship with performance responses. Frame and muscle scores were investigated to influence carcass results and live performance. Also, the relationship between clinical treatment and presence of lung lesions at harvest was investigated. The ultimate goal of this type of research is to deliver valuable feedback to the producers to better predict the final value of their cattle in retained ownership scenarios.

LITERATURE REVIEW

The health of cattle can play a very significant role in profit potential for producers. Healthy cattle do not require treatment and antibiotics, nor do they require the extra labor and time to the producer or feeder of being run through the chute for medications. The major impact of health problems on calves is the inability to fully express their genetic potential, and the costs associated with sick cattle extend beyond just the cost of treatment (McNeill, 1999). Over a five-year summary of Ranch to Rail data, 12,595 steers were classified as either sick or healthy, based on whether or not they were treated for disease. Healthy cattle (based on physiological symptoms) numbered 9,393 head and sick cattle numbered 3,202 head. Healthy steers had only a 0.5% death loss, while sick steers had a 3.4% death loss. Performance reflected differences as well, as healthy steers gained .08 kg/d more than sick steers (1.34 vs. 1.26). Total cost of gain was computed per 45.5 kg. Cost of gain was lower for healthy steers ($56.68) than for sick steers ($65.96). Medicine costs per steer were calculated for sick steers was $31.33, and healthy steers (not treated) had cost of $0. Net return then reflected an advantage for healthy steers over sick steers as healthy calves returned a positive $61.23 per head, while sick steers lost $31.97 per head. The total difference in value between a healthy steer and a sick steer was $93.20. There were also differences shown in carcass data between the two groups. Healthy steers had a better chance of marbling as 39% of them graded U.S. Choice, whereas only 29% of the sick steers graded U.S. Choice. The sick steers did have a better opportunity of grading U.S. Standard, as 8% of them achieved this, whereas only 5% of the healthy steers obtained this grade in a much larger sample size (McNeill, 1999).

Morbidity, or sickness in cattle, can greatly reduce average daily gain (ADG), increase expenses due to medicine costs, require more labor, and result in premature culling (Smith, 1998). In a similar trial, Smith (1996) reported that during receiving periods of 28 days, steers that became sick and required treatment had .23 kg less ADG, and Bateman et al. (1990) recorded similar findings and determined healthy steers gained .14 kg/d more than steers requiring treatment. Additionally, cattle documented as sick more than once can spread the margin even farther as evidenced in a 90 day Canadian feeding trial, where calves with one period of sickness had .18 kg lower ADG than healthy steers, and calves with two periods of sickness had .33 kg lower ADG (Morck et al. 1993). This is a very significant difference and can certainly be detrimental to the producer’s profit margin. Wittum et al. (1995) reported in their 273 day feeding trial that calves with lung lesions at slaughter had .08 kg less ADG than calves that remained healthy. Direct medical expenses not only account for immense costs, but decreased performance of cattle is another source of value loss. From 1992-1995, Ranch to Rail data showed that medical expenses averaged from $20.76 to $37.90 per treated animal. When this factored in to total production cost, calves that got sick had $.19 to $.35 less value per kg of the purchase weight than calves that remained healthy during the trial (Smith, 1998). This particular finding also reported that respiratory disease was the most common source of morbity. Edwards (1996) stated that 67-82% of calves that got sick during their trial were due to respiratory disease, only 3-

7% was due to digestive disorders, and the remaining 14-28% was other causes such as injury, urinary calculi, and prolapse. They also reported that cattle got sick sooner than later as 65-80% of the sick cattle became sick in the first 45 days of arrival. This is also true for mortality, as a higher percentage will die in the first 45 days than past 90 days into the feeding period (Edwards, 1996). Vogel and Parrott (1994) concluded mortality is the lowest in April and the highest in December for feedlots in the Great Plains. Their data set included beef cattle and Holstein cattle from 1990 to 1993. Mortality rates were .179% in April and .425% in December and had a monthly mean of .268%. To put this into perspective, in a 10,000 head feedlot, 27 steers would die each month. However, Holstein death losses were significantly higher than the beef breeds, as they died more from digestive disorders and they had been in the yard as calves with a more extended time on feed. Therefore, the total number of predicted deaths of calves each month could probably be lowered by only using beef breeds. Also, environment and climate factors, along with placement numbers and placement weight, play significant roles in determining these results. Obviously, cattle that die in the latter part of the feeding period are more costly because of a greater investment in medication and feed expenses (Smith, 1998).

Bovine respiratory disease (BRD) is the most common disease problem in a feedlot setting. Edwards (1996) indicated that 75% of morbidity and 50% of mortality in feedlots is attributable to BRD. However, some cattle that have been treated are still not detected with any lesions at slaughter, and some cattle that have never been treated end up with respiratory tract lesions in the end. McNeill (1999) reported healthy steers, those that were not treated for sickness, had higher average daily gains than sick steers, those that received treatment for clinical signs of disease. Healthy steers gained 1.33 kg/d and the sick steers gained 1.26 kg/d. The healthy steers achieved the choice grade more frequently with a 12% advantage over treated steers. On the other hand, while still concurring with these results, Wittum et al. (1996) reported that while only 35% of steers in their trial were diagnosed with BRD, 72% had pulmonary lesions at slaughter. Also, of the treated cattle, 28% failed to show any sign of respiratory tract lesions. Gardner et al. (1999) conducted a trial with 204 steers to determine performance and carcass results with healthy steers, steers treated once for BRD, steers treated more than once, and also evaluated lung lesions at the time of slaughter. Steers that were treated were calves that had rectal temperatures that exceeded 40°C. Of the 204 calves in the trial, 102 (50%) were treated at least once. Steers not receiving treatment once again outperformed the treated steers in ADG, 1.53 kg/d vs. 1.47 kg/d. This trial lasted 150 days, so that meant that healthy steers gained 9 kg more than sick steers. At slaughter, sick steers had 7.5 kg lighter carcass weights than the healthy steers. Van Donkersgoed et al. (1993) reported similar results as sick steers were gaining 1.11 kg/d, and healthy steers were gaining 1.25 kg/d. Also, Gardner et al. (1999) reported steers that were treated just once outperformed the steers that were treated more than once by .14 kg/d (1.49 vs. 1.35). This showed steers treated just once gained an additional 21 kg compared to steers that were treated more than once. These results again match up well with Van Donkersgoed et al. (1993), who reported a .49 kg/d difference between steers treated once and steers treated more than once. The steers in that trial that were treated once gained 1.19 kg/d and the steers that were treated more than once gained .70 kg/d. Of the 102 steers never treated for sickness in the Gardner et al. (1999) trial, 37% still had lung lesions at the time of slaughter. The steers that were treated for clinical signs of disease had lung lesions in 48% of the cattle. As earlier mentioned, Wittum et al. (1996) reported that lung lesions occurred in 72% of the treated steers in their trial. For the steers never treated, it could be concluded that lesions occurred prior to the feeding phase and stayed permanently or that respiratory infection came from a viral rather than a bacterial source. Due to the fact that 52% of the treated steers did not have any lesions reveals that clinical diagnosis of disease was not precise, subclinical infections were detected, or a full recovery was accomplished (Gardner et al., 1999). Steers that were detected for respiratory tract lesions had lower final weights as the steers without lesions gained 11% more weight per day than their contemporaries. The steers without lesions gained 1.58 kg/d and the steers with lesions gained 1.40 kg/d. There were 117 steers without lesions detected and 87 were detected with lung lesions, and the steers without lesions clearly outperformed their counterparts.

The carcass data reported on this same set of treated and untreated calves documented differences as well. While dressing percentage did not drastically differ between the two groups, a slight advantage occurred for steers never treated over steers that did receive treatment more than once. These steers treated more than once were a percentage point below steers that were never treated, 63.5 and 62.6 respectively (Gardner et al., 1999). However, carcass weights did differ, as steers that were treated were harvested with 2.3% lighter carcass weights than non-treated steers that did not receive treatment. Fat thickness was also influenced. Steers that went untreated had more internal and external fat. External fat was measured based on subcutaneous fat. Untreated steers averaged 1.17 cm of external fat, steers treated once averaged 1.09 cm of subcutaneous fat, and the steers treated for BRD more than once averaged only .76 cm. Internal fat was measured as a percentage of kidney, pelvic, and heart fat, and untreated steers had higher percentages of KPH than treated steers. Steers that did not receive treatment also tended to have larger longissimus muscle areas.

