DIFFERENCES IN PROFITABILITY AND PERFORMANCE DUE TO VARIATION IN FRAME SIZE AND MUSCLE SCORE IN STOCKER AND FEEDER CATTLE

By

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Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

2000

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the degree of
MASTER OF SCIENCE
August, 2002

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MUSCLE SCORE IN STOCKER AND

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ACKNOWLEDGEMENTS

I would like to thank my advisor, Dr. Clem Ward, and my committee members for their help in putting this project together and making sure it was done correctly. They were always available for any questions that I had. I would also like to thank Dan Childs for leading this research. His encouragement and wisdom have helped me immensely during my short career. I would like to thank The Samuel Roberts Noble Foundation and those that work at the Noble Foundation for funding and executing this project. Also, I would like to thank Gary Bledsoe of the Oklahoma Department of Agriculture and Robert Miles of the USDA for their help in grading the cattle. Without their help, I don't know how we would have graded the cattle. I would like to thank the Animal Science Department of Colorado State University for feeding the cattle and measuring the carcass data. I would especially like to thank Kirby Childs, Derek Vote, Bill Platter, and Dr. Keith Belk.

Willis, Keith, Jared, and my other classmates- thanks for getting me through my classes and finished with my thesis. Finally, I would like to thank my parents for putting me in a position to excel. The love and discipline that was given to me will continue to be an aid as I continue in life.

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Introduction

Problem Statement

Two important beef cattle production traits that affect performance and profitability are frame size and muscle thickness. Tatum et al. (1988) found that frame size and muscle thickness affected growth rates and muscle-to-bone ratios. Camfield et al. (1997) found that smaller-framed cattle mature faster than larger-framed cattle. Dolezal, Tatum, and Williams found that both frame size and muscling level affected time-on-feed, which affects the cost of production in the feedlot. Thus, cattle with different frame sizes and muscle scores perform differently. For this reason, stocker cattle bring a premium or discount due to their frame size and muscling level. Smith et al. (1998) found that differences in frame size amounted to as much as $18.86 per cwt. for steers and $20.99 per cwt. for heifers. Differences in muscling level were as much as $8.10 per cwt. for heifers and $26.48 per cwt. for steers. Does this premium or discount due to frame size and muscling level accurately reflect the performance difference that is caused by a particular frame size and muscling level? What effect does frame size and muscling level in stocker cattle have on performance and profitability in feeder cattle and live cattle?

Objectives

The overall objective of this research is to increase the efficiency of the cattle market in valuing frame size and muscle score in feeder cattle. Specific objectives are to determine the effect of frame size and muscle score of feeder cattle on performance and profitability in stocker cattle, feeder cattle, live (fed) cattle, and beef carcasses.

Conceptual Framework

If the cattle market is efficiently valuing frame size and muscle thickness of feeder cattle, there should be no excess profit from buying a certain frame size and muscling level instead of another. The performance differences caused by frame size and muscle score will cause the profit from the cattle to be the same no matter what degree of frame size and muscle thickness. For example, if large-framed cattle have greater ADG's and performance, they should be worth more as stocker cattle. Smaller cattle should have enough of a discount as stockers to be just as profitable as the better performing, but more expensive large-framed cattle. Marginal revenue from producing a certain frame size and muscle score should equal the marginal cost from producing that same frame size and muscle score. Each marginal revenue minus marginal cost should be equal to zero and should be equal to the marginal revenue minus marginal cost of different frame sizes and muscling levels.

(1) $$MR_{FiMi} = MC_{FiMi}$$

(2) $$MR_{FiMi} - MC_{FiMi} = 0$$

(3) $$MR_{FiMi} - MC_{FiMi} = MR_{FjMj} - MC_{FjMj}$$

Based on this theory, it is hypothesized:

Ho: Profits due to differences in frame size and muscling level are equal.

Ha: Profits due to differences in frame size and muscling level are not equal.

If the null hypothesis is rejected, then it will be concluded that the market does not efficiently value frame size and muscle score. If the null hypothesis is not rejected, then it will be concluded that the market is efficient in valuing frame size and muscle score.

Chapter 2

Literature Review

Introduction

Stocker and feeder cattle production are competitive and operations must be as efficient as possible to stay profitable. Two important production traits that affect perceived performance and profitability are frame size and degree of muscling. While there have been several studies that investigated performance due to frame size and muscling level, and a few that considered the price of these traits, there has not been any study that determined whether the performance differences were equal to the price differences. Therefore, the pricing efficiency of feeder cattle frame size and muscle score was examined in this study.

Sorting Differences

Cattle typically are born in either the spring or fall calving season. Beef consumption, though, occurs throughout the year. For this reason, cattle are sorted and produced differently in order to spread out the production of beef throughout the calendar year. Cattle can be sorted numerous ways. Two of the more common ways of sorting feeder cattle are via frame size and muscle score.

The U. S. Department of Agriculture (USDA) changed feeder cattle grades in 2000 because much has changed in the cattle industry since 1979, when the USDA feeder cattle grades were last updated. The use of newer breeds of cattle and increase in crossbreeding since 1979 has extensively altered the genetics and, in turn, the type of cattle being produced in the U.S. Grona et al. conducted a study to determine the live weights at which large, medium, and small-framed feeder cattle finish with a carcass quality grade of low Choice and examined the relationship between feeder cattle muscle thickness and carcass yield grade. Grona et al. found the 1979 USDA feeder grades were not as accurate now and needed to be updated to meet today's standards of cross-bred cattle. Because of this study, the USDA revised the feeder cattle grades.

On October 1, 2000, the USDA revised the standards for feeder cattle frame size and muscle thickness. The revisions updated the grade standards from 1979. Feeder cattle under the age of 36 months are graded for three characteristics: frame size, thickness, and thriftiness. Frame size is a measure of an animal's skeletal size in relation to its age. Thus, a large-framed animal would be taller and longer than a medium-framed animal of the same age. Thickness is a measure of an animal's development of muscle at a constant degree of fatness (slightly thin). No. 1 thickness cattle are heavier muscled than No. 2 thickness, No. 2 thickness cattle are heavier muscled than No. 3 thickness, and No. 3 thickness cattle are heavier muscled than No. 4 thickness cattle. According to the USDA, thicker feeder cattle will have a higher muscle-to-bone ratio and a higher yield grade. Thriftiness is a measure of an animal's overall health and ability to grow normally. There are few unthrifty cattle so most research is confined to thrifty cattle.

According to the USDA, frame size indicates the weight of the animal at a particular quality grade such as Choice and muscle score indicates the yield grade of the animal at a particular quality grade such as Choice. Large-framed steers would be expected to reach frame size and muscle score were considered. Frame size and muscle score were correlated with marbling, quality grade, fat thickness, rib-eye area, percentage of kidney, pelvic, and heart fat, carcass weight, and yield grade. When the effects of apparent breed type were accounted for, frame size and muscle score were only correlated with fat thickness, rib-eye area, and carcass weight. Palatability was not associated with either frame size, muscling, or breed type. Smith et al. hypothesized that time-on-feed is the primary determinant of palatability of beef. Basically, sorting by breed type helped identify the marbling and fat characteristics of cattle, while frame size and muscling level helped identify the size and maturity of cattle at slaughter.

Production Differences

High performance is assumed synonymous with profitable cattle production. One of the most complete studies of feeder cattle performance due to frame size and muscle score was done by Adams et al. In their study, performance characteristics such as average daily gain (ADG), fed cattle weight, dressing percentage, and marbling score were measured for each of the frame sizes and muscling scores. Quality grade, fat thickness, rib-eye area, yield grade, fat trim, % bone, and % edible portion were measured in the same manner for each of the frame sizes and muscling scores. Larger-framed cattle had greater ADG's, smaller fat thicknesses, and poorer quality grades. This result was rather interesting, especially because the cattle were slaughtered when they were supposed to be about low Choice in quality grade. No. 1 and No. 2 muscle steers had a greater muscle-to-bone ratio than No. 3 steers. No. 3 steers also tended to have more internal fat and less subcutaneous fat. This may be caused because No. 3 steers were generally of dairy breeding and not beef breeding under the 1979 feeder grade standards.

The amount of time on feed can cause significant differences in cost and efficiency of producing cattle. Dolezal, Tatum, and Williams measured the effects of frame size, muscle thickness, and age on days fed, weight, and carcass characteristics. Feeder steers were divided into nine different categories based on the 1979 USDA Feeder cattle grades for frame size (large, medium, small) and muscling level (No.1, No.2, No.3). These steers then were put on different production regimens so that the steers would reach slaughter weights at different ages. Some of the cattle were put on a high concentrate diet from the start to grow quickly. Another regimen allowed the steers to be backgrounded on silage for 112 days before going to a high concentrate diet. These steers reached the finishing stage of production as yearlings. The third regimen backgrounded the steers for 280 days on silage before shifting to a high concentrate finishing diet. These cattle referred to as long yearlings, went into the finishing stage at about eighteen months of age. All cattle in this experiment were fed to the same subcutaneous fat level. Dolezal, Tatum, and Williams found that age class, frame size, and muscle thickness were all significantly related to time-on-feed, slaughter weight, and carcass weight. Steers with larger frame sizes and smaller muscling levels usually had greater time-on-feed and heavier weights at slaughter. Muscle thickness did not have a consistent effect on any of the slaughter traits. Muscle thickness usually affected the muscle-to-bone ratio only when the muscling level was very large or very small. Dolezal, Tatum, and Williams concluded that frame size is helpful for determining the size of the steer when finished. One finding of this study was that the type of cattle (frame size and muscling level) may be customized with a production program (short-, medium-, and long-term) to produce a steer that meets industry specifications. For example, a long-term production strategy can be used for small-framed cattle to raise the slaughter weights of cattle without overly fattening them.

Similar studies such as Camfield et al.(1997, 1999) have shown comparable results. In 1999, Camfield et al. studied the effects of growth type on carcass traits of pasture or feedlot steers. Camfield et al. indicated the purpose of their research was not to compare pasture-developed steers to feedlot-developed steers, but to characterize the differences in carcass traits among four fundamentally different growth types of cattle within the pasture and feedlot regimens. The four different growth types of cattle that were studied were large framed-late maturing (LL), characterized by Charolais and Chianina cattle; intermediate framed-intermediate maturing (II), characterized by Red Poll and Hereford cattle; intermediate framed-early maturing (IE), characterized by current pedigreed Angus cattle; and small framed-early maturing (SE), characterized by cattle similar to "1950-model" Angus cattle. Half the cattle from each growth type were produced on pasture while the other half were produced in the feedlot. A least squares regression was used to find the variables that affected carcass traits the most. It was found that growth type affected all carcass traits regardless of feeding regimen, with the exception of dressing percentage for pasture-developed steers. This study provides some interesting information about the way a feeding regimen and the type of cattle produced can affect carcass traits. The authors noted, though, that differences in muscle mass may have been due to breed type. Because this study used different breeds for different growth types, it is almost impossible to know which actually had an effect on carcass traits. Was it the breed type or the growth type? So extrapolation beyond the sizes and breeds of this research is not scientifically possible.