Quality grade also proved noteworthy differences. Steers that were not treated had a higher percentage of carcasses that graded U.S. Choice and U.S. Select and steers that did receive treatment had a higher percentage of carcasses that graded U.S. Standard. Of the steers treated more than once, none graded U.S. Choice, and 23.1% of these steers graded U.S. Standard (Gardner et al., 1999). Another notable difference was also detected in steers with or without lesions at harvest. Steers that did have respiratory tract lesions had slightly lower dressing percentages, 61.8 vs. 63.6, than steers that did not have any lesions. Carcass weight proved to have a large gap between the two groups. The steers without respiratory tract lesions had 14.82 kg heavier carcass weights than those steers with lesions (334.8 vs. 319.98). Steers without lesions were also fatter both externally and internally as well. External fat for steers without lesions measured at 1.15 cm, and the steers with lesions measured with 1.05 cm of subcutaneous fat. Kidney, pelvic, and heart fat revealed a slight advantage for steers without lesions as they recorded 2.3%, and steers with lesions had 2.1% (Gardner et al., 1999). Steers without lesions also had more longissimus muscle area. Steers without lesions recorded

86.6 sq cm and the steers with lesions recorded 83.5 sq cm. These steers without lesions were heavier muscled and fatter, which helped to keep these steers having a good combination of quality and yield grade. The steers with lesions had a lower numerical yield grade because of being leaner, but it was insignificant, 2.5 vs. 2.6. Quality grade was another important factor to discuss. Steers without respiratory tract lesions graded U.S. Choice more frequently, 5.1% vs. 3.33%, and also most of the steers without lesions achieved the U.S. Select grade as well. The steers without lesions, 91.4%, made these two grades compared to only 75.8% of the steers with lesions. The steers with lesions also tended to produce carcasses that graded U.S. Standard more often, as 19.6% of these steers achieved this grade, compared to 8.6% of steers without lesions (Gardner et al., 1999). These results show that morbidity due to respiratory illness can decrease performance, lower carcass weights, depress fat deposition, and prevent steers from maximizing longissimus muscle area. Lung lesions proved to be a better indicator than clinical appraisal of disease as steers with lesions had lower carcass quality and a definite drop in performance.

Feeding and watering behavior is one reason why decreased performance can be seen for morbid steers compared to healthy steers. Sowell et al. (1999) reported that steers that were treated for clinical disease spent 23% less time eating at the feed bunk and also made fewer trips to the bunk during a 32 day receiving trial. It was reported that the first four days shows the widest spread in time at the bunk, as the healthy steers spent 47% more time eating. Two more trials were conducted in 1996 in Arizona (Sowell et al., 1999). The first trial was in July, and the second followed in November.

Radio frequency technology was used to determine appearances at the feed bunk. In trial one, healthy steers spent more time at the feed bunk than morbid steers. Of the 108 steers in trial one, 57 were recorded as morbid. In trial two, 117 of the 143 steers were identified as morbid. On the first day one of trial one, 94% of the healthy steers appeared at the feed bunk, while 87% of the morbid steers appeared at the bunk. On the first day of trial two, only 13% of the healthy steers appeared at the bunk, but then only 10% of the morbid steers showed up at the feed bunk either. By the third day of trial one, 100% of the healthy steers appeared at the feed bunk for at least five minutes, while 91% of the morbid steers spent time at the bunk. By day four in trial two, 100% of the healthy steers were eating feed at the bunk and only 76% of the morbid steers were at the feed bunk (Sowell et al., 1999). These numbers agree with past reports by Hutcheson and Cole (1986) that reported that 39% of healthy steers consumed feed on day one, while 27% of sick steers consumed feed, and, that by day seven, 88% of the healthy steers were eating, while only 70% of the morbid steers were eating. Feeding bouts and time spent at the feed bunk reflected differences as well. In trial one, during the first four days, healthy steers spent 59 min/d at the feed bunk and morbid steers spent 31.2 min/d. During the entire receiving period, the healthy steers spent 60.4 min/d at the bunk and the morbid steers spent 46.3 min/d at the bunk. Time drinking water showed no major differences. In trial two, during the first four days, healthy steers spent 50.7 min/d at the feed bunk, and morbid steers spent 32.6 min/d. For the entire period, there was just a slight difference of 45.8 min/d and 41.0 min/d for healthy and sick steers. Once again, watering behavior was fairly equal (Sowell et al., 1999). Healthy steers also had more feeding bouts per day than sick steers. Healthy steers had 3.7 more trips to the feed bunk during the first four days in trial one than sick steers, 10.5 vs. 6.8. In trial two, the healthy steers visited the feed bunk three more times per day, 7.8 vs. 4.8. During the 32 day trials, the healthy steers in trial one had 10.9 bouts/d and the morbid steers had 9.8 bouts/d. In trial two, the healthy steers had 14.8 bouts/d, and the sick steers had 13.3 bouts/d (Sowell et al., 1999). This trial revealed that the first four days after arrival show the most pronounced differences in feeding behavior and also that healthy steers do spend more time eating and make more trips to the feed bunk than morbid steers.

Other factors that can affect performance besides health are frame size and muscle thickness. These two factors are the components of the USDA feeder cattle grades. The USDA has three frame size grades: Large, Medium, and Small. Currently, there are four muscle thickness scores: #1, #2, #3, and #4. Most beef cattle will be either: #1, 2, or 3 while dairy cattle will fall into the #4 muscle score for the most part. Past research by Camfield et al. (1997) has shown that frame size and muscle thickness can affect live and carcass performance. Large framed cattle had higher daily gains and heavier carcass weights, while medium frame cattle, or non large frame cattle in their particular study, had more internal fat, higher marbling scores, and greater fat thickness. Frame size and muscle thickness have shown to affect time on feed, which in turn will affect cost of production.

Frame size and muscle thickness can certainly correlate into how many days it requires beef heifers or steers to be on feed prior to slaughter. The fewer the days on feed for cattle, the lower the production costs, and this means profit capabilities increase.

Dolezal et al. (1993) evaluated how frame size, muscle thickness, and age of calves influenced days on feed, carcass weight, fat deposition, and carcass composition. With increased age and decreased frame size, the number of days on feed for a group of 189 steers was reduced. Large frame steers required an average of 213.7 d on feed to reach 13 mm of subcutaneous fat. The medium framed steers stayed on feed for 162.5 d, and the small framed steers were on feed the fewest days at 138.8 d to reach the same endpoint. As expected, slaughter weight and carcass weight increased with increased frame size, and dressing percentage slightly increased with frame from 61.5% for small, 62.8% for medium, and 63.2% for large cattle. Muscle thickness also affected days on feed. The #1 muscled steers required the least amount of days on feed at 138.5, then the #2’s at 156.1, and the #3’s were on feed for the longest period, 219.5. This explained why, though, that #3 muscled cattle had heavier carcass weights and slaughter weights than #1’s or #2’s because of the extended time on feed. There were no differences in dressing percentage for the different muscle thickness scores. For the interaction of frame size and muscle thickness, several observations should be noted. The #3 muscle cattle required the most days on feed in all frame sizes as small #3’s, medium #3’s, and large #3’s spent the most time on feed compared to the other six groups. Small #1’ spent the least amount of time on feed, followed by small #2’s and medium #1’s. For carcass weight, the frame size and muscle thickness interaction revealed that all three of the large frame combinations were the heaviest on the rail. Small framed #2’s and #1’s were the lightest followed by small #3’s (Dolezal et al., 1993). This study shows that the USDA’s category system for predicting feeder calves frame size to reach a similar carcass composition was accurate and that frame size and muscle thickness and their interactions directly correlate to days on feed, carcass weight, and subcutaneous fat deposition.

In a research trial done by Baggett et al. (2002), 120 feeder steers were selected for use in a 3 x 2 experiment to evaluate frame and muscle grades. The three frame size scores were represented along with muscle score #1 and #2. There were 20 large #1's, 20 large #2's, 20 medium #1's, 20 medium #2's, 20 small #1's, and 20 small #2's. Live performance and carcass data were collected to determine differences. The small framed cattle proved to be more efficient in converting feed to gain. Number one muscled cattle also had lower feed conversion, or increased feed efficiency. Large framed cattle had significantly higher carcass weights than medium and small framed cattle. Yield grades were greatly affected by muscle thickness score. Number one muscled cattle also had significantly lower numerical yield grades than #2 muscled cattle. This supports the USDA's use of muscle score to help predict future yield grades for cattle. Where this research trial focused primarily was on a profit model to determine revenue produced for the different feeder cattle grades. Muscle score did not prove to be a significant factor in determining revenue per animal, but frame size did, however. Overall, with small framed cattle being more efficient and spending less time on feed, they proved to be $21.13 per head more profitable than medium framed cattle, and the medium framed cattle made $12.93 per head more than large framed cattle. This would compute to prove that small framed cattle were $34.06 more profitable than large framed cattle. These cattle were bought at a fixed point in time, and it is important to note that prices fluctuate frequently; therefore, these spreads do not hold true year after year. However, the cattle buyer was instructed to buy wisely, and these results will be discussed. When these cattle were sold on a grid, the same results as above were reported with small framed cattle outdistancing large framed cattle by a wide margin. *Ceteris paribus* (all other things held constant or equal) is a term discussed that can explain profit: the lower the input price, the higher the profit potential (Baggett et al., 2002). May et al. (1992a) studied total carcass value and determined that large framed cattle had the most value over medium and small framed cattle, even for three different trim levels on carcass fatness. They concluded that carcass fatness and muscle score had the greatest effect on value. Thick muscled cattle were worth more than average muscled cattle, and average muscled cattle were worth more than thin muscled cattle from a total carcass value standpoint (May et al., 1992a). Grona et al (2002) researched the 1979 USDA feeder cattle grading system and offered suggestions to change the guidelines, specifically wanting to add a fourth muscle score. Their research detailed that most "beef type" cattle would fall into #1 muscle thickness score and that there were virtually zero #3 muscled cattle. That meant that all cattle were either #1's or #2's. Their suggestions were to add a #4 muscle score, which would take the place of the old #3's and then it would harder for cattle to also get thrown into a #1 muscle thickness score as well. Their suggestions made the USDA revise the 1979 standards in October of 2000, using their results from this study (Grona et al., 2002). Of 864 steers and heifers in their study, 323 were placed into the muscle score #1 group, 277 were put in the #2 group, 244 were placed in the #3 group, and 20 were in the #4 muscle thickness score group. Dressing percentage proved to be the highest for the heavier muscled cattle and declined slightly for the rest of the groups. Yield grade showed the most significant difference between the four muscle groups, being the most desirable for the #1 muscled cattle and then declining with each drop in muscle score. The other factor that was greatly influenced was longissimus muscle area, as the #1 muscled cattle had the largest area and then the measures declined with each drop in muscle thickness score (Grona et al., 2002).

May et al. (1992b) did another study with 329 commercial slaughter steers and 335 heifers to determine beef carcass composition with differing frame sizes and muscle scores. Their results concluded that muscle score had the greatest effect on percentage yield of round and rib, as thick cattle yielded the most, and the percentage lowered with decreased muscling. They classified muscle as either: thick, average, or thin. The thick muscled cattle had the largest longissimus muscle areas at 89.9 cm^2, followed by average muscled calves at 78.7, and the thin muscled cattle measured 72.2, respectively. Hot carcass weight followed the same trend with thick muscled cattle weighing 323.2 kg on the rail, average muscled cattle at 304.6, and thin muscled cattle at 270.7. Yield grade was also the most desirable for the thick muscled group as they registered a 2.4 on the average, while the other two were at 3.0 and 2.9. Live weight showed the same results as above as they went from thick to thin. There also proved to be a higher percentage of ribeye roll, chuck roll, and strip loin yield for the thick muscled cattle than for the average or thin muscled cattle. Also, as muscle score went from thick to thin, the estimated yield of inside and outside round decreased (May et al., 1992b). These results show that the thick muscled cattle produce a higher percentage of retail cuts compared to average or thin muscled cattle. Thus, thick muscled cattle have the potential to capture more carcass value at harvest.

MATERIALS AND METHODS

The data for this investigation were obtained from the 2003-2004 Texas A&M University Ranch to Rail Program South. The calves were fed out at Hondo Creek Cattle Company in Edroy, Texas. This collection included 430 steer calves. Upon arrival in October and November 2003, steers were processed, individually identified with eartags, and weighed. Processing included a modified live vaccine for respiratory disease, clostridial vaccine, implant, and dewormer. Steers with a rectal temperature of 40 °C or greater were administered an antibiotic to counter bovine respiratory disease. Each individual steer was assigned an initial value per 45.4 kg weight basis based on their frame score, muscle score, and weight in accordance with the current market conditions of the local feedyard trade area. Steers were then sorted into pens based on weight, frame size, and body condition. Steers were fed and managed under normal operating procedures for the feedlot throughout the trial.

Steers were marketed at an acceptable weight and fat thickness by current beef industry trends. Cattle were weighed individually at the conclusion of the feeding phase, and a 4% pencil shrink was applied to determine live sale weight, and this was used for calculations of feedyard performance. The steers were sold on carcass basis at a commercial beef plant, and premiums and discounts for quality grades, yield grades, and carcass weights were assigned. A USDA grader determined the quality and yield grades at the harvesting plant. As steers were harvested, electrical stimulation was applied to each carcass to enhance tenderness. Lung scores were given to steers based on a 5 point scale (1 – 5). A steer with a score of one had zero lesions at slaughter, a steer with a score of two had one lesion, a steer with a score of three had two lesions, a steer with a score of four had three lesions, and a steer with a score of 5 had four lesions at slaughter. The producers of the steers were then given the differences between the carcass values and the feed, medicine, and processing expenses.

There were several modifications applied to the data set in order to analyze it thoroughly. There were many different breeds used for sires and dams from the various ranches involved in this program. Therefore, the sire breeds were grouped into a biological type code. Group one was British-sired steers, group two was Continental-sired steers, group three was American-sired steers, group four was Brahman-sired calves, group five was ¾ Hereford ¼ Brahman-sired steers, group six was Santa Gertrudis x Braunvieh-sired steers, and group seven was sale barn-sired calves for which exact breed composition was unknown or unreported. This allowed for a more detailed analysis with fewer categories due to the diverse breeding decisions of the producers. These groups are presented in Table 1. Due to the large numbers of different breed types of dams, with less obvious groupings, genetic type of dam was not included in the analyses. Also, medicine costs had a wide range ($0 - 124.66) of disparity, and a number value for level of treatment of 1 - 4 was assigned for better analysis. Steers with a medicine cost of $0 equaled a level of treatment value of 1. Costs between $.01 - 14.99 were assigned a value of 2, medicine costs between $15 - 39.99 became level of treatment 3, and steers that required $40 or more, were assigned a value of a 4. These breakpoints were assigned to separate one treatment from two treatments and multiple treatments for a score of 4.

Table 1. Sire code by biological type and breed classification

Sirecode	Breed type/classification	n
1	British breeds	108
2	Continental breeds	85
3	American breeds	183
4	Brahman	27
5	3/4 Hereford 1/4 Brahman	3
6	Santa Gertrudis x Braunvieh	7
7	Sale Barn	10

The General Linear Model Procedure of the SAS statistical package (1999-2000) was used to analyze these data. The independent class variables used in each analysis were feeder calf muscle thickness (M) and frame size (F), muscle thickness score and frame size interaction (M*F), sire breed type classification (SIRECODE), lung score (LUNG), ranch of origin nested within sire code (RANCH), and level of treatment (LVLTRT). The dependent, or response variables, included in the analyses were ribeye area (REA), marbling score (MARB), fat thickness (FAT), hot carcass weight (HCW), average daily gain (ADG), medicine costs (MED), days on feed (DOF), initial value upon arrival in the feedyard (VALUE), and carcass value (CARCVAL). These variables were analyzed with initial weight at arrival in feedlot (INWT) as a covariate.

The frequency procedure (PROC FREQ) in SAS (1999-2000) was used to determine the incidence of sires used and grouped into a biological type category. Phenotypic correlations were analyzed with the correlation procedure (PROC CORR) in SAS between ribeye area, marbling score, fat thickness, medicine costs, temperature upon arrival (TEMP), lung score, hot carcass weight, average daily gain, carcass value, days on feed, initial weight, final weight at end of feeding phase (OUTWT), and initial value.

The association of lung score and level of treatment were analyzed using PROC FREQ (Table 2). When the data were evaluated, a few interesting facts surfaced. There was one steer in the trial that had a lung score of 5 and a level of treatment at 1, or no treatment. This particular steer had 4 lung lesions at slaughter, yet never was treated for disease. Also, eight more steers that were never treated had a lung score of 4 (3 or more

Table 2. Distribution of lung scores by level of treatment

	LVLTRT[a]				
LUNG[b]	1	2	3	4	Total
1	86	27	11	11	135
2	127	21	16	14	178
3	39	4	9	7	59
4	8	0	0	1	9
5	1	0	0	0	1
Total	261	52	36	33	382

[a]Level of treatment, 1 = \$0, 2 = \$.01-14.99, 3 = \$15-39.99, 4 = \$40 or more

[b]Lung score, 1 = 0 lesions, 2 = 1 lesion, 3 = 2 lesions, 4 = 3 lesions, 5 = 4 or more lesions

lesions). This shows that clinical appraisal of respiratory disease is likely inaccurate and very difficult for feedlot managers and workers to identify and treat the correct cattle. Also, 25 steers that received the most treatment from the feedlot and these steers had either zero or one lesion at harvest. These steers could either have been cured for respiratory disease, or they were administered an antibiotic for no reason. Calves that are treated metaphyllactically will all be treated and this can prove to be a waste of time and money. Ranch of origin was significant possibly due to genetics or to some calves entering the feedyard having been vaccinated and some have not, and the use of different vaccination protocols used by producers, or possible interactions of these. The different schemes the ranches utilize before entering their cattle in this program definitely plays a role in their health throughout the trial.