Camfield et al. (1997) also studied the effects of frame size and time-on-feed on carcass characteristics. Medium and large-framed calves were divided into four different finishing regimens: 0, 30, 60, and 90 days after a 150-day common backgrounding period. The objective of this study was to determine what interactions frame size and time-on-feed had on final carcass performance. It was found that large-framed, slow-maturing steers had lower quality grades and marbling scores and heavier carcass weights than intermediate-framed, slow-maturing steers. Also, as time-on-feed increased, quality grades increased and numerical yield grades increased.

Ludwig's article on frame size and its relationship to feedlot and carcass performance reviews the history of cattle feeding and the way that feeder cattle frame sizes have changed so that the cattle matched the production system that was used. Ludwig showed how cattle have been bred to be larger and better suited to concentrate feeding. He also showed how geographic regions have influenced the size of cattle. According to Ludwig, physiological maturity and the bovine growth curve are a function of frame size. While this article does not offer much scientific information, it does provide historical information that explains how the U.S. beef industry changed over time.

Previously discussed research has shown that there is a difference in performance between cattle of different frame sizes and muscling levels. Armstrong et al. analyzed different breeding systems that produce different sized cattle. One system included purebred Herefords (HE), another small dual purpose breeds (SR). Another system involved a three-way rotational cross of Charolais, Simmental, and Maine-Anjou (LR) and the final system used Angus sires on LR heifers (AL). In this study, larger breeds generally had greater net returns (LR>SR>AL=HE). AL had lower net returns when feed supply was the constraining resource and HE had lower net returns when herd size was constrained. The authors of this study point out, though, that the results were sensitive to changes in calving rate, environment, management, beef to feed prices, and resource constraints.

Composition Differences

Much of the performance research concerning frame size and muscle score focuses on the composition of gain effects. That is, the research looks at whether cattle gain more fat or muscle and where in the carcass fat is partitioned. May et al. examined the effect of slaughter cattle phenotypic characteristics (sex class, frame size, muscle score, and external fatness) on live and carcass value as influenced by subprimal fat trim level. Large, thickly muscled cattle with an adjusted fat thickness of 2.25 cm and a trim level of .64 cm had the highest valued carcasses. Carcass fatness and muscle score had more influence on live and carcass value than frame size and sex class. Frame size had little effect on live and carcass value. This study found that edible muscle is valuable. Beef, after all, is sold by the pound.

McCarthy et al. did an experiment to find out what role frame size plays in determining the composition of gain in cattle. Do smaller framed cattle get fatter than larger framed cattle? This study separated cattle into two different categories, large frame (LG) and small frame (SM) and individually fed the cattle an 80% concentrate, corn-based diet. Average daily gains were greater for LG, but feed efficiency was similar for both types of cattle. The SM cattle had a greater fat thickness and less desirable yield grades, but the quality grades were about the same for both SM and LG cattle. The data from this study indicates that LG and SM cattle have the same feed efficiency and quality grades, but LG cattle have more desirable yield grades and fat thicknesses.

Tatum et al. (1986 I) have conducted many studies concerning feeder cattle frame size and muscling level. One of the first things they did was measure objectively the subjective 1979 USDA feeder cattle frame scores and muscling levels. Many have argued that because these grades are based on visual judgement, they may lack objectivity and consistency. A 5-person panel graded cattle and then the cattle were measured to see how accurate the appraisers were. They found that the appraisers did a good job of grading the cattle and concluded that someone with a fairly good understanding of the feeder cattle grading system could distinguish between different frame sizes and muscling levels of cattle.

After Tatum et al. (1986 II) found that feeder cattle grades could be distinguished visually, the authors studied the effect of these grades on absolute growth and carcass

It is likely that differences in the way No. 3 muscled steers deposited fat was more likely caused by breed differences. In 1961, Callow found that beef breeds of cattle had a higher percentage of IM and SC fat and less INT fat. He also found that dairy breeds had a lower percentage of IM and SC fat and more INT fat. Because most No. 3 steers were either of longhorn or dairy breeding, it is likely that the differences in the deposition of fat are more likely caused by breed effects.

Tatum et al. (1988) also did research considering the influence of diet as well as frame size and muscling level on growth rate and carcass composition. The three main objectives of this project were to study the relationship between frame size and growth rate during finishing, the relationship of frame size to carcass fatness at a common degree of maturity, and the relationship of muscling level to muscle-to-bone ratios. The cattle in this experiment were divided into a 3 x 3 x 3 factorial with frame size (Large, Medium, Small), muscling level (No. 1, No. 2, No. 3) and diet (grain, silage, forage) as the independent variables. Diet interacted with frame size to affect growth rate. This effect was more pronounced with the grain diet, followed by silage and forage diets. The degree of finish for steers on silage diets depended on the frame size of the steer. Small steers on silage had a degree of finish similar to that of steers fed grain. Large steers on silage were very lean, though. Muscle score also had some effect on muscle-to-bone ratio (No. 1 > No. 2 > No. 3). Diet had some effect on muscle-to-bone ratios, but it did not change the outcome that muscle score predicted.

One thing that is lacking in all of these performance studies is an in-depth look at the pricing and profitability differences due to frame size and muscling levels. Performance and pricing differences are needed to get a proper understanding of the profitability differences.

Pricing Differences

Feeder cattle prices are determined by characteristics such as weight, breed, grade, age, sex, frame size, and other descriptions (Buccola; Turner, McKissick, and Dykes). These characteristics cause variations in expected slaughter revenues and animal production costs. Thus, relative price premiums and discounts among lots of feeder cattle should reflect the demand for specific traits of a lot such as sex, weight, number of head, breed, health, grade, and body condition (Schroeder et al. 1988). Schroeder et al. specifically tried to determine the value of these traits taking into account seasonality and market changes (i.e. feeder cattle futures market prices). The authors found that these factors did indeed interact to establish different feeder cattle values.

Mintert et al. studied prices received at auction barns in Kansas for different feeder cattle traits. Like Schroeder et al., price differences for breed, muscling score, frame size, health, body condition, weight, presence of horns, gut fill, lot size, and time of year sold were measured for steers and heifers. This study gives insight into the industry's determination of the value of these feeder cattle traits. Premiums were paid for cattle with larger frames (Large>Medium>Small) and more muscle thickness (No.1 > No. 2 > No.3).

A few years later, Sartwelle et al. updated the Mintert et al. study. Sartwelle et al. included more auction barns, but largely did the same thing as Mintert et al. Significant price differences were recorded for different feeder cattle traits. The results of this research were similar to that of Mintert et al. However, different market conditions can cause some traits to be valued differently.

Smith et al. (1998) conducted a similar study in eastern Oklahoma to that of Sartwelle et al. and Mintert et al. in Kansas. Smith et al. found significant price differences for traits such as weight, sex, frame size, muscling score, presence of horns, gut fill, body condition, number of head in sale lot, uniformity of multiple head lots, and health. As with Mintert et al. and Sartwelle et al. research, Smith et al. found that larger framed cattle brought higher prices (Large>Medium>Small) and heavier muscled cattle brought higher prices (Heavy > Medium > Small).

Troxel et al. measured the price differences for feeder cattle traits in Arkansas and identified improvements that could be made by producers to increase total returns. As in previous studies, frame score, muscle thickness, color, sex, fill, body condition, presence of horns, health, and size and uniformity of lot price differences were determined. One novel aspect of this study was the effect of breed and breed interaction on feeder cattle price. This study also showed the percentage of frame scores, muscling scores, and color for each breed and breed interaction. For example, 11% of Angus x Hereford cattle in this study had a frame score of large, 87% had a frame score of medium, and 2% had a frame score of small. 99% of Angus x Hereford cattle had No. 1 level muscling and 1% had No. 2 level muscling. This information is insightful. It shows just how much traits such as frame size and muscling can vary between breeds.

These studies show the value that the industry places on these traits at the stocker/feeder level at different points in time, at different locations, and at different market conditions. While these studies do a good job showing the value the industry places on frame size and muscling level, they do not show the efficiency of the valuations. Are price differences for varying levels of frame and muscling efficient? Do they accurately measure the production differences and eventually the profitability differences that these traits will cause?

Profitability Differences

One study that considered profitability differences as well as performance differences is Trenkle's "Effects of Sorting Steer Calves on Feedlot Performance and Carcass Value". In this study, weaned steer calves were sorted by frame size and then by backfat. The cattle were fed a constant number of days. Smaller-framed cattle tended to have superior feed conversion. Larger-framed cattle gained faster, but also consumed more feed. Calves with more backfat were fed fewer days than those with less backfat. The carcasses of the larger-framed cattle tended to have less backfat, were heavier at slaughter, had larger rib-eye areas, and had a greater value according to the grid used. The author does note that the reason for the greater carcass value was probably because the larger-framed cattle simply had heavier carcasses. The purchase price was set to

$90/cwt for all cattle in the experiment. At this price, smaller-framed steers were $18.26 per head more profitable than larger-framed steers. Steers with less initial backfat were $25.47 per head more profitable than steers with more initial backfat. Given a $40 per head profit from feeding the steers, larger-framed steers should have been discounted $3.50/cwt. compared to smaller-framed steers to be efficiently priced. While backfat measurements are not usually made available to feeder cattle buyers, this study indicates that this may be important and useful in the future. One problem with this study is that cattle were harvested at a constant number of days and not necessarily a biological endpoint. Cattle of different frame size grow at different rates and thus have different biological growth curves. By harvesting according to days fed, some cattle may not have been finished (ready to harvest) while other may have been overly finished. Profit research should replicate real world situations in which cattle are usually fed to a biological endpoint such as four tenths of an inch backfat (low Choice).

Langemeier, Schroeder, and Mintert identified factors that influence the variability in profit per head for finishing steers and heifers over time. Close-out data were gathered from western Kansas feedlots and regression analysis used to explain variability in profit per head. Cattle were separated by sex and by placement weight. The authors found that much of the variation in profit could be explained by fed cattle price, feeder cattle price, corn price, interest rates, feed conversion, and average daily gain. As much as 50 % of the variability in feeding profits was explained by changes in fed cattle price alone. Feeder cattle price and corn price explained roughly 25 % and 22 % of the variability of cattle feeding profitability respectively. This study points out that profitability can be affected by cattle prices, performance, and costs, but it does not identify traits that increase cattle prices, improve performance, or lower costs.

Schroeder et al. (1993) updated much of Langemeier, Schroeder, and Mintert's work. Instead of using monthly average close-out data, Schroeder et al. used pen data. Again, fed cattle price, feeder cattle price, corn price, feed conversions, average daily gain, and interest rates were all significant in explaining variations in feeding profitability. More specifically, fed cattle price and feeder price explained 70-80 % of the variation in feeding profit. Corn price accounted for 6-16 % and cattle performance accounted for 5-10 % of the variation in feeding profit.

Cattle feeding profitability in the Midwest was examined by Lawrence, Wang, and Loy. The authors hypothesized that feedlots in the Midwest would have unique variations in profitability due to weather and lot conditions. Factors that significantly impacted feeding profitability included input prices, output prices, animal performance, sex, placement weight, facility design, and placement season. Ordinary least squares regression analysis was used to identify the significant variables, just as in Schroeder et al. (1993). Separate regressions were used for steers and heifers for four different placement weight categories: less than 600 pounds, 600-699 pounds, 700-799 pounds, and 800 pounds and over. The results were extremely similar to those of Langemeier, Schroeder, and Mintert, and Schroeder et al. (1993) with one exception. Corn price had less influence than feed efficiency and average daily gain on feeding profit. Fed cattle and feeder cattle price explained over 70% of the variation in feeding profit for all groups except the heifers placed under 600 pound group.

Between these three studies, it is clear that a few important variables explain a large part of the variation in profitability. In particular, the importance of fed cattle and feeder cattle prices is evident. None of these studies measured the efficiency of cattle prices. Do cattle prices accurately reflect the performance and carcass differences apparent in different cattle?

Summary

There has been much research on the performance of cattle with different frame sizes and muscling levels. Cattle performance due to differences in frame size and muscling level is largely known. The price of cattle with different frame sizes and muscling levels is also known. Several studies have identified prices paid for different feeder cattle traits. Profitability, though, depends on both performance and price information. Little research has been done measuring profitability of producing feeder cattle with different frame size and muscle score. If the market for feeder cattle is efficient, then there should be no difference in the profitability of cattle with different frame sizes and muscling scores. The prices paid for these different grades of cattle should reflect differences in performance due to these grades.

Chapter 3

Data and Procedure

USDA Feeder Cattle Grades

The USDA has three feeder cattle frame scores (Large, Medium, and Small) and four muscling scores (1, 2, 3, 4). These two traits combined result in 12 different grades of feeder cattle (e.g. L1, M2, S3). Table 1 shows the combinations of traits that can be made using the 2000 USDA Feeder Cattle Grades. Cattle with muscle scores of 3 and 4 usually have a considerable amount of dairy genetics. This project focuses on beef cattle production, so only large, medium, and small frame feeder cattle and #1 and #2 muscle feeder cattle were examined.

Table 1. USDA Frame and Muscling Scores

	Large Frame	Medium Frame	Small Frame
#1 Muscle Score	Large #1	Medium #1	Small #1
#2 Muscle Score	Large #2	Medium #2	Small #2
#3 Muscle Score	Large #3	Medium #3	Small #3
#4 Muscle Score	Large #4	Medium #4	Small #4

Data

This research is part of a study conducted by the Noble Foundation in Ardmore, Oklahoma. The research experiment was designed to determine performance and profitability differences in feeder cattle with varying degrees of frame size and muscle score. Six combinations of feeder cattle frame size and muscling score were considered in the experiment: large frame, #1 and #2 muscling; medium frame, #1 and #2 muscling; and small frame, #1 and #2 muscling.

A 3X2 factorial experimental design was incorporated in this project (Table 2). A factorial experiment is an experiment in which the response y is observed for all factor-level combinations in the independent variables. The independent variables in this experiment were frame size with three levels (large, medium, small) and muscle thickness (#1 and #2) with two levels. The dependent variables are commonly used performance and profitability measures such as average daily gain (ADG), feed efficiency, harvest weight, dressing percentage, hot carcass weight, rib-eye area, yield grade, quality grade, feeding costs, cattle prices, stocker-level profit, feedlot-level profit, and retained ownership profit (stocker-level plus feedlot-level). A complete list of the variables used and their definitions is presented in Table 3 and a table of summary statistics is presented in Table 4.

Table 2. Factorial Experimental Design.

	Large Frame	Medium Frame	Small Frame
#1 Muscle Score	25 Head	30 Head	15 Head
#2 Muscle Score	17 Head	34 Head	14 Head

Table 3. Variable Definitions.

Variable	Definition of Variable
Frame	Frame Size of animal prior to pasture phase of production. 1=small, 2=medium, 3=large.
Muscle	Muscle score of animal prior to pasture phase of production. 1=No.1, 2=No.2.
Trtmt	Treatment of animal judged prior to pasture phase. 1=S1, 2=S2, 3=M1, 4=M2, 5=L1, 6=L2.
Sale	Sale location where animal was bought. 1=Atoka, 2=Hugo, 3=McAlester, 4=Paris, TX (Cattleman's).
Flesh	Flesh of animal at time of purchase. 1=thin, 2=light medium, 3=medium.
Color	Color/Breed of animal. 1=black, 0=other.
Sex	Sex of animal when bought. 1=bull, 0=other
Horns	Presence of horns on animal when bought. 1=horned, 0=other.
Buydate	Date animal was bought. (Calendar date converted to SAS date value)
Buyweight	Weight of animal when bought. (lbs.)
Buyprice	Price paid when animal was bought. ($/cwt.)
BuyHat	Predicted purchase price of animal. ($/cwt.)
AdjBuy	Predicted purchase cost of animal. ($)
Preweight	Weight of animal after preconditioning on Feb. 13, 2001. (lbs.)
PreADG	Average daily gain during preconditioning. (Pounds/Day)
Pasweight	Weight of animal after pasture phase of production on May 1, 2001. (lbs.)
PasADG	Average daily gain on pasture. (Pounds/Day)
Medcost	Total medicine cost during preconditioning and pasture phase of production. ($/hd)
Avgkillw	Weight of animal at slaughter. (lbs.)
HCW	Hot carcass weight of animal. (lbs.)
Dressing	Dressing percentage of animal. (%)
KPH	Percent of kidney, pelvic, and heart fat. (%)
AdjFat	Adjusted fat thickness of animal at slaughter. (inches)
AvgMarb	Average marbling (200=traces, 300=slight, 400=modest, 500=moderate).
OverMat	Overall maturity of animal at slaughter. (<100=A Maturity, >100=B Maturity)
QG	Quality grade. 1=Prime, 2=Choice, 3=Select, 4=Standard, 5=Utility.
YG	Yield grade. 1=YG 1, 2=YG 2, 3=YG 3, 4=YG 4, 5=YG 5.
REA	Rib-eye area (longissimus muscle). (inches^2)
Daysfed	Days in feedlot.
Feedeff	Feed efficiency of animal in feedlot. (Feed in pounds/Gain in pounds)
FeedADG	Average daily gain during feedlot phase of production. (Pounds/Day)
Adjstpr	Adjusted Profit from backgrounding and pasture phases of production. ($/hd)
Fdlivep3	Adjusted Profit from feedlot phase of production. ($/hd by liveweight)
Fdprof3	Adjusted Profit from feedlot phase of production. ($/hd by grid)
Adjlive3	Adjusted Profit from all phases of production. ($/hd by liveweight)
Adjactp2	Adjusted Profit from all phases of production. ($/hd by on grid)

Table 4. Summary Statistics.

Variable	N	Units	Mean	Std. Dev.	Minimum	Maximum
Buyweight	135	Lbs.	462.459	23.421	420.000	530.000
Buyprice	135	$/cwt.	100.385	7.747	72.000	113.000
Buyhat	131	$/cwt.	100.206	5.323	74.680	110.446
Adjbuy	131	$/hd.	462.945	27.868	373.400	521.343
Preweight	135	Lbs.	500.052	50.981	391.000	617.000
PreADG	135	Lbs./Day	0.314	1.111	-4.600	2.636
Pasweight	134	Lbs.	699.045	69.590	518.000	864.000
PasADG	134	Lbs./Day	2.575	0.527	1.013	3.753
Medcost	135	$/hd.	1.169	4.583	0	36.830
Avgkillw	135	Lbs.	1230.390	124.609	959.000	1569.000
HCW	135	Lbs.	747.919	79.322	581.000	925.000
Dressing%	135	%	0.608	0.017	0.561	0.661
AdjFat	134	Inches	0.441	0.157	0.120	0.827
AvgMarb	134	Scale	385.100	56.289	285.000	740.000
OverMat	133	Scale	60.075	17.559	30.000	200.000
QG	134	Scale	2.694	0.564	1	5
YG	134	Scale	2.595	0.666	0.489	3.990
KPH	134	%	1.964	0.379	1.000	3.000
REA	134	Inches	13.268	1.642	10.100	18.000
DaysFed	135	Days	131.074	24.734	83.000	152.000
Feedeff	135	Ratio	7.304	0.645	6.267	8.539
FeedADG	135	Lbs./Day	3.551	0.643	2.007	5.530
Adjstpr	130	$/hd.	48.617	45.119	-64.109	155.102
Fdlivep3	134	$/hd.	-36.009	70.985	-194.699	132.985
Fdprof3	133	$/hd.	-80.966	78.243	-389.055	96.044
Adjlive3	130	$/hd.	2.237	75.667	-187.553	177.026
Adjactp2	129	$/hd.	-31.497	81.784	-358.944	149.401

Procedures

An experienced cattle buyer purchased roughly 20 feeder cattle for each of the six grade classes. The period in which cattle were bought started on November 6, 2000 and continued until January 23, 2001 (Appendix Figure 1). Table 2 shows the experimental design and the number of cattle in each treatment. Cattle purchased were predominately of Angus genetics and were bought individually or in small lots. Appendix figures 2-9 show the frequency of cattle characteristics in this experiment. Calves were processed the day after being bought, backgrounded on hay and feed until small-grain pasture was ready, and then officially graded by current and former market reporters from the Oklahoma Department of Agriculture and the USDA. Processing included the following vaccinations and treatments: pasturella (Polybac) with somnus, Bovishield 4 plus Lepto 5, 7-way Clostridial plus I-site (pink eye), Micotil (7 cc), Back pour for lice, Ivomec Plus dewormer, dehorning (if needed) and castration (if needed). Table 5 illustrates a breakdown of preconditioning costs in this experiment.

Table 5. Preconditioning Costs

Treatment	Cost
Pasturella (Polybac) with Somnus	$1.00/hd
Bovishield 4 plus Lepto 5	$1.00/hd
Micotil (7 cc)	$7.28/hd
Back Pour for Lice	$0.35/hd
Ivomec Plus Dewormer	$2.25/hd
Chute Charge (Misc. costs including dehorning and castration if needed)	$2.00/hd
Transportation and Buying Fee	$5.00/hd
Bermudagrass Hay	$30/bale
Creep Pellets	$8.95/cwt.
Total Preconditioning Costs	$32.50-74.73

The cattle were then retreated with Bovishield 3 on December 17, 2000, January 24, 2001, February 13, 2001. A Synovex S implant was also administered to the cattle on February 13, 2001. Eight calves were treated for photosensitivity with Naxcel bullets. Other medicine treatments were administered to sick or unhealthy cattle under the following system.

1st Pull: 1st Treatment Nuflor (wait 48 hours); if no response then:

2nd Treatment Nuflor (wait 48 hours); if no response then:

3rd Treatment Baytril (wait 48 hours); Turn out.

2nd Pull

1st Treatment Micotil; Turn out.

3rd Pull

1st Treatment Penicillin (10 cc/100 lbs. Every other day, 3 times.

During preconditioning, cattle were fed bermudagrass hay, johnsongrass hay, and 4 pounds of creep pellets each. The creep pellets were made of wheat midds, corn, and cottonseed meal. The price of each calf was recorded as well as flesh, color, sex, horn status, sale location where the calf was bought, date when calf was bought, weight at which calf was bought, ADG during backgrounding, feed and hay cost during backgrounding, vaccination costs, and medicine costs.