RESULTS AND DISCUSSION

General Statistical Summaries

The statistical summary is presented in Table 3. There were differences in total number of observations for variables due to incomplete data on several steers throughout the trial. The average ribeye area was 92.43 sq cm with a standard deviation of 13.48 sq cm, with a range of 12.26 sq cm to 139.32 sq cm. Marbling score had an average of 455.58 (small 56) with a standard deviation of 85.14, and maximum at 840 (moderately abundant 40) and minimum of 200 (traces 0). Fat thickness was recorded with a mean of 1.17 cm, standard deviation of 0.51 cm, maximum of 3.30 cm, and a minimum at 0.13 cm. Medicine costs averaged $9.27 with a standard deviation of $20.86. The range was from $0 - $124.66. The rectal temperature of the steers averaged 39.08 ^{o}C with a standard deviation of 0.94 °C. The maximum was 41.44 °C and the minimum was 37.83 ^{o}C. Lung score averaged 1.83 out of the 1-5 scale it was measured upon with a standard deviation of 0.71; the maximum was 5, and the minimum was 1. Hot carcass weight (HCW) averaged 370.19 kg with a standard deviation of 38.86 kg. Average daily gain (ADG) had a mean of 1.43 kg and had a standard deviation of 0.23 kg. The average carcass value (CARCVAL) for the steers was $1,077.00 with a standard deviation of $189.11. Days on feed (DOF) averaged 217.5 d and had a standard deviation of 25.32 d. The steer's initial weight (INWT) in the feedlot was 266.92 kg with a standard deviation of 59.70 kg. Out weight (OUTWT), or final live weight, averaged 600.45 kg with a standard deviation of 58.60 kg. Initial value into feedlot was 525.84 and had a standard deviation of 86.38. Maximum levels were HCW (508.18 kg), ADG (2.41 kg), CARCVAL ($1532), DOF (250 d), INWT (514.55 kg), OUTWT (802.27 kg), and VALUE ($849). Finally, the minimum levels were HCW (248.64 kg), ADG (0.84 kg), CARCVAL ($0), DOF (174 d), INWT (146.36 kg), OUTWT (434.55 kg), and VALUE ($322).

Table 3. Summary of traits for simple statistics

Variable	n	Mean	SD[a]	Minimum	Maximum
REA[b]	419	92.43	13.48	12.26	139.32
MARB[c]	419	455.58	85.14	200.00	840.00
FAT[d]	419	1.17	0.51	0.13	3.30
MED[e]	430	9.27	20.86	0.00	124.66
TEMP[f]	385	39.08	0.94	37.83	41.44
LUNG[g]	382	1.83	0.71	1.00	5.00
HCW[h]	422	370.19	38.86	248.64	508.18
ADG[i]	423	1.43	0.23	0.84	2.41
CARCVAl	430	1077.00	189.11	0.00	1532.00
DOF[k]	423	217.50	25.32	174.00	250.00
INWT[l]	430	266.92	59.70	146.36	514.55
OUTWT[m]	423	600.45	58.60	434.55	802.27
VALUE[n]	430	525.84	86.38	322.00	849.00

[a]Standard deviation	[h]Hot carcass weight (kg)
[b]Ribeye area (cm^2)	[i]Average daily gain (kg)
[c]Marbling score	[j]Carcass value ($)
[d]Fat thickness (cm)	[k]Days on feed (days)
[e]Medicine costs ($)	[l]Initial weight (kg)
[f]Temperature (°C)	[m]Out weight (kg)
[g]Lung scores 1-5	[n]Initial value ($)

Analysis of Variance

Ribeye Area (REA). Ranch of origin showed a significant effect on ribeye area (P = .0045) (Table 4). This shows that ranch's genetic schemes and/or general management practices play a significant role in how these steers perform from a muscular standpoint. The backgrounding and how ranches breed their steers likely influenced the performance of the steers in relation to longissimus muscle area. However, the purpose of this study was not to compare ranches, therefore, ranch to ranch comparisons will not be discussed. Surprisingly, feeder calf muscle score revealed to be an insignificant influence on ribeye area. This shows that certainly there are subjective opinions in grading these cattle as they enter the feedlot, and that visual appraisal in young cattle is difficult to be accurate for predicting carcass ribeye area. The least squares means for ribeye area under the three muscle scores are listed in Table 5. Frame size also showed to not be significant on longissimus muscle area, but, the least squares means revealed as frame decreases, ribeye area falls as well (Table 5). Muscle and frame interaction, sire code, lung score, and level of treatment proved to not be significant influences on ribeye area (Table 4). Although sire code was not significant, the least squares means for sire code (Table 5) for this trait did give some biological type findings worth noting. The Continental-sired steers ranked higher for ribeye area than British- and American-sired steers, 94.15 cm^2 vs. 88.70 cm^2 and 89.67 cm^2. This goes along with the common perception that one of the exotic breeds' main advantages over the other two types is muscle thickness. The least squares means for ribeye area based upon lung scores did not prove any differences between the three

Table 4. Levels of significance for carcass traits of ribeye area, marbling score, fat thickness and hot carcass weight with initial weight as covariate

	REA[a]	MARB[b]	FAT[c]	HCW[d]
M[e]	0.4366	0.7378	0.0659	0.9821
F[f]	0.4004	0.6936	0.0721	0.8039
M*F[g]	0.6344	0.8534	0.0722	0.4285
SIRECODE[h]	0.2584	0.2790	0.0148	0.0056
LUNG[i]	0.4950	0.8234	0.8782	0.1637
RANCH[j]	0.0045	<.0001	<.0001	<.0001
LVLTRT[k]	0.6674	0.1096	0.1392	0.5230
INWT[l]	<.0001	0.2935	0.1472	<.0001
R^2 Value	0.3726	0.2951	0.3183	0.4757

[a]Ribeye area (cm^2)
[b]Marbling score
[c]Fat thickness (cm)
[d]Hot carcass weight (kg)
[e]Muscle score
[f]Frame size
[g]Muscle by frame interaction
[h]Sire breed type
[I]Lung score 1-5
[j]Ranch of orgin
[k]Level of treatment 1-4
[l]Initial weight into feedyard

Table 5. Least squares means and standard errors for ribeye area, marbling score, fat thickness, and hot carcass weight by feeder calf frame score, muscle score, and sire code

FRAME	n[a]	REA[b]	Std. Error	MARB[c]	Std. Error	FAT[d]	Std. Error	HCW[e]	Std. Error
L[f]	77	94.82	2.82	472.09	19.08	1.16	0.11	365.67	7.43
M[g]	250	92.94	1.99	482.00	13.44	1.11	0.08	361.86	5.23
S[h]	46	87.81	4.81	460.44	32.50	1.55	0.19	366.56	12.65
MUSCLE									
1[i]	45	91.62	4.79	484.65	32.40	1.45	0.19	366.23	12.62
2[j]	276	93.59	1.93	462.21	13.04	1.11	0.08	363.94	5.07
3[k]	52	90.36	2.84	467.66	19.22	1.27	0.11	363.92	7.46
SIRECODE[l]									
1	102	88.70	2.41	493.01	16.32	1.30	0.10	363.93	6.36
2	68	94.15	2.79	481.42	18.86	1.11	0.11	364.68	7.35
3	158	89.67	2.43	461.93	16.45	1.15	0.10	358.56	6.41
4	26	89.52	3.33	459.86	22.51	1.17	0.13	386.77	8.75
5	3	89.28	7.12	495.43	48.13	1.77	0.29	345.51	18.75
6	6	96.54	5.25	416.89	35.49	1.56	0.21	392.81	13.81
7	10	95.13	4.37	492.03	29.54	0.86	0.18	340.61	11.51

[a] Number of steers
[b] Ribeye area (cm^2)
[c] Marbling score
[d] Fat thickness (cm)
[e] Hot carcass weight (kg)
[f] Large frame score
[g] Medium frame score
[h] Small frame score
[i] Thick muscle score
[j] Average muscle score
[k] Thin muscle score
[l] Sire breed type, 1 = British, 2 = Continental, 3 = American, 4 = Brahman, 5 = 3/4 Hereford 1/4 Brahman, 6 = Santa Gertrudis x Braunvieh, 7 = Sale barn

Table 6. Least squares means and standard errors for ribeye area, marbling score, fat thickness, and hot carcass weight by lung score and level of treatment

LUNG[a]	n[b]	REA[c]	Std. Error	MARB[d]	Std. Error	FAT[e]	Std. Error	HCW[f]	Std. Error
1	135	91.51	2.44	475.41	16.48	1.29	0.10	366.75	6.42
2	172	92.92	2.51	471.44	16.99	1.27	0.10	368.21	6.62
3	66	91.13	2.65	467.69	17.92	1.26	0.11	359.14	6.98
LVLTRT[g]									
1	253	92.43	2.13	458.04	14.37	1.37	0.09	369.34	5.59
2	52	93.05	3.36	464.01	22.68	1.12	0.14	361.03	8.80
3	35	89.51	3.10	499.55	20.98	1.31	0.13	365.68	8.17
4	33	92.42	3.07	464.44	20.75	1.29	0.12	362.74	8.08

[a]Lung score 1 = 0 lesions, 2 = 1 lesion, 3 = 2 or more lesions

[b]Number of steers

[c]Ribeye area (cm^2)

[d]Marbling score

[e]Fat thickness (cm)

[f]Hot carcass weight (kg)

[g]Level of treatment, 1 = $0, 2 = $.01-14.99, 3 = $15-39.99, 4 = $40 or more

(Table 6). Past research by Gardner et al. (1999) reported steers that were detected without lesions at slaughter had 3.1 cm^2 larger ribeyes than steers that were detected with lesions. The same can be noted for the means based on level of treatment as ribeye area showed no major fluctuations for the different categories (Table 6). The covariate, initial weight, proved to be significant for ribeye area ($P < .0001$). Steers that entered the feedyard heavier had larger longissimus areas when harvested. The regression for ribeye area showed that for every additional .45 kg of initial weight, .035 ± .009 sq cm of ribeye area was present at slaughter. The added weight at the start of the trial corresponded to a larger ribeye area at the end of the feeding period. All in all, these independent variables accounted for 37.26% of the variation in ribeye area, marked by the R^2 value in Table 4.