After the preconditioning period (February 13, 2001), cattle were put on small-grain pasture together at the Noble Foundation's Red River Research and Demonstration Farm in Burneyville, OK. The small-grain pasture consisted of conventional and no-till Maton rye planted at 100 pounds per acre in early to mid-September and fertilized with 80 pounds per acre of actual Nitrogen at planting and topdressed with 60 pounds per acre of actual Nitrogen in February. Cattle entered the small-grain pasture on February 12, 2001 and were taken off on May 1, 2001 for a total of 77 days on small-grain pasture. Clipping data were obtained from four exclosures (2 from each treatment) at four different dates (2/12, 3/09, 3/22, and 4/09). The clippings were used to measure the dry matter produced by the rye. The cattle were actively grazing during all but the first clipping date. Dry matter yields for each clipping date by planting procedure are reported in table 6.

Table 6. Maton Rye Production.

Clipping Date	No-till (lbs/acre)	Coventional-till (lbs/acre)
2/12/01	1914	1193
3/09/01	1293	1348
3/22/01	528	534
4/09/01	330	198
Total	4065	3473

At the end of graze-out small-grain pasture, cattle were weighed, re-graded, priced by four independent order/buyers, and sent to the Colorado State University research feedlot in Fort Collins, CO. Cattle were priced by original treatment group as if they were being sold in the field directly to the order buyer. The value of each animal was found by multiplying the average treatment price by the weight of the animal. Profit during the background and small-grain pasture (stocker) phase of production using equation (4) will be measured and tested to find inefficiencies using least squares means in SAS's GLM procedure.

(4) $$\pi_i = P_iY_i - R_iX_i - C_iZ_i$$

π_i is profit for the i[th] production stage. The term "profit" in this study is returns to unpaid death loss, labor, transportation, selling, and management costs. P_i is the output price of cattle in the i^{th} production stage, which depends on frame size and muscling level. Y_i is the output weight of cattle in the i^{th} production stage. R_i is the input price of cattle in the i^{th} production stage and X_i is input weight of cattle in the i^{th} production stage, both of which depend on frame size and muscling level. C_i is cost of production inputs in the i^{th} production stage (appendix table 1) and Z_i is amount of production inputs in the i^{th} production stage, such as medicine and feed. Profit is equal to the price of cattle in the i^{th} production stage multiplied by the weight of the cattle in the i^{th} production stage minus the purchase price of cattle multiplied by the purchase weight of cattle and minus the cost of production in the i^{th} production stage. The three stages of production are pasture, feedlot, and retained ownership.

Purchase price was also adjusted to remove some of the bias associated with an order buyer specifically trying to buy certain types of cattle (i.e. small # 1's). The auction barns where cattle were purchased are small and the order buyer could have influenced the price at which the cattle normally would have been purchased. The actual purchase price was regressed on independent variables that describe the cattle bought (equation 5)

(5) Buyhat = f(fm01, fm03, m01, sale1, sale2, sale3, flesh1, flesh2, color, horns, sex, buyweight, buydate)

where variables are as described in table 2. The predicted values for this model were then used as the adjusted purchase price in the adjusted profit models. The other models used actual purchase price. Table 7 shows the results of the buyhat model.

Table 7. Purchase Price Model.

Adjusted Purchase Price Model (\$/cwt.)	
Explanatory Variable	Parameter Estimate
Intercept	968.384**
	(183.466)
Small Frame Binary	-4.273**
	(1.507)
Large Frame Binary	3.608**
	(1.421)
No. 1 Muscle Binary	0.983
	(1.156)
Atoka Sale Binary	2.825*
	(1.675)
Hugo Sale Binary	-1.005
	(1.297)
Paris Sale Binary	2.945
	(3.36)
Thin Flesh Binary	3.797**
	(1.745)
Lt-medium Flesh Binary	-3.539**
	(1.369)
Color Binary	-0.22
	(1.374)
Horns Binary	1.775
	(1.274)
Sex Binary	-0.152
	(1.124)
Purchase Weight	-0.073**
	(0.025)
Purchase Date	$-6.461E^{-7}$**
	($1.446E^{-7}$)
Adjusted R^2	0.407

Least-squares (LS) means analysis was done using the SAS statistical program. LS means are the predicted population means of the effects of classification variables on dependent variables. The classification variables in this case are frame size, muscle score, and treatment (frame size X muscle score). One model used frame size and muscle score, while another model used treatment alone. Adjusted fat thickness was used as a covariate and set to 0.4 inches so that variation caused by differences in adjusted fat thickness would not interfere with LS means results. This was done because all the cattle in this experiment were targeted to a common biological endpoint (backfat = 0.4 inches). The dependent variables in this case are pasture profit and pasture performance. The i LS means were then tested for differences between j groups using the Bonferroni pairwise comparison test. The null hypothesis was that there were no differences in the LS means across frame size, muscle thickness, or treatment groups.

(6) $$Ho\text{: LS-mean}(i) = \text{LS-mean}(j)$$

(7) $$Ha\text{: LS-mean}(i) \quad \text{LS-mean}(j)$$

If the cattle market efficiently values frame size and muscle score, there should be no excess profit from buying a certain frame size and muscle score instead of another. The performance differences caused by frame size and muscle score will cause the profit of cattle to be the same no matter what the degree of frame size and muscle score. Thus, the profit from different levels of frame size and muscling will be equal when the market is efficient:

(8) $$\pi_{i}(\mathrm{F}i, \mathrm{M}i) = \pi_{i}(\mathrm{F}j, \mathrm{M}j)$$

$\pi_{i}(\mathrm{F}i, \mathrm{M}i)$ is profit in the i^{th} production stage from a certain frame size and a certain muscle score, and is equal to $\pi_{i}(\mathrm{F}j, \mathrm{M}j)$, profit in the i^{th} production stage from a different frame size and a different muscle score.

Data collected at the feedlot included feed intake, morbidity, mortality, feed cost, feedlot processing cost, and ADG. Cattle were fed in treatment groups to find feed efficiency. 15 pens of cattle were fed with 7 to 12 head per pen. The cattle were sorted to pens of similar weight and anticipated finishing time within treatments. When the average of the pen of cattle had an estimated 0.4 inches of backfat, the pen was harvested. Cattle were harvested in three groups. The first group was harvested on September 9, 2001; the second group on October 24, 2001; and the last group on November 13, 2001. The price of cattle was assessed by live-weight and by the Gelbvieh Alliance's muscle grid. Carcass data, important for valuing cattle, such as harvest weight, hot carcass weight, dressing percentage, overall maturity, rib-eye area, quality grade, and yield grade were obtained by experts at Colorado State University. Appendix figure 10 illustrates the percentage of choice or better by treatment. Using the carcass information, profit was measured in a manner similar to equation (4). As before, to test for market inefficiencies, differences in LS means were tested. Besides being done for the feedlot stage of production, similar analyses were conducted for the two stages of production together. Thus, profit was measured at the stocker stage, feedlot stage, as well as both stages combined. Feedlot valuation involved live-weight and grid pricing.

The cattle in this experiment were sold via the Gelbvieh's muscle grid. The muscle grid emphasizes yield grade, but does pay premiums for quality grade so it can be used for cattle that fit both grade strengths. Appendix tables 2-3 show the specifications of the Gelbvieh muscle grid and averages of the premiums/discounts at the harvest dates. The liveweight used to determine profit was the Cattle-Fax US average live price for the harvest dates.

Three other grids were also used to calculate the simulated profit that would have been made had the cattle been sold differently. The USDA national average of reported grid prices (Appendix Table 4) on the harvest dates was taken from the Livestock Marketing Information Center (LMIC) website (http://www.lmic.info/). This grid is supposed to be an average grid that emphasizes both quality and yield grade. Different types of cattle do well on grids that emphasize different meat characteristics. Two simulated grids were also used to simulate profit: one emphasizing quality grade, the other yield grade. Appendix tables 5-6 show the premiums and discounts associated with the simulated grids. The simulated grid premiums and discounts mirror those of commonly used industry grids. Base prices and plant averages were not obtained for some of these grids, therefore, these simulated grids were used in their place.

Ordinary least squares regression was also used to analyze production and profit data. Models included quality grade, yield grade, harvest weight, ADG during backgrounding, ADG during small-grain pasture, ADG during feeding, feed efficiency in feedlot, adjusted actual profit from the stocker enterprise, actual profit from the feedlot enterprise when cattle were sold on a liveweight basis, actual profit from the feedlot enterprise when cattle were sold on the Gelbvieh muscle grid, adjusted actual profit from all enterprises when cattle were sold on a liveweight basis, and adjusted actual profit from all enterprises when cattle were sold on the Gelbvieh muscle grid as dependent variables. Theoretically significant independent variables were used in each of these models.

First, the models were checked for multicollinearity using the variance inflation factor (VIF) that measures the relationship between the independent variables. Variance inflation factors greater than 10 indicate multicollinearity. Days fed was found to cause multicollinearity problems and was subsequently dropped from the models. Some other variables were found to be collinear, but were retained because they did not cause bias or inefficiency. Heteroskedasticity was then checked using the Breusch-Pagan test. Models that were found to reject the null hypothesis of homoskedasticity were then re-estimated using estimated generalized least squares regression (EGLS).

Growth curves were created to show the rate that cattle of different frame sizes grow. Weight, hip height, and fat thickness each were regressed on days and days squared for each different frame size. Appendix figures 11-13 show the growth to be expected for cattle with different frame sizes. The weight curves data began on February 13, 2001; hip height data began on June 14, 2001; and fat thickness data began on July 4, 2001. Liveweight at Small^{00} marbling (average marbling = 400) was predicted using frame and muscle as class variables. Average marbling was used as a covariate and set equal to 400. The predicted values from this model were then used as dependent variables with frame as an independent variable. This model then reveals the weights that different frame score cattle should finish at low Choice (Small^{00} marbling) and is illustrated in Appendix figure 14.

Chapter 4

Empirical Results

LS Means Differences

Least squares means for production traits, carcass characteristics, profits, and breakeven prices are shown in tables 8 through 19. The LS means were calculated for both frame and muscle classifications and also for treatment classifications (frame X muscle) using adjusted fat thickness at harvest as a covariate. The model for adjusted fat thickness did not have a covariate. Also included in these tables are the standard errors for the estimates and superscripts identifying groups that have significantly different means (5% level).

Production and Performance Differences

Production traits analyzed with LS means difference testing included the initial weight of cattle, ADG during backgrounding (before small-grain pasture), ADG on small-grain pasture, ADG in the feedlot, feed efficiency in the feedlot, days fed in the feedlot, and weight of cattle at harvest. As seen in table 8, medium-framed cattle weighed significantly less when purchased than large-framed cattle (as designated in the table by the superscript 'a' for medium-framed cattle versus 'b' for large-framed cattle), while small-framed cattle were not significantly different from either medium or large-framed cattle (as designated by the superscript 'ab'). There were no significant differences in initial weight due to muscle score and there were no significant differences in initial weight due to treatment (Table 9).

There were also no differences in the ADG during backgrounding, on small-grain pasture, or in the feedlot. Feed efficiency, days fed, and liveweight (weight at harvest) had some noteworthy differences, though. Small-framed cattle were more efficient (i.e. lower pounds of feed fed per pound of gain) than medium-framed cattle, which were in turn more efficient than large-framed cattle. Also, # 1 muscled cattle were significantly more efficient than # 2 muscled cattle. Small # 1's, small # 2's, and medium # 1's were significantly more efficient than medium # 2's, large # 1's and large # 2's. Medium # 2's were statistically more efficient than large # 1's but not large # 2's.

Large-framed cattle were fed longer than medium-framed cattle and medium-framed cattle were fed longer than small-framed cattle. Muscle score did not statistically affect the amount of days fed in this experiment. For treatments, medium # 2's, large # 1's, and large # 2's were fed longer than small # 1's , small # 2's and medium # 1's.

Similarly, small-framed cattle weighed less at harvest than medium-framed cattle and medium-framed weighed less at harvest than large-framed cattle. The USDA feeder cattle grades are supposed to help predict the harvest weight of the cattle, and in this study they did, in fact, explain differences in harvest weight. # 2 muscled cattle also weighed more than # 1 muscled cattle. This result was unexpected. One would think that heavier muscled cattle would weigh more at harvest, but this was not verified by the evidence in this experiment. Small # 1's were significantly lighter at harvest than medium # 1's, medium # 2's, large # 1's and large # 2's. Small # 2's were significantly lighter at harvest than medium # 2's, large # 1's and large # 2's. Medium # 1 and 2's were statistically lighter than large # 2's but not large # 1's.

Carcass Differences

Carcass characteristics play an important role in the valuation of cattle sold in a value-based pricing system such as a grid or alliance. In this experiment, dressing percentage, adjusted fat thickness, hot carcass weight, rib-eye area, overall maturity, yield grade, average marbling, percent kidney, pelvic, and heart fat, and quality grade were evaluated.

Small-framed cattle had a significantly lower dressing percentage than medium-framed cattle, but not large-framed cattle (Table 10). # 1 muscled cattle did not dress significantly differently than # 2 muscled cattle. Small # 2 cattle dressed significantly lower than medium # 2 and large # 1 cattle (Table 11). The other groups did not dress significantly differently from each other.

Again, adjusted fat thickness was not used as a covariate when modeling adjusted fat thickness. Large-framed cattle had significantly less adjusted fat thickness than medium-frame cattle, but not small-framed cattle. There were no statistical differences in adjusted fat thickness between the muscle or treatment groups. Likewise, there were no statistical differences in average marbling for any of the groups.

Hot carcass weight, like harvest weight, had considerable differences in means between frame sizes. Small-framed cattle averaged nearly 100 pounds less than medium-framed cattle and medium-framed cattle averaged about 50 pounds less than large-framed cattle. # 2 muscled cattle averaged 20 pounds more than # 1 muscled cattle. Large # 1 and # 2 cattle had significantly heavier hot carcass weights than small # 1, small # 2, and medium # 1 cattle. Small # 1 and 2's were significantly lighter than medium # 1 and 2's also. Overall maturity (part of quality grade standards) was not significantly different for any of the frame sizes, muscle scores, or treatment groups. This result verifies that the cattle were of different frame and muscle levels, but not of different ages.

Rib-eye area was greater for large and medium-framed cattle than it was for small-framed cattle, but there was no difference between rib-eye area means for the two muscle groups. It was expected that muscle scores would help predict muscle size (i.e. rib-eye area), but these data do not support that assumption.

There were no significant differences between the frame sizes or treatment groups regarding yield grade. However, there were significant differences in yield grade between # 1 and # 2 muscled cattle. # 1 muscled cattle did, indeed, have superior yield grades compared to # 2 muscled cattle. This evidence supports the theory that muscle scores help predict the yield grade of cattle at harvest.

There were no differences between the groups in either percent kidney, pelvic, and heart fat or quality grade. It has been theorized that time-on-feed and genetics had more to do with the quality grade of cattle than frame size and muscling. The data from this experiment supports this conjecture.

Profit Differences

If prices are efficient, profit from different frame sized and muscle scored cattle should not be significantly different. Using LS means difference testing, average profits for each group of cattle were tested for differences (tables 12-17). Stocker enterprise profit (backgrounding and small-grain pasture), feeder enterprise profit, and total enterprise profit were examined. Actual profits were examined as well as profits with adjusted (for possible bias) purchase prices. Feeder and total enterprise profits were calculated on both liveweight price and grid prices. Also, several grids were used to calculate total enterprise profits.

LS means for actual stocker enterprise profit were not significantly different across frame size groups (Table 12). Small-framed cattle averaged \$52.15 profit per head, medium-framed cattle averaged \$42.73 profit per head, and large-framed cattle averaged \$36.33 profit per head. # 1 muscled cattle averaged \$48.65 profit, while # 2 muscled cattle averaged \$38.83 profit. However, the difference between # 1 muscled profit and # 2 muscled profit was not significant. According to table 13, small # 1's generated the greatest profit followed by medium # 1's, small # 2's, large # 2's, large # 1's, and finally medium # 2's. Adjusted stocker profit results were not greatly different from actual stocker profit. Again, none of the groups were statistically different at the 5 % level. However, profit differences may be economically significant since they could exceed \$20 per head.

Although not statistically significant, actual profit per head for the feedlot enterprise when the cattle were sold on the Gelbvieh's muscle Grid was greater (i.e. cattle lost less money) for small-framed cattle than for medium-framed cattle and medium-framed cattle profit was larger than large-framed cattle profit (Tables 12-13). Likewise, actual profit per head for the feedlot enterprise when the cattle were sold on a liveweight basis was significantly greater for small-framed cattle than it was for large-framed cattle. Profit for medium-framed cattle was not significantly different than profit for small or large-framed cattle. # 1 and # 2 muscled cattle did not have significantly different profit for the feedlot enterprise when sold by liveweight or by the muscle grid. While actual feedlot profit using grid prices did not have any significant differences, those profits using live prices did. Small # 2's had larger profits than large # 1's, while the other treatment groups were not significantly different from either groups. Liveweight prices were higher than grid prices because the overall quality of the cattle used in this experiment were not high enough to benefit from grid premiums and avoid large grid discounts.

The actual profit results were unlike those using average prices of the three dates cattle were harvested (Tables 12-13). Average profit per head for the feedlot enterprise when the cattle were sold on the Gelbvieh's muscle grid or on a liveweight basis were not significantly different for any of the groups. Medium # 2's, had the greatest average profit for the feedlot enterprise when sold on the muscle grid, followed by small # 2's, large # 1's, large # 2's, medium # 1's, and small # 1's. Large # 1's had the greatest average profit for the feedlot enterprise when sold by liveweight, followed by small # 2's, medium # 2's, medium # 1's, large # 1's, and small # 1's. The cattle in this experiment were lower than industry average cattle causing the profit from liveweight price, which is an average of the industry to be higher than the profit from grid price, which is an average of the cattle in this experimental sample.

Small cattle had lower profits, though not significant, than medium or large cattle for both average grid and liveweight feedlot profits. Therefore, the main difference in profits was probably due to changes in cattle prices during the time between harvest dates. It should be noted that the first group of cattle, predominantly made up of small-framed cattle, was harvested before September 11, 2001 while the other groups of cattle, predominately made up of medium and large-framed cattle were harvested after September, 11, 2001. The live cattle market as well as many other commodity and financial markets suffered from lower prices after September 11, 2001 due to the terrorist attacks on New York, NY and Washington, DC. This price difference in the general cattle market can be seen in appendix figure 1.

There were no differences between muscle score groups in actual profit or average profit per head for the feeder enterprise sold on the Gelbvieh muscle grid or on a liveweight basis. According to these results muscling does not play a significant role in the profitability of feeder cattle.

Small cattle were significantly more profitable than large-framed cattle when profit was calculated based on the actual profit for all enterprises when cattle were sold on a liveweight basis (Tables 14-15). There were no differences in the actual profit due to muscling level. The same results were obtained for adjusted actual profit for all enterprises when cattle were sold on a liveweight basis. There were no differences due to frame size or muscle score in average or adjusted average profit for all enterprises when cattle were sold on a liveweight basis. Again, this shows that much of the actual profit variation was due to harvest date price changes and not true differences in cattle value.

Actual profit for all enterprises for cattle sold on the Gelbvieh muscle grid was greater (i.e. losses were less) for small-framed cattle than for large-framed cattle (Table 14). Adjusted actual profit for all enterprises for cattle sold on the Gelbvieh muscle grid did not have any significant differences. The muscle score of the cattle did not affect actual or adjusted actual profit for all enterprises for cattle sold on the muscle grid. Like the feedlot enterprise profit data, average and adjusted average profit for all enterprises when cattle were sold on the Gelbvieh muscle grid were not significantly different for any of the frame, muscle, or treatment groups (Tables 16-17).

Cattle grids are usually tailored either for heavier muscled, lower quality grade cattle or for higher quality grade, lighter muscled cattle and it was hypothesized that large-framed, heavy muscled cattle would be better suited to those grids that are more interested in higher yield grades and less interested in higher quality grades. It was also hypothesized that small-framed cattle would be better suited to those grids emphasizing higher quality grades because they usually have a greater amount of fat thickness and marbling. Three additional grid prices were used to simulate the profits that the cattle would have made had they been sold on those grids. The USDA national average of reported grid prices on the harvest dates were obtained from the Livestock Marketing Information Center (LMIC) website (http://www.lmic.info/). One simulated grid emphasized quality grade with larger premiums for quality grades while another simulated grid emphasized yield grade with higher premiums for yield grades. Attached in the appendix are tables 4-6 with the grade premiums and discounts for these grids.

The adjusted average national average grid profit was not significantly different for any of the frame, muscling, or treatment groups. There were also no significant differences in the profits based on the simulated quality and yield grids for cattle of different frame and muscle scores. Each group of cattle performed better on the simulated yield grid than on the simulated quality grid because the cattle in this experiment had such poor quality grades. Again, profit differences were not statistically significant. However, profit differences of $10 per head or more may be economically significant.

Pricing Efficiency

Actual and adjusted purchase price LS means were calculated for cattle of differing frame sizes, muscle scores, and treatment groups (Tables 18-19). Actual and adjusted small-framed cattle purchase prices were significantly less than those for medium or large-framed cattle. Large-framed cattle adjusted purchase prices were also significantly higher than medium-framed adjusted purchase prices. There were no differences in actual and adjusted purchase prices for cattle differing in muscle score. In treatment, small # 2's had the lowest actual and adjusted purchase price mean followed by small # 1's, medium # 1's, medium # 2's, large # 2's, and large # 1's.