Marbling Score (MARB). Muscle thickness and frame size feeder grades were not significant for marbling, and neither was the muscle by frame interaction (Table 4). The least squares means offered numbers to discuss. The medium framed steers proved to rank higher in marbling score compared to the large and small framed steers (Table 5). Also, muscle thickness #1 steers ranked higher in marbling than the other two muscle scores tested (Table 5). Sire code proved not to be significant for marbling score, but the British-sired steers figured with higher scores than the Continental- and American-sired calves (Table 5). Lung score also showed not to be significant for marbling (Table 4); however, least squares means for marbling score based upon lung scores seemed to decrease with the presence of lesions (Table 6). Steers without lesions at slaughter ranked higher for marbling scores than steers that did have the presence of at least one lesion at harvest. Level of treatment did have a considerable lower P-value (P = .1096) compared to the other independent variables above, but was not considered to be significant. The least squares means for marbling by the levels of treatment to steers reflected values to note (Table 6). Despite not being significant for marbling, steers that did not require treatment had the lowest numerical marbling scores. This contradicts data that McNeill (1999) reported, where he stated that steers not requiring treatment reached the choice grade at a 10% higher rate than steers that required an antibiotic (39% vs. 29%). Once again, ranch of origin was highly significant (P < .0001) (Table 4) and this certainly can be explained by the same measures as discussed for ribeye area. Initial weight did not influence marbling score (P = .2935). These independent variables accounted for the least of the four carcass traits observed with an R-square of 29.51% for marbling score (Table 4).

Fat Thickness (FAT). Muscle thickness (P = .0659) and frame size (P = .0721) feeder calf grades proved to be moderately significant in influencing fat thickness (Table 4). Table 5 shows that for the different frame sizes, small framed steers were harvested with the most fat thickness. They were significantly fatter (1.55 cm vs. 1.16 and 1.11 cm) than large and medium framed steers, respectively. Smaller framed steers finish at a lower final weight and, due to the steers being on similar days on feed groups, these steers expectedly harvested fatter externally. The least squares means for fat thickness were 1.45 cm for muscle score #1, 1.11 cm for muscle #2, and 1.27 cm for muscle score #3 (Table 5). This revealed that the heavier muscled steers, for example, #1's, carried the most external fat cover than lighter muscled steers, when muscle was determined from a feeder calf standpoint. Furthermore, muscle by frame interaction was also slightly significant (P = .0722) (Table 4). The least squares means for fat thickness based on muscle by frame interaction showed that small #1 steers harvested with more fat thickness than any combination, 2.13 cm (Table 7). This was significantly more than medium #1 and large framed #1 muscled steers, 1.03 cm and 1.18 cm, respectively. Large framed #2 steers railed with the least fat thickness at harvest at 1.00 cm. Small #2 and medium #2 were similar to each other but significantly higher than large framed #2 steers. Small framed #3 muscled steers were significantly fatter at the 12^{th} than medium #3's, 1.37 cm and 1.14 cm, and slightly ahead of large #3's, which possessed 1.30 cm (Table 7). Sire code was significant for fat thickness also (P = .0148). The crossbred sires, 5 and 6, showed to be the fattest externally despite the small number of steers out of these sires (n = 3 for 3/4 Hereford ¼ Brahman and n = 6 for Santa Gertrudis x Braunvieh). Fat thickness was lowest for sale barn-sired steers, for which breed type was unknown, which harvested with .86 cm (Table 5). Also, British-sired steers harvested with .15 cm more fat thickness than Continental- and American-sired steers. Ranch of origin again showed to be significant for fat thickness (P < .0001). Lung score (P = .8782) and LVLTRT (P = .1392) revealed to be non-significant for fat thickness (Table 4). Lung score least squares means for fat thickness revealed no major differences (Table 6). Although level of treatment was not significant, calves that did not require treatment ranked higher in fat thickness at harvest than calves that did require treatment (Table 6). This correlates to a report by Gardner et al. (1999) where they found that steers never treated had 1.17 cm of fat thickness, and calves that did require

Table 7. Least squares means for fat thickness and initial value by feeder calf frame and muscle interaction

M[a]	F[b]	FAT[c]	VALUE[d]
1	L	1.18	559.93
1	M	1.03	552.99
1	S	2.13	490.79
2	L	1.00	537.32
2	M	1.17	526.14
2	S	1.15	486.03
3	L	1.30	454.78
3	M	1.14	467.41
3	S	1.37	444.79

[a]Muscle thickness score 1= thick, 2 = average, 3 = thin

[b]Frame score L = large, M = medium, S = small

[c]Fat thickness (cm)

[d]Initial value upon arrival ($)

one treatment had 1.09 cm, and steers needing more than one treatment harvested with only .76 cm of fat thickness. INWT was not significant for fat thickness (P = .1472). These variables accounted for 31.83% of the variation for fat thickness (Table 4).

Hot Carcass Weight (HCW). The R^2 value for carcass weight was the highest (.4757) for the four carcass traits analyzed in this study (Table 4). Muscle thickness, frame size, and muscle by frame interaction were not significant effects influencing hot carcass weight. This contradicts past research discussed in the literature review. Least squares means for carcass weight based upon frame and muscle scores did not show any rank differences between them. However, sire code was greatly significant for carcass weight (P = .0056) (Table 4). The least squares means for the different sire codes were 363.93 kg, 364.68 kg, 358.56 kg, 386.77 kg, 345.51 kg, 392.81, and 340.61 kg, for British-, Continental-, American-, Brahman-, ¾ Hereford ¼ Brahman-, Santa Gertrudis x Braunvieh-, and sale barn-sired steers, respectively (Table 5). Sire code 6, Santa Gertrudis x Braunvieh, were the heaviest on the rail. This, however, is partially due to the amount of time they spent on feed compared to the other sire groups at 230.53 days (Table 8). Brahman-sired steers possessed the next heaviest carcasses. Lung score was not significant for carcass weight, and neither was level of treatment. Lung score least squares means were not different for carcass weights (Table 6), but level of treatment least squares means revealed that calves without treatment ranked heaviest on the rail by a few kg (Table 6). This is supported by Gardner et al. (1999), where they found steers never receiving treatment 7.5 kg heavier on the rail than steers requiring treatment. Ranch was significant (P < .0001) for this trait which can be explained by the different

Table 8. Least squares means for average daily gain, medicine costs, and days on feed by feeder calf frame score, muscle score, and sire code

FRAME	n[a]	ADG[b]	Std. Error	MED[c]	Std. Error	DOF[d]	Std. Error
L[e]	77	1.48	0.05	23.63	1.61	210.75	2.32
M[f]	250	1.42	0.04	24.56	1.13	211.85	1.63
S[g]	46	1.39	0.09	23.85	2.74	213.73	3.94
MUSCLE							
1[h]	45	1.42	0.09	23.49	2.73	211.09	3.93
2[i]	276	1.45	0.04	24.02	1.10	211.10	1.58
3[j]	52	1.42	0.05	24.52	1.62	214.13	2.32
SIRECODE[k]							
1	102	1.42	0.04	25.46	1.38	209.70	1.98
2	68	1.41	0.05	24.07	1.59	210.92	2.29
3	158	1.35	0.04	25.63	1.39	215.23	2.00
4	26	1.52	0.06	23.55	1.89	209.85	2.73
5	3	1.49	0.13	23.62	4.06	201.72	5.84
6	6	1.56	0.10	23.54	2.99	230.53	4.30
7	10	1.24	0.08	22.23	2.49	206.81	3.59

[a]Number of steers
[b]Average daily gain (kg)
[c]Medicine costs ($)
[d]Days on feed (days)
[e]Large frame score
[f]Medium frame score
[g]Small frame score
[h]Thick muscle score
[i]Average muscle score
[j]Thin muscle score
[k]Sire breed type, 1 = British, 2 = Continental, 3 = American, 4 = Brahman, 5 = 3/4 Hereford 1/4 Brahman, 6 = Santa Gertrudis x Braunvieh, 7 = Sale barn

breed types, sires and dams, and backgrounding used by the various ranches involved.

Hot carcass weight was influenced by initial weight ($P < .0001$). The estimate and standard error for the regression of HCW on INWT in was .209 ± .023 kg. This showed that for every .45 kg increase in initial weight, an additional .209 kg of hot carcass weight was revealed, therefore, calves that entered the trial heavier railed with heavier carcass weights when harvested.