Breakeven purchase prices were calculated for each of the cattle groups. The breakeven price was based upon a 450-pound purchase weight. Small-framed cattle breakeven prices were significantly less than large-framed cattle breakeven prices (Tables 18-19). This does not seem to correspond to the previous results concerning stocker profit. Small-framed cattle were more profitable in the stocker phase, but not significantly more profitable. The discrepancy between these results can be explained by the fact that the breakeven price is based on a 450-pound weight when purchased and the stocker profit is based on the actual weight when the animal was purchased. # 1 muscled cattle were also worth significantly more than # 2 muscled cattle during the stocker phase of production. Small # 2's had significantly lower purchase break-even prices than medium # 1's, large # 1's, and large # 2's. A cattle producer could pay up to $12.89 per cwt. more for large # 2's at 450 pounds in weight than for small # 2's at 450 pounds in weight.

Breakeven purchase prices for the feedlot phase of production were not significantly different for any of the frame, muscling, or treatment groups when cattle were sold on a liveweight basis or on the Gelbvieh muscle grid. Breakeven prices for cattle sold on a grid were about $5-6 lower than those of cattle sold by liveweight. Again, this discrepancy between the liveweight breakeven prices and the grid breakeven prices is probably due to the overall low quality of the cattle purchased in this experiment.

Small-framed cattle breakeven prices for all enterprises were significantly lower than those for large-framed cattle. Again, this result does not seem to correspond to the average profit results, but may be due to the adjustment to 450 pounds made in calculating the breakeven prices. According to these results, large-framed cattle at 450 pounds should receive roughly a $5-6 premium and small-framed cattle at 450 pounds should receive roughly a $3-5 discount compared to medium-framed cattle at 450 pounds. # 1 and # 2 muscled cattle did not have significantly different breakeven prices. Small # 1's had significantly lower breakeven prices than large # 2's for all enterprises when cattle were sold by liveweight. There were no significant differences in breakeven prices for all enterprises between the treatment groups when sold on the muscle grid.

Profits and breakeven purchase prices were different for each of the phases of production. This result is not out of the ordinary, though. Due to the seasonality and cycle of the cattle market, different segments of the industry will be more or less profitable than others. According to the breakeven purchase prices for all enterprises, small-framed cattle should receive a $ 5-6 discount to medium-framed cattle and large-framed cattle should receive a $ 3-5 premium to medium-framed cattle. In this experiment, though, small-framed cattle were bought at a $ 6-7 discount to medium-framed cattle and large-framed cattle were bought at a $ 2-3 premium to medium framed cattle. Small-framed cattle were profitable because they were purchased for much less than they should have been if the market is efficient. This is evidence that the stocker cattle market is inefficient in valuing frame size. Purchase prices for muscling differences were not significantly different and show evidence of being valued properly.

Regression Analysis

Several production and profit models were analyzed via ordinary least squares regression. The performance models included regressions for ADG during backgrounding, ADG during small-grain pasture, ADG during feeding, feed efficiency in feedlot, quality grade, yield grade, and harvest weight. The profit models included regressions for adjusted actual profit from the stocker enterprise, actual profit from the feedlot enterprise when cattle were sold on a liveweight basis, actual profit from the feedlot enterprise when cattle were sold on the Gelbvieh muscle grid, adjusted actual profit from all enterprises when cattle were sold on a liveweight basis, and adjusted actual profit from all enterprises when cattle were sold on the Gelbvieh muscle grid. Some of the variables used in these models have collinearity problems, but were retained because they didn't cause any problems with bias or efficiency. The existence of heteroskedasticity was tested with the Breusch-pagan test and corrected using estimated generalized least squares (EGLS).

Performance Models

The backgrounding (or preconditioning) ADG model was tested using White's test and the Breusch-Pagan test for heteroskedasticity and the null hypothesis of homoskedasticity was rejected. Heteroskedasticity in ordinary least squares regression can cause the results to be inefficient. Therefore, estimated generalized least squares (EGLS) was used for this model using Harvey's procedure. It was very difficult to explain the variation in ADG during the backgrounding or preconditioning phase of production (Table 20). The adjusted R^2 for this model was 0.142. Small-framed cattle had lower ADG during backgrounding. Cattle purchased in Atoka and thin-fleshed cattle had significantly lower ADG's during backgrounding. The previously mentioned variables may be more significant due to health differences in the cattle and not necessarily because of frame size, sale location, or flesh score of the cattle. Medicine costs were also inversely related to ADG's during the backgrounding phase of production as expected. This result demonstrates the importance of maintaining animal health through proper management (i.e. preconditioning or backgrounding). Cattle bought as bulls had lower ADG's during backgrounding most likely because bulls were castrated and needed to become healthy before growing again.

The model for pasture ADG did not explain much of the variation contained in this data (Table 20). Frame size and muscle score had no significant relationship with the ADG of cattle on small-grain pasture. The only important variables that were statistically important in explaining pasture ADG were hide color and presence of horns. Black cattle and horned cattle tend to have higher ADG's than other cattle. While these variables were significant in this model, their true relationship with pasture ADG is unclear. Basically, ADG during the small-grain pasture phase of production was unpredictable.

Predicting feedlot ADG proved even more difficult than predicting pasture ADG (Table 20). Cattle bought from Hugo had significantly lower ADG's while cattle bought with light-medium flesh had significantly higher feedlot ADG's. There really is no explanation for the significance of these variables. Medicine costs is the only other significant variable in the feedlot ADG model and its sign is contrary to what was expected. One would think that as medicine cost increased, feedlot ADG would decrease, but this was not found. Overall, this model does not explain much and is not very helpful.

The feed efficiency model was much better than the feedlot ADG model (Table 21). After correcting for heteroskedasticiy using estimated generalized least squares, the adjusted R^2 for the feed efficiency model was 0.64. Small-framed cattle had significantly lower feed efficiency than medium-framed cattle, while large-framed cattle had significantly higher feed efficiency than medium-framed cattle. # 1 muscled cattle also had significantly lower feed efficiency than # 2 muscled cattle. Cattle that performed well during preconditioning and pasture continued to perform well in the feedlot. Backgrounding ADG, pasture ADG, and feedlot ADG all had negative coefficients. Medicine costs, like it did in the feedlot ADG model, had a negative relationship with feed efficiency. Again, this is not what one would expect.

From the results in table 22, it is clear that the model did not explain well the variation in quality grade. These results are largely as expected. Even experts have difficulty identifying animals that grade well just by visual inspection, and production records. The only significant variables are light-medium flesh, black-hide, and overall maturity of the animal. Black-hided cattle usually have more Angus and other English genetics. Angus and English genetics in general are known for their higher marbling characteristics so these results are not surprising. It is also generally known that beef from younger cattle is more tender than beef from older cattle, which would lead one to believe that overall maturity would be significant as well. Days fed is probably the most significant management variable in explaining beef quality. While the coefficient for days fed is negative, the relationship with quality grade is still positive since prime=1, choice=2, select=3, standard=4, and utility=5. As days fed increases, the quality grade of cattle, in general, improves. Again, this was expected.

Variation in yield grade was explained better by the model than quality grade (Table 22). Horned cattle tended to have inferior yield grades relative to polled cattle. This may be due to horn damage done to cattle, but was not expected and may be just a quirk in this data set. Adjusted fat thickness plays an important role in yield grade because yield grade is calculated based on fat thickness of the carcass. Dressing percentage, as expected, also explained much of the variation in expert yield grade. The most interesting result from this model, for this study, is that # 1 muscled cattle had significantly better yield grades than # 2 muscled cattle. This result is consistent with the LS means findings. Anderson found that muscle level did not help predict yield grade, but this result verifies the USDA's use of muscle scores in estimating future yield grades of cattle.

Much of the variation in harvest weight was explained by the model in table 23. Frame size and muscle score significantly impacted the harvest weight of cattle. This result also verifies the use of frame size and muscle score in estimating the future harvest weight of cattle. Thin-fleshed animals had lower harvest weights. While this may be true, the flesh of cattle may sometimes be confused with the muscle level of cattle. Days fed and feedlot ADG were also statistically significant in explaining harvest weight.

Profit Models

Regression models were also used to analyze profits from each of the different phases of cattle production and combined phases. The dependent variable was the adjusted actual stocker profit, which is adjusted to remove bias that may have entered the experiment because the cattle buyer was buying certain types of cattle. The adjusted actual stocker profit model was tested and corrected for heteroskedasticity using estimated generalized least squares (EGLS). Small and large frame size were significantly related to the adjusted actual profit for the stocker enterprise (Table 24). Muscle score, though, was not significant. Small-framed cattle were $21.13 more profitable than medium-framed cattle and large-framed cattle were $12.93 less profitable than medium-framed cattle. Cattle without horns were $11.70 more profitable than cattle purchased with horns. The adjusted purchase price was very important in explaining variability in stocker profit. Cattle bought at a lower price tended to be more profitable. This result illustrates the importance of buying wisely. Pasture ADG is negative because small-grain pasture costs were calculated on a per pound of gain basis. Every pound of gain added $0.30 of cost to the animal. Ending (feeder) weight, medicine cost, and feeder sale price were also significantly related to stocker profit. So procurement, performance, and marketing all are important parts of stocker enterprise profitability.

The results from this model also lead one to believe that some stocker cattle prices are inefficient. Frame size, sale location, and presence of horns were all statistically important in explaining stocker profitability. If prices were efficient, the profit from producing cattle with different traits would be the same, but this was not the case.

Frame size and muscle score were significant in explaining variations in average feedlot profit when the cattle were sold on a liveweight basis (Table 25). This is different from the LS means results. According to the regression results, small-framed cattle were $25.52 more profitable and large-framed cattle were $1.54 less profitable than medium-framed cattle. # 1 muscled cattle were $20.62 less profitable than # 2 muscled cattle. Cattle purchased as bulls had significantly lower profits than cattle purchased as steers. Feeder purchase price, beginning (feeder) weight, feed efficiency, feedlot ADG, harvest weight, liveweight price, yield grade, dressing percentage, overall maturity, and adjusted fat thickness were all statistically significant in explaining liveweight feeder enterprise profit. Feeder purchase price was positive, which is not expected, but feeder weight's sign was as expected. Feed efficiency and feedlot ADG were very important in this model and had expected signs. In general, the lower the beginning weight, the greater the profit. Profit also tended to increase as harvest weight increased. Cattle are raised for beef and unless the carcass is excessively large (>950-1000 lbs.) the more pounds per carcass, the better. Live price, dressing percentage, and adjusted were significant and had the expected signs, but yield grade, and overall maturity had unexpected signs. The adjusted R^2 for this model was very high at 0.993.

Unlike the LS means results, frame size and muscle score were significant in explaining average profit from the feeder enterprise when the cattle were sold on the Gelbvieh muscle grid (Table 25). Small-framed cattle were $36.03 more profitable and large-framed cattle were $19.49 less profitable than medium-framed cattle. # 1 muscled cattle were $48.31 less profitable than # 2 muscled cattle. The coefficients for frame size and muscle score were considerably greater in the muscle grid model than in liveweight model. Cattle with black-hides and cattle purchased as bulls were significantly different from the non-black hided cattle and cattle purchased as steers. Feeder purchase price, beginning (feeder) weight, feed efficiency, harvest weight, grid base price, quality grade, yield grade, and dressing percentage were all statistically significant in explaining grid feeder enterprise profit, just as they were for liveweight profit. Quality grade, yield grade, and dressing percentage, helped explain much of the feeder enterprise profits as well. As quality and yield grade improved, profit also improved. Quality and yield grade coefficients are negative, but this is expected because of the way quality and yield grade were recorded (prime=1, choice=2, select=3, standard=4, utility=5) (YG 1=1, YG 2=2, YG 3=3, YG 4=4, YG 5=5). Likewise, as dressing percentage increased, profit also increased. Younger cattle were more profitable than older cattle. The grid price feeder enterprise model had more variables with expected signs and shows that grid pricing is usually more accurate than liveweight pricing. That is, grid pricing better reflects the value of the beef produced.

The adjusted R^2 for the adjusted average profit model for all enterprises when cattle are sold on a liveweight basis was 0.94 (Table 26). There was a difference of $37.85

between small-frame cattle profit and medium-frame cattle profit. There was also a $17.13 difference between large-frame cattle profit and medium-frame cattle profit. These differences are much greater than the differences found using LS means. # 1 muscled cattle were $3.88 more lucrative than # 2 muscled cattle. LS means differences for muscle score were much greater and averaged almost $16. Cattle purchased in Paris and light medium-fleshed cattle were significantly different than cattle purchased in McAlester and medium-fleshed cattle. Cattle with horns at purchase were significantly less profitable than cattle without horns and cattle purchased as bull were significantly less profitable than cattle purchased as steers. The adjusted purchase price also significantly explained variation in profit for all enterprises in this experiment. Other things being equal, the lower the input price, the higher the profit potential. Beginning (stocker) weight, pasture ADG, feed efficiency, and harvest weight were all significant in explaining profit variation. This result verifies the use of these production performance variables in predicting cattle profitability. Dressing percentage was significant at the 5 % level, but quality grade and yield grade were not significant and had unexpected signs on the coefficients. Profit was expected to increase as quality and yield grades declined numerically. These variables, of course, are not known when cattle are sold via liveweight. Adjusted fat thickness is not important in determining profitability. This is probably due to the design of the experiment in which the cattle were all fed to a constant backfat thickness. Medicine cost was also statistically significant in this model. Cattle that get sick are not as profitable as those that stay healthy. This result illustrates the importance of having a good vaccination program. Liveweight price was significant and had the expected sign.

The only considerable difference between the adjusted average profit for all enterprises using the Gelbvieh muscle grid and using liveweight was the importance of carcass characteristics that cannot be ascertained prior to slaughter (Table 26). Some of these characteristics included quality grade, yield grade, and dressing percentage. The coefficients for each of these variables have the expected signs on the coefficients. That is, quality and yield grade coefficients are negative and dressing percentage coefficients are positive. Dressing percentage probably has the most different coefficient between these two models. It changed from 304.26 to 1510.535. This shows the greater importance of dressing percentage in grid pricing. Adjusted fat thickness was not significant. Again, this is probably due to the design of this experiment. Frame size and muscle score are still both significant and the coefficients do not vary much from the average liveweight model. Adjusted purchase price is significant as well as the production variables such as beginning (stocker) weight, pasture ADG, feedlot ADG, feed efficiency, and harvest weight. Medicine cost was not significant in this model, though.

Growth Curves

Weight, hip height, and fat thickness for each frame score was regressed on days and days squared to find the rate of growth in cattle of different frame sizes. Large and medium-framed cattle grew in weight at similar rates, while small-framed cattle grew at a slower rate. Hip height was largely already different at the beginning of the feedlot enterprise and continued that way. Small and medium-framed cattle began with more fat, The only considerable difference between the adjusted average profit for all enterprises using the Gelbvieh muscle grid and using liveweight was the importance of carcass characteristics that cannot be ascertained prior to slaughter (Table 26). Some of these characteristics included quality grade, yield grade, and dressing percentage. The coefficients for each of these variables have the expected signs on the coefficients. That is, quality and yield grade coefficients are negative and dressing percentage coefficients are positive. Dressing percentage probably has the most different coefficient between these two models. It changed from 304.26 to 1510.535. This shows the greater importance of dressing percentage in grid pricing. Adjusted fat thickness was not significant. Again, this is probably due to the design of this experiment. Frame size and muscle score are still both significant and the coefficients do not vary much from the average liveweight model. Adjusted purchase price is significant as well as the production variables such as beginning (stocker) weight, pasture ADG, feedlot ADG, feed efficiency, and harvest weight. Medicine cost was not significant in this model, though.

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Table 8. LS Means for Production Characteristics by Frame Size and Muscle Score (Adjfat=0.4).

		Frame Size			Muscle Score	
Trait	Units	Small	Medium	Large	No. 1	No. 2
Purchase Weight of Cattle	Pounds	462.333^{ab}	456.894^{a}	469.894^{b}	465	461.081
Standard Error		4.321	3.033	3.631	2.841	3.052
Backgrounding ADG	Pounds/Day	0.164	0.331	0.418	0.125	0.483
Standard Error		0.209	0.146	0.175	0.137	0.147
Pasture ADG	Pounds/Day	2.461	2.628	2.67	2.572	2.601
Standard Error		0.097	0.068	0.083	0.064	0.069
Feedlot ADG	Pounds/Day	3.49	3.546	3.491	3.496	3.523
Standard Error		0.118	0.083	0.099	0.077	0.083
Feed Efficiency In Feedlot	Feed/Gain in Pounds	6.742^{a}	7.191^{b}	7.852^{c}	7.135^{a}	7.389^{b}
Standard Error		0.092	0.065	0.077	0.061	0.065
Days Fed in Feedlot	Days	106.064^{a}	129.611^{b}	148.791^{c}	125.69	130.62
Standard Error		3.71	2.604	3.118	2.439	2.62
Harvest Weight	Pounds	1095.733^{a}	1225.93^{b}	1312.24^{c}	1191.898^{a}	1230.704^{b}
Standard Error		17.704	12.427	14.878	11.638	12.502

a,b,c,d Means in the same row for the same item with a different superscript letter differ (P>.05).

Table 9. LS Means for Production Characteristics by Treatment (Adjfat=0.4).

		Treatment (Frame Size X Muscle Score)					
Trait	Units	Small No.1	Small No.2	Med. No.1	Med. No.2	Large No.1	Large No.2
Purchase Weight of Cattle	Pounds	465.758	458.808	459.54	454.334	470.154	470.59
Standard Error		6.004	6.247	4.327	4.104	4.647	5.802
Backgrounding ADG	Pounds/Day	0.105	0.215	0.139	0.52	0.183	0.686
Standard Error		0.290	0.302	0.209	0.198	0.224	0.280
Pasture ADG	Pounds/Day	2.434	2.491	2.709	2.56	2.546	2.849
Standard Error		0.133	0.138	0.096	0.091	0.105	0.128
Feedlot ADG	Pounds/Day	3.252	3.746	3.723	3.396	3.387	3.646
Standard Error		0.157	0.163	0.113	0.107	0.121	0.152
Feed Efficiency In Feedlot	Feed/Gain in Pounds	6.651^{a}	6.828^{a}	6.881^{a}	7.477^{b}	7.922^{c}	7.673^{bc}
Standard Error		0.119	0.124	0.086	0.081	0.092	0.115
Days Fed in Feedlot	Days	105.384^{a}	106.545^{a}	121.216^{a}	137.2^{b}	152.307^{b}	141.93^{b}
Standard Error		4.939	5.139	3.560	3.376	3.823	4.773
Harvest Weight	Pounds	1064.345^{a}	1128.108^{ab}	1215.472^{bc}	1237.64^{c}	1289.412^{cd}	1336.958^{d}
Standard Error		24.543	25.539	17.689	16.776	18.998	23.717

a,b,c,d Means in the same row for the same item with a different superscript letter differ (P>.05).

Table 10. LS Means for Carcass Characteristics by Frame Size and Muscle Score (Adjfat=0.4).

		Frame Size			Muscle Score	
Trait	Units	Small	Medium	Large	No. 1	No. 2
Dressing Percentage	%	0.6[a]	0.611[b]	0.61[ab]	0.608	0.606
Standard Error		0.003	0.002	0.003	0.002	0.002
Adjusted Fat Thickness	Inches	0.443[ab]	0.471[a]	0.392[b]	0.427	0.444
Standard Error		0.029	0.019	0.024	0.019	0.020
Hot Carcass Weight	Pounds	657.765[a]	748.777[b]	799.793[c]	725.195[a]	745.695[b]
Standard Error		11.033	7.745	9.271	7.253	7.791
Rib-Eye Area	Inches^2	12.129[a]	13.405[b]	13.944[b]	13.28	13.039
Standard Error		0.283	0.199	0.238	0.186	0.200
Overall Maturity	Scale	58.337	63.686	59.164	60.84	59.951
Standard Error		3.231	2.289	2.716	2.137	2.282
Yield Grade	Scale	2.501	2.453	2.462	2.39[a]	2.554[b]
Standard Error		0.078	0.054	0.065	0.051	0.055
Average Marbling	Scale	385.346	385.291	368.031	378.141	380.971
Standard Error		9.754	6.847	8.197	6.412	6.888
Percent KPH	%	1.911	1.987	1.923	1.918	1.962
Standard Error		0.071	0.050	0.059	0.046	0.048
Quality Grade	Scale	2.69	2.702	2.792	2.749	2.708
Standard Error		0.104	0.073	0.087	0.068	0.073

a,b,c,d Means in the same row for the same item with a different superscript letter differ (P>.05).
Scales listed in Table 2.

Table 11. LS Means for Carcass Characteristics by Treatment (Adjfat=0.4).

		Treatment (Frame Size X Muscle Score)					
Trait	Units	Small No.1	Small No.2	Med. No.1	Med. No.2	Large No.1	Large No.2
Dressing Percentage	%	0.605[ab]	0.596[a]	0.608[ab]	0.613[b]	0.614[b]	0.605[ab]
Standard Error		0.004	0.004	0.003	0.003	0.003	0.004
Adjusted Fat Thickness	Inches	0.429	0.457	0.467	0.476	0.382	0.404
Standard Error		0.040	0.042	0.028	0.027	0.031	0.039
Hot Carcass Weight	Pounds	643.742[a]	672.077[a]	739.38[b]	758.303[bc]	790.8[c]	808.073[c]
Standard Error		15.349	15.972	11.063	10.491	11.881	14.832
Rib-Eye Area	Inches^2	12.169[a]	12.094[a]	13.475[ab]	13.329[ab]	14.174[b]	13.653[ab]
Standard Error		0.393	0.409	0.283	0.269	0.304	0.380
Overall Maturity	Scale	58.752	57.917	63.526	63.746	60.321	57.609
Standard Error		4.496	4.678	3.298	3.073	3.480	4.345
Yield Grade	Scale	2.435	2.566	2.394	2.515	2.343	2.601
Standard Error		0.108	0.112	0.078	0.074	0.083	0.104
Average Marbling	Scale	372.119	399.429	382.361	388.06	375.531	355.514
Standard Error		13.392	13.936	9.652	9.154	10.367	12.941
Percent KPH	%	1.912	1.909	1.982	1.993	1.866	1.999
Standard Error		0.098	0.102	0.071	0.067	0.076	0.095
Quality Grade	Scale	2.758	2.62	2.79	2.624	2.704	2.941
Standard Error		0.142	0.148	0.102	0.097	0.110	0.137

a,b,c,d Means in the same row for the same item with a different superscript letter differ (P>.05).
Scales listed in Table 2.