Average Daily Gain (ADG). Muscle thickness, frame size, and muscle by frame interaction were not significant influences on average daily gain. For average daily gain, least squares means appeared lower as frame size decreased (Table 8). Large framed calves ranked higher than medium framed steers, and small framed steers ranked last of the three. On the other hand, sire code was significant ($P = .0120$) for ADG. The least squares means for sire code were 1.42 kg, 1.41 kg, 1.35 kg, 1.52 kg, 1.49 kg, 1.56 kg, and 1.24 kg, for British-, Continental-, American-, Brahman-, ¾ Hereford ¼ Brahman-, Santa Gertrudis x Braunvieh-, and sale barn-sired steers, respectively (Table 8). The crossbred sire groups, ¾ Hereford ¼ Brahman and Santa Gertrudis x Braunvieh, were two of the best gaining sire groups, although with a small number of steers. Brahman-sired steers were very high in average daily gain as well. This could be explained that these steers sired by the Brahman bulls were utilizing hybrid vigor, or heterosis. Heterosis is the enhanced performance of cattle due to crossbreeding, especially when crossing *Bos indicus* sires with *Bos taurus* dams. The sire group with the lowest ADG was the American-sired steers (Table 8). This also was, however, the group with the largest sample number and had the largest range from top to bottom.

Table 9. Levels of significance for average daily gain, medicine costs, and days on feed with initial weight as a covariate

Variable	P-Value		
	ADG[a]	MED[b]	DOF[c]
M[d]	0.7880	0.9193	0.3710
F[e]	0.4263	0.7938	0.7589
M*F[f]	0.6795	0.9921	0.4439
SIRECODE[g]	0.0120	0.6666	<.0001
LUNG[h]	0.2133	0.9362	0.9865
RANCH[i]	<.0001	<.0001	<.0001
LVLTRT[j]	0.2649	<.0001	<.0001
INWT[k]	0.7754	0.8326	<.0001
R^2 Value	0.3343	0.9180	0.8751

[a]Average daily gain (kg)
[b]Medicine costs ($)
[c]Days on feed (days)
[d]Muscle score
[e]Frame size
[f]Muscle by frame interaction
[g]Sire breed type
[h]Lung score 1-5
[i]Ranch of orgin
[j]Level of treatment 1-4
[k]Initial weight into feedyard

Lung scores and level of treatment were not significant influences on average daily gain (Table 9). Steers that required the most treatment (LVLTRT 3 and 4) did rank the lowest for ADG, but the differences were minimal at most (Table 10). This is contradicted by many findings that reflected large differences between treated and non-treated steers. McNeill (1999) reported a .08 kg difference between non-treated calves (LVLTRT 1) and treated steers; similarly, Smith (1996) showed a .23 kg difference, and Bateman et al. (1990) revealed a .14 kg difference for an advantage of non-treated steers over treated steers. Morck et al. (1993) reported that steers requiring two periods or more of sickness (LVLTRT 3 and 4) had .33 kg lower ADG than steers never receiving treatment (LVLTRT 1). Least squares means under lung score did not reflect numbers to discuss despite past research showing a .08 kg/d difference for steers not having lesions at slaughter compared to steers having at least one lesion present (Wittum et al., 1995). Gardner et al. (1999) showed a .18 kg difference for steers without lesions compared to steers with lesions. Ranch of origin was found to be a significant influence on average daily gain (Table 8). This could possibly be due to different ranches putting their calves through different backgrounding programs to acclimate them to approaching and eating from the feed bunk. In summation, calves that entered the feeding phase having just been weaned, never have eaten creep feed, or not backgrounded for a period of time would then possibly start certain trials off by losing weight, and in turn, have lower average daily gain numbers. The covariate, initial weight, was not significant for influencing average daily gain (P = .7754) (Table 9).

Medicine Costs (MED). The independent variables investigated in this trial

Table 10. Least squares means for average daily gain, medicine costs, and days on feed by lung score and level of treatment

LUNG[a]	n[b]	ADG[c]	Std. Error	MED[d]	Std. Error	DOF[e]	Std. Error
1	135	1.44	0.04	23.99	1.39	212.16	2.00
2	172	1.45	0.05	24.20	1.43	212.20	2.06
3	66	1.39	0.05	23.86	1.51	211.96	2.18
LVLTRT[e]							
1	253	1.42	0.04	-0.18	1.21	216.66	1.74
2	52	1.50	0.06	8.72	1.91	198.51	2.74
3	35	1.40	0.06	22.69	1.77	216.36	2.55
4	33	1.39	0.06	64.84	1.75	216.91	2.52

[a]Lung score 1 = 0 lesions, 2 = 1 lesion, 3 = 2 or more lesions

[b]Number of steers

[c]Average daily gain (kg)

[d]Medicine costs ($)

[e]Days on feed (days)

[e]Level of treatment, 1 = $0, 2 = $.01-14.99, 3 = $15-39.99, 4 = $40 or more

accounted for 91.80% of the variation in medicine costs. Muscle thickness and frame size feeder calf grades were insignificant effects for medicine costs (P = .9193, P = .7938) (Table 9), and the muscle by frame interaction was also not a significant influence on medicine costs. Medicine costs least squares means for frame and muscle scores are presented in Table 8. Neither sire code or lung score proved to affect medicine cost either. These two variables' least squares means for medicine costs proved no differences in rank when analyzed as well (Tables 8 and 10, respectively). Ranch and level of treatment were certainly significant for medicine costs, though. Level of treatment is obviously significant because the LVLTRT variable was created from the medicine costs trait. Therefore, as medicine costs increase, LVLTRT does as well. The least squares means for medicine costs on LVLTRT were $-.18, $8.72, $22.69, and $64.84 respectively (Table 10). The negative value for level of treatment 1 could virtually be regarded as zero, as it does reflect a zero value. The covariate, initial weight, was not a significant influence on medicine costs.

Days on Feed (DOF). Feeder calf muscle thickness grade showed to not be a significant influence to the amount of time steers spent on feed (Table 9). The least squares means for days on feed by muscle thickness grade are presented in Table 8. It showed that muscle score #3 cattle ranked last for days on feed, but just by three days compared to #1 and #2 muscle steers (Table 10). Dolezal et al. (1993) found that muscle thickness #3 steers also spent the most time on feed in their trial, 219.5 d compared to 138.5 d for #1 steers and 156.1 d for #2 steers. Frame size and muscle by frame interaction were also not significant in influencing days on feed. Sire code was very significant to how many days on feed the steers spent (Table 9). The least squares means for sire code was the lowest for the ¾ Hereford ¼ Brahman- and sale barn-sired steers (Table 8), who spent 201.72 and 206.81 days on feed, respectively. It is important to note, though, that these steers entered the feedlot the heaviest by far. The least squares means for the other sire groups was 209.70 for British-sired steers, 210.92 for Continental-sired steers, 215.23 for American-sired offspring, 209.85 for Brahman-sired calves, and 230.53 days for sale barn-sired steer calves (Table 8). The American-sired steers spent more time on feed than the British and Continental-sired steers. Lung score was very insignificant (P = .9865) for days on feed (Table 9). The least squares means for days on feed on lung score are presented in Table 10. Ranch of origin was very significant for days on feed, though (Table 9). This could be explained for the same reasons as the other variables mentioned earlier in the discussion. Level of treatment was also very significant (P < .0001) for days on feed for the steers (Table 9). However, the least squares means showed that levels 1, 3, and 4 were almost equal in time on feed, but calves treated in the second level (LVLTRT 2) spent almost 18 days less in the feedlot. This does show that calves treated just once were spent significantly fewer days on feed than calves treated more than once (Table 10). This shows that calves that require more frequent antibiotic treatment are more susceptible to not put on the extra weight to become market ready. These steers experience weight loss due to extra sickness frequencies, and in turn, have to spend more time in the feedlot recovering and resuming the weight gaining process. Days on feed was affected by the covariate of initial weight. The regression of days on feed revealed that for every .45 kg of initial weight observed, -.11 ± .007 days on feed were found to occur. Steers that were the heaviest at the start spent fewer days on feed in this ranch to rail trial. This is expected as the steers have fewer pounds to reach their market weight compared to steers that enter the feeding phase at lighter weights.

Initial Value upon arrival (VALUE). Muscle thickness score was very significant for the calf's initial value ($P < .0001$) (Table 11). The least squares means proved that the heavier muscled steers were the most valuable upon arrival. As muscle score decreased, so did initial value (Table 12). Steers with muscle score #1 were valued at $534.57, steers with muscle score #2 had a value of $516.50, and steers with muscle score #3 were at $455.66. Frame size also was very significant ($P <.0001$) (Table 11). As frame size increased, initial value increased as well. Large framed steers were valued at $517.34, medium framed calves at $515.52, and small framed calves were valued at $473.87 (Table 12). This shows that cattle buyers will spend extra money on more muscular, supposedly growthier steers for the feedlot, who they expect to spend fewer days on feed and receive more premiums at slaughter. However, as discussed earlier, muscle thickness and frame size were not significant influences on average daily gain. This shows that our feeder calf grading system is not precise in pointing out the fastest growing cattle. Muscle by frame interaction was also a significant influence on initial value (Table 11). The least squares means showed that large and medium framed #1 muscled steers were valued the highest upon arrival (Table 7). They were both significantly higher than small #1 calves, $559.93 and $552.99 vs. $490.79. Large and medium framed #2 steers were also significantly higher in initial value than small #2

Table 11. Levels of significance for initial value and carcass value with initial weight as covariate

Variable	P-Values	
	VALUE[a]	CARCVAL[b]
M[c]	<.0001	0.9897
F[d]	<.0001	0.6754
M*F[e]	<.0001	0.7884
SIRECODE[f]	<.0001	0.0344
LUNG[g]	0.3689	0.2211
RANCH[h]	<.0001	0.0571
LVLTRT[i]	0.0016	0.7905
INWT[j]	<.0001	<.0001
R^2 Value	0.9813	0.3456

[a]Value at arrival in feedyard ($)
[b]Carcass value ($)
[c]Muscle score
[d]Frame size
[e]Muscle by frame interaction
[f]Sire breed type
[g]Lung score 1-5
[h]Ranch of orgin
[I]Level of treatment 1-4
[j]Initial weight into feedyard

Table 12. Least squares means for initial value and carcass value by feeder calf frame score, muscle score, and sire code

FRAME	n[a]	VALUE[b]	Std. Error	CARCVAL[c]	Std. Error
L[d]	77	517.34	3.22	1089.16	24.73
M[e]	250	515.52	2.26	1083.93	17.39
S[f]	46	473.87	5.47	1049.26	42.10
MUSCLE					
1[g]	45	534.57	5.46	1070.55	41.99
2[h]	276	516.50	2.19	1074.79	16.88
3[i]	52	455.66	3.23	1076.99	24.83
SIRECODE[j]					
1	102	499.49	2.75	1102.89	21.16
2	68	508.23	3.18	1090.17	24.46
3	158	508.51	2.77	1051.57	21.32
4	26	493.87	3.78	1118.08	29.10
5	3	488.45	8.11	1019.17	62.40
6	6	517.94	5.98	1116.26	45.96
7	10	499.21	4.98	1020.62	38.30

[a]Number of steers
[b]Value at arrival in feedyard ($)
[c]Carcass value ($)
[d]Large frame score
[e]Medium frame score
[f]Small frame score
[g]Thick muscle score
[h]Average muscle score
[i]Thin muscle score
[j]Sire breed type, 1 = British, 2 = Continental, 3 = American, 4 = Brahman, 5 = 3/4 Hereford 1/4 Brahman, 6 = Santa Gertrudis x Braunvieh, 7 = Sale barn

steers. The small #3 steers were the lowest in terms of initial value and medium framed #3's were valued higher than large #3's by $12.63 (Table 7). This shows that for all combinations, small framed steers were worth the least compared to large and medium framed steers. Also, as muscle decreased, so did initial value. This shows that feeder calf grades are certainly valuable in determining value of steers. Sire code also showed a great level of significance ($P < .0001$) for initial value (Table 11). The least squares means for the different sires used were $499.49, $508.23, $508.51, $493.87, $488.45, $517.94, and $499.21, for British-, Continental-, American-, Brahman-, ¾ Hereford ¼ Brahman-, Santa Gertrudis x Braunvieh-, and sale barn-sired steers, respectively (Table 12). Lung score proved to be the only variable that was not significant for initial value ($P = .3689$). The least squares means for initial value based upon lung score are presented in Table 13. Ranch of origin was a very significant influence on initial value ($P < .0001$) (Table 11). This showed the ranches' various differences in genetics and preparation of their calves before entering them in the feedlot impacted their value at the entry of the trial. Level of treatment also was significant ($P = .0016$) for value (Table 11). The steers that did not require any medicine costs, or level of treatment 1, were the most valuable at the beginning, even though it was by a very small margin. The least squares means for the 4 treatment groups were $507.03, $496.14, $501.18, and $504.63 (Table 13). This shows that calves of all different values upon arrival were all susceptible to requiring treatment along the feeding phase. Overall, these independent variables accounted for 98.13% of the variation in initial value (Table 11). Initial weight was also significant for initial value. Weight plays a significant role in the total value of

Table 13. Least squares means for initial value and carcass value by lung score and level of treatment

LUNG[a]	n[b]	VALUE[c]	Std. Error	CARCVAL[d]	Std. Error
1	135	503.44	2.78	1084.62	21.37
2	172	501.12	2.86	1080.96	22.02
3	66	502.17	3.02	1056.75	23.23
LVLTRT[e]					
1	253	507.03	2.42	1074.62	18.60
2	52	496.14	3.81	1073.76	29.28
3	35	501.18	3.54	1087.72	27.20
4	33	504.63	3.50	1060.34	26.89

[a]Lung score 1 = 0 lesions, 2 = 1 lesion, 3 = 2 or more lesions

[b]Number of steers

[c]Value at arrival in feedyard ($)

[d]Carcass value ($)

[e]Level of treatment, 1 = $0, 2 = $.01-14.99, 3 = $15-39.99, 4 = $40 or more

all calves sold and bought across the world of trading of cattle. This trial's regression of initial value on INWT showed that for every pound of initial weight, \$.535 ± .010 of initial value was found. This just supports that cattle are still sold on a weight basis and exhibited how the cattle market goes along pricing cattle.

Carcass Value (CARCVAL). Sire code proved to be the most significant influence on carcass value (P = .0344) (Table 11). The least squares means for sire code were \$1,102.89, \$1,090.17, \$1,051.57, \$1,118.08, \$1,019.17, \$1,116.26, and \$1,020.62, for British-, Continental-, American-, Brahman-, ¾ Hereford ¼ Brahman-, Santa Gertrudis x Braunvieh-, and sale barn-sired steers, respectively (Table 12). The Brahman-sired calves were the highest in value from a carcass standpoint, as they gained better per day and remained healthier throughout the trial. The ¾ Hereford ¼ Brahman-sired steers and the sale barn sired calves were the lowest in terms of carcass value. This is unexpected because these two groups spent the least time on feed, and therefore, attained the least feed expense (Table 8). They were the lightest in terms of carcass weight, though, and this shows that weight still pays a good portion back to the producer. Comparing the three major breed classifications, British-sired steers had significantly higher carcass values than Continental- and American-sired steers. This is due to quality grade advantages that the British-sired steers had over the other two types. Muscle thickness, frame size, and muscle by frame interaction proved to not be significant for carcass value (Table 11). Least squares means for carcass value by muscle thickness are presented in Table 12. The least squares means with frame size revealed that large framed calves ranked highest for carcass value, and as frame size decreased, carcass value decreased as well (Table 12). Large framed cattle had a value of $1,089.16, medium framed calves valued at $1,083.93, and small framed steers were valued at $1,049.26 (Table 12). This, once again, showed that weight still pays the most dividends back to the producer. Lung score was not a significant effect for carcass value (Table 11). Cattle without lesions ranked highest for carcass value (Table 13), and the largest difference in rank was between lung score 2 and 3, as there was a $24.21 difference. Ranch was slightly significant and can be attributed to several reasons discussed earlier in the text. Level of treatment was not a significant influence on carcass value as the P-value was very high (P = .7905) (Table 11). The least squares means for this trait are presented in Table 13. The covariate, initial weight, was also significant for carcass value. The regression of CARCVAL on INWT was $.423 ± .077. This finding showed that for every .45 kg of weight at the start of the trial, an additional $.423 was expected at harvest for each steer's value on the rail.

Correlation Coefficients

The following correlation coefficients are presented in Table 14. CARCVAL had a positive correlation with each of the four carcass traits in this investigation: REA (r = .3966), MARB (r = .2070), FAT (r = .2769), and HCW (r = .8817). HCW was the most correlated to CARCVAL of any trait analyzed, and this proves that weight still determines the vast majority of carcass value. OUTWT (r = .7359) was also very correlated to carcass value. For the most part, the final weight of the animal plays the most significant role in determining carcass weight, and this finding does support that generalization. ADG was also highly correlated to CARCVAL (r = .5847), which

Table 14. Correlation coefficients between performance and carcass traits

Variable	MARB[b]	FAT[c]	MED[d]	TEMP[e]	LUNG[f]	HCW[g]	ADG[h]	CARCVAL[i]	DOF[j]	INWT[k]	OUTWT[l]	VALUE[m]
REA[a]	-0.0188	-0.1192	-0.0307	0.0869	-0.0342	0.4439	0.2033	0.3966	-0.3091	0.3878	0.3897	0.4048
	0.7019	0.0146	0.5315	0.0932	0.5061	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
MARB[b]		0.1070	-0.0736	0.0212	0.0026	0.0319	-0.0128	0.2070	0.0320	-0.0205	-0.0125	-0.0332
		0.0285	0.1325	0.6828	0.9594	0.5156	0.7936	<.0001	0.5139	0.6763	0.7981	0.4983
FAT[c]			-0.1139	-0.023	-0.0294	0.3641	0.3481	0.2769	0.0404	-0.0199	0.3206	-0.0324
			0.0198	0.6565	0.5673	<.0001	<.0001	<.0001	0.4094	0.6837	<.0001	0.5088
MED[d]				-0.03	0.0238	-0.0691	-0.0263	-0.1034	0.0126	-0.0225	-0.0306	-0.0152
				0.5554	0.6426	0.1566	0.5892	0.0321	0.7956	0.6419	0.5303	0.7527
TEMP[e]					0.0863	0.0814	-0.0206	-0.0018	0.0191	0.1022	0.0860	0.1207
					0.1138	0.1147	0.6904	0.9726	0.7121	0.0450	0.0951	0.0178
LUNG[f]						-0.1206	-0.1555	-0.1147	0.0705	-0.0315	-0.1374	-0.0410
						0.0183	0.0023	0.0250	0.1694	0.5399	0.0073	0.4243
HCW[g]							0.7122	0.8817	-0.3315	0.4795	0.9285	0.4798
							<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
ADG[h]								0.5847	-0.0114	-0.0888	0.7731	-0.0426
								<.0001	0.8155	0.0680	<.0001	0.3821
CARCVAL[i]									-0.2066	0.1761	0.7359	0.1669
									<.0001	0.0002	<.0001	0.0005
DOF[j]										-0.8354	-0.2515	-0.7255
										<.0001	<.0001	<.0001
INWT[k]											0.4469	0.9283
											<.0001	<.0001
OUTWT[l]												0.4803
												<.0001

[a]Ribeye area (cm^2)
[b]Marbling score
[c]Fat thickness (cm)
[d]Medicine costs ($)
[e]Temperature (°C)
[f]Lung score
[g]Hot carcass weight (kg)
[h]Average daily gain (kg)
[i]Carcass value ($)
[j]Days on feed
kInitial weight at arrival in feedyard
[l]Out weight at end of trial
[m]Initial value at arrival in feedyard

indicates that faster gaining animals generally weigh more at the end of the feeding phase and harvest with more carcass weight, which in turn, generates more value. MED, TEMP, and LUNG all showed to have negative relationships with CARCVAL and were not correlated at all with each other. Initial value was also positively correlated with several traits. REA and HCW were positively related with initial value, but MARB and FAT were negatively correlated. The health traits showed differences to note. While medicine costs and lung lesion scores recorded negative figures, rectal temperature at entry into feedyard showed a positive relationship with initial value. Though it was lowly correlated, it reflected a positive relationship worth noting. Expectedly, INWT was extremely correlated to initial value (r = .9283). Once again, weight pays the most dollar to the producer and cattlemen should have calves as heavy as possible for entry into a feedyard. However, initial value and carcass value had a correlation of only .17. Days on feed showed a real large negative relationship (r = -.7255) with initial value. This shows that calves that are worth the least upon entry spend the most time on feed. These calves are generally the lightest because value is based mainly upon weight, so this figure should be expected. INWT and DOF also has a large negative relationship (r = -.8354) which definitely supports the discussion above.

Average daily gain was highly correlated with final out weight and hot carcass weight. This shows that steers that gained more weight in the feeding phase finished heavier at the end of the trial. Lung lesion score was positively correlated with medicine costs and temperature but was lowly correlated at best (r = .0238, r = .0863). REA showed moderate correlations with HCW (r = .4439), INWT (r = .3878), and OUTWT (r

= .3897). This shows that an increase in longissimus area reflects on heavier weights at entry into feedlot and at the end of the trial.

SUMMARY

Feeder calf muscle thickness and frame size grades, along with muscle by frame interaction, proved to be very significant in affecting initial value when calves were sent to the feedlot. This shows that the cattle industry places trust in our feeder calf grading system to determine value. However, muscle thickness and frame size were not significant influences on any other live and carcass traits despite fat thickness. Lung scores were not significant influences on any of the traits analyzed. Level of treatment was a significant influence on initial value, medicine costs, days on feed, and was slightly significant on marbling score. These findings suggest that with the incidence of sickness, steers that require two or more periods of treatment spend more time on feed increasing expenses. Ranch of origin and sire breed type (SIRECODE) proved to be most influential factors on the carcass traits, value at the beginning and end of trial, live performance, and health status. The management practices the different ranches perform on their operations were certainly important in how the steers performed. Different genetic lines and schemes are also very influential in impacting these performance and value factors. The different breed types play significant roles in determining value and performance. Certain breeds have advantages over others and this study proves that the use of some breeds influences numerous traits. Weight is still highly regarded by the cattle industry and is one of the most influential factors in determining feeder calf value and also carcass value when the steers on the rail. However, although weight at feedlot arrival was highly related to animal value at that point, this initial weight and value was lowly correlated (r = .17) to carcass value in this retained ownership program.

Due to the results that incurred in this trial, further analysis needs to be conducted in the areas of feeder calf grades to further determine their significance on carcass and live performance. Health status also needs to be further studied to deliver more feedback to the producers of the cattle industry. Age of cattle needs to be factored in the analysis to determine maturity of steers in the trial.

LITERATURE CITED

Baggett IV, H.B., C.E. Ward, and D.M. Child. 2002. Efficiency of market price signals for feeder cattle frame size and muscling. Proceedings of annual meeting of the American Agricultural Economics Association and Western Agricultural Economics Association, Long Beach California. 1:1-6.

Bateman, K.G., S.W. Martin, P.E. Shewen, and P.I. Menzies. 1990. An evaluation of antimicrobial therapy for undifferentiated bovine respiratory disease. Can. Vet. J. 31:689-696.

Camfield, P.K., A.H. Brown, Jr., P.K. Lewis, L.Y. Rakes, and Z.B. Johnson. 1997. Effects of frame size and time-on-feed on carcass characteristics, sensory attributes, and fatty acid profiles of steers. J. Anim. Sci. 75:1837-1844.

Dolezal, H.G., J.D. Tatum, and F.L. Williams, Jr. 1993. Effects of feeder cattle frame size, muscle thickness, and age class on days fed, weight, and carcass composition. J. Anim. Sci. 71:2975-2985.

Edwards, A.J. 1996. Respiratory diseases of feedlot cattle in the central USA. Bovine Pract. 30:5-7.

Gardner, B.A., H.G. Dolezal, L.K. Bryant, F.N. Owens, and R.A. Smith. 1999. Health of finishing steers: effects on performance, carcass traits, and meat tenderness. J. Anim. Sci. 77:3168-3175.

Grona, A.D., J.D. Tatum, K.E. Belk, G.C. Smith, and F.L. Williams. 2002. An evaluation of the USDA standards for feeder cattle frame size and muscle thickness. J. Anim. Sci. 80:560-567.

Hutcheson, D.P. and N.A. Cole. 1986. Management of transit-stress syndrome in cattle: nutritional and environmental effects. J. Anim. Sci. 62:555-560.

May, S.G., W.L. Mies, J.W. Edwards, F.L. Williams, J.W. Wise, J.J. Harris, J.W. Savell, and H.R. Cross. 1992a. Effect of frame size, muscle score, and external fatness on live and carcass value of beef cattle. J. Anim. Sci. 70:3311-3316.

May, S.G., W.L. Mies, J.W. Edwards, F.L. Williams, J.W. Wise, J.B. Morgan, J.W. Savell, and H.R. Cross. 1992b. Beef carcass composition of slaughter cattle differing in frame size, muscle score, and external fatness. J. Anim. Sci. 70:2431-2445.

McNeill, J. 1999. Value added calves: 4 year health summary. Texas Cooperative Extension, Department of Animal Science, Texas A&M University. Available at: http://animalscience.tamu.edu. Accesses November, 2004.

Morck, D.W., J.K. Merrill, B.E. Thorlakson, M.E. Olson, L.V. Tonklison, and J.W. Costerton. 1993. Prophylactic efficacy of tilmicosin for bovine respiratory tract disease. J. Am. Vet. Med. Assoc. 202:273-277.

Smith, R.A. 1996. Work with producers to reduce economic losses of BRD in stocker and feeder cattle. DVM 27:1F-3F.

Smith, R.A. 1998. Impact of disease on feedlot performance: a review. J. Anim. Sci. 76:272-274.

Sowell, B.F., M.E. Branine, J.G.P. Bowman, M.E. Hubbert, H.E.Sherwood, and W. Quimby. 1999. Feeding and watering behavior of healthy and morbid steers in a commercial feedlot. J. Anim. Sci. 77:1105-1112.

Van Donkersgoed, J.F., F.J. Schumann, R.J. Harland, A.A. Potter, and E.D. Janzen. 1993. The effect of route and dosage of immunization on the serological response to a *Pasteurella haemolytica* and *Haemophilus somnus* vaccine in feedlot calves. Can. Vet. J. 34:731-735.

Vogel, G.L. and J.C. Parrott. 1994. Mortality survey in feedyards: the incidence of death from digestive, respiratory, and other causes in feedyards of the Great Plains. Compend. Contin. Educ. Pract. Vet. 16:227-234.

Wittum, T.E., N.E. Woolen, L.J. Perino, and E.T. Littledike. 1995. Relationship between treatment for respiratory disease, pulmonary lesions present at slaughter, and rate of gain in feedlot cattle. J. Anim. Sci. 73 (Suppl. 1):238 (Abstr.).

Wittum, T.E., N.E. Woolen, L.J. Perino, and E.T. Littledike. 1996. Relationships among treatment for respiratory tract disease, pulmonary lesions evident at slaughter, and rate of weight gain in feedlot cattle. J. Am. Vet. Med. Assoc. 209:814-818.

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