Table 12. LS Means for Profit by Frame Size and Muscle Score (Adjfat=0.4).

		Frame Size			Muscle Score	
Trait	Units	Small	Medium	Large	No. 1	No. 2
Actual Profit from Stocker Enterprise	$/hd.	52.151	42.734	36.333	48.65	38.828
Standard Error		9.566	6.715	8.128	6.329	6.756
Adj. Actual Profit from Stocker Enterprise	$/hd.	58.193	50.898	40.299	54.532	45.061
Standard Error		8.434	6.041	7.27	5.606	6.078
Actual Profit from Feedlot Enterprise (muscle grid)	$/hd.	-79.406	-89.248	-116.426	-102.638	-87.415
Standard Error		13.822	9.702	11.743	9.144	9.762
Avg. Profit from Feedlot Enterprise (muscle grid)	$/hd.	-95.75	-83.893	-87.576	-98.326	-79.819
Standard Error		13.992	9.822	11.888	9.257	9.882
Actual Profit from Feedlot Enterprise (live)	$/hd.	-36.967[a]	-57.656[ab]	-79.965[b]	-66.467	-49.926
Standard Error		12.411	8.712	10.545	8.211	8.765
Avg. Profit from Feedlot Enterprise (live)	$/hd.	-55.438	-50.269	-45.682	-59.546	-41.381
Standard Error		12.479	8.76	10.602	8.256	8.813

a,b,c,d Means in the same row for the same item with a different superscript letter differ (P>.05).

Table 13. LS Means for Profit by Treatment (Adjfat=0.4).

		Treatment (Frame Size X Muscle Score)					
Trait	Units	Small No.1	Small No.2	Med. No.1	Med. No.2	Large No.1	Large No.2
Actual Profit from Stocker Enterprise	$/hd.	55.783	48.68	53.576	32.696	34.694	41.228
Standard Error		13.227	13.764	9.533	9.041	10.449	12.782
Adj. Actual Profit from Stocker Enterprise	$/hd.	66.403	49.736	57.364	44.596	40.773	42.383
Standard Error		11.704	12.18	8.556	8.241	9.246	11.68
Actual Profit from Feedlot Enterprise (muscle grid)	$/hd.	-92.409	-65.979	-94.608	-83.564	-123.446	-109.711
Standard Error		19.226	20.007	13.858	13.142	15.189	18.579
Avg. Profit from Feedlot Enterprise (muscle grid)	$/hd.	-109.451	-81.765	-97.185	-71.13	-89.035	-90.004
Standard Error		19.41	20.198	13.99	13.268	15.334	18.757
Actual Profit from Feedlot Enterprise (live)	$/hd.	-54.452^{ab}	-18.632^{a}	-50.855^{ab}	-62.39^{ab}	-101.136^{b}	-52.396^{ab}
Standard Error		16.887	17.573	12.172	11.543	13.341	16.319
Avg. Profit from Feedlot Enterprise (live)	$/hd.	-72.988	-37.175	-51.543	-47.911	-59.132	-30.077
Standard Error		17.27	17.971	12.447	11.805	13.643	16.689

a,b,c,d Means in the same row for the same item with a different superscript letter differ (P>.05).

Table 14. LS Means for Profit by Frame Size and Muscle Score (Adjfat=0.4).

		Frame Size			Muscle Score	
Trait	Units	Small	Medium	Large	No. 1	No. 2
Actual Profit from All Enterprises (live)	$/hd.	15.184^{a}	-14.922^{ab}	-43.633^{b}	-17.817	-11.097
Standard Error		14.161	9.94	12.031	9.369	10.001
Adj. Actual Profit from All Enterprises (live)	$/hd.	28.631^{a}	10.672^{ab}	-15.151^{b}	2.96	13.141
Standard Error		12.705	9.101	10.952	8.444	9.156
Avg. Profit from All Enterprises (live)	$/hd.	-3.287	-7.536	-9.35	-10.896	-2.552
Standard Error		12.773	8.966	10.852	8.45	9.021
Adj. Avg. Profit from All Enterprises (live)	$/hd.	-30.38	-15.906	-21.377	-28.946	-16.163
Standard Error		13.423	9.615	11.571	8.922	9.674
Actual Profit from All Enterprises (muscle grid)	$/hd.	-27.255^{a}	-46.514^{ab}	-80.093^{b}	-53.988	-48.587
Standard Error		15.132	10.622	12.856	10.011	10.687
Adj. Actual Profit from All Enterprises (muscle grid)	$/hd.	-13.975	-20.594	-50.717	-33.168	-23.689
Standard Error		14.117	10.113	12.17	9.383	10.174

a,b,c,d Means in the same row for the same item with a different superscript letter differ (P>.05).

Table 15. LS Means for Profit by Treatment (Adjfat=0.4).

		Treatment (Frame Size X Muscle Score)					
Trait	Units	Small No.1	Small No.2	Med. No.1	Med. No.2	Large No.1	Large No.2
Actual Profit from All Enterprises (live)	$/hd.	1.331^{ab}	30.048^{a}	2.722^{a}	-29.694^{ab}	-66.442^{b}	-11.168^{ab}
Standard Error		19.022	19.795	13.711	13.003	15.028	18.382
Adj. Actual Profit from All Enterprises (live)	$/hd.	18.794^{ab}	38.911^{a}	19.497^{ab}	3.309^{ab}	-34.00^{b}	11.924^{ab}
Standard Error		17.328	18.033	12.668	12.202	13.689	17.293
Avg. Profit from All Enterprises (live)	$/hd.	-17.205	11.505	2.033	-15.215	-24.439	11.15
Standard Error		17.473	18.183	12.594	11.944	13.804	16.885
Adj. Avg. Profit from All Enterprises (live)	$/hd.	-36.339	-24.487	-27.473	-4.878	-21.815	-24.502
Standard Error		18.635	19.394	13.624	13.122	14.722	18.597
Actual Profit from All Enterprises (muscle grid)	$/hd.	-36.626	-17.299	-41.032	-50.868	-88.752	-68.483
Standard Error		20.976	21.827	15.118	14.338	16.571	20.27
Adj. Actual Profit from All Enterprises (muscle grid)	$/hd.	-19.265	-8.638	-24.389	-16.699	-56.246	-44.715
Standard Error		19.655	20.455	14.369	13.841	15.527	19.615

a,b,c,d Means in the same row for the same item with a different superscript letter differ (P>.05).

Table 16. LS Means for Profit by Frame Size and Muscle Score (Adjfat=0.4).

		Frame Size			Muscle Score	
Trait	Units	Small	Medium	Large	No. 1	No. 2
Avg. Profit from All Enterprises (muscle grid)	$/hd.	-43.599	-41.16	-51.243	-49.677	-40.991
Standard Error		14.238	9.994	12.097	9.419	10.055
Adj. Avg. Profit from All Enterprises (muscle grid)	$/hd.	-30.38	-15.906	-21.377	-28.946	-16.163
Standard Error		13.423	9.615	11.571	8.922	9.674
Adj. Avg. Profit from All Enterprises (Nat. Avg. Grid)	$/hd.	-52.001	-35.696	-53.495	-51.089	-43.039
Standard Error		9.84	7.049	8.483	6.54	7.092
Adj. Avg. Profit from All Enterprises (Sim. Quality Grid)	$/hd.	-46.104	-29.945	-42.446	-44.849	-34.148
Standard Error		11.628	8.33	10.024	7.729	8.38
Adj. Avg. Profit from All Enterprises (Sim. Yield Grid)	$/hd.	-32.697	-15.379	-27.262	-29.7	-20.525
Standard Error		10.536	7.548	9.083	7.003	7.593

a,b,c,d Means in the same row for the same item with a different superscript letter differ (P>.05).

Table 18. LS Means for Break-even Purchase Prices by Frame Size and Muscle Score (Adjfat=0.4).

		Frame Size			Muscle Score	
Trait	Units	Small	Medium	Large	No. 1	No. 2
Actual Purchase Price	$/cwt.	94.206^{a}	101.28^{b}	103.958^{b}	100.048	99.581
Standard Error		1.295	0.909	1.088	0.851	0.915
Adjusted Purchase Price	$/cwt.	94.045^{a}	100.723^{b}	104.029^{c}	99.884	99.314
Standard Error		0.734	0.526	0.626	0.485	0.529
Avg. BEP from Stocker Enterprise at 450 pounds	$/cwt.	109.353^{a}	113.29^{ab}	117.509^{b}	115.065	111.703
Standard Error		1.876	1.317	1.594	1.241	1.325
Avg. BEP from Feedlot Enterprise at May 1 Weight (live)	$/cwt.	81.406	83.665	83.708	82.961	82.892
Standard Error		1.774	1.245	1.507	1.173	1.253
Avg. BEP from Feedlot Enterprise May 1 Weight (muscle grid)	$/cwt.	75.485	78.703	77.929	77.273	77.471
Standard Error		2	1.404	1.699	1.323	1.413
Avg. BEP from All Enterprises at 450 pounds (live)	$/cwt.	97.033^{a}	102.119^{ab}	107.357^{b}	101.832	102.507
Standard Error		2.497	1.753	2.122	1.652	1.764
Avg. BEP from All Enterprises at 450 pounds (muscle grid)	$/cwt.	88.075^{a}	94.647^{ab}	98.048^{b}	93.215	93.966
Standard Error		2.855	2.004	2.425	1.889	2.016

a,b,c,d Means in the same row for the same item with a different superscript letter differ (P>.05).

Table 19. LS Means for Break-even Purchase Prices by Treatment (Adjfat=0.4).

		Treatment (Frame Size X Muscle Score)					
Trait	Units	Small No.1	Small No.2	Med. No.1	Med. No.2	Large No.1	Large No.2
Actual Purchase Price	$/cwt.	96.418^{ab}	91.834^{a}	100.266^{bc}	102.118^{bc}	104.484^{c}	103.272^{bc}
Standard Error		1.772	1.843	1.277	1.211	1.371	1.712
Adjusted Purchase Price	$/cwt.	95.294^{a}	92.721^{a}	100.622^{b}	100.779^{b}	104.179^{c}	103.97^{bc}
Standard Error		1.012	1.053	0.74	0.712	0.783	1.01
Avg. Stocker Enterprise BEP at 450 pounds	$/cwt.	113.2^{ab}	105.348^{a}	115.173^{b}	111.427^{ab}	117.581^{b}	118.242^{b}
Standard Error		2.581	2.685	1.86	1.764	2.039	2.494
Avg. Feedlot Ent. BEP at May 1 Weight (live)	$/cwt.	81.088	81.761	84.557	82.891	82.903	84.931
Standard Error		2.46	2.57	1.773	1.681	1.943	2.377
Avg. Feedlot Ent. BEP at May 1 Weight (muscle grid)	$/cwt.	75.742	75.192	77.779	79.514	78.629	76.833
Standard Error		2.777	2.89	2.002	1.898	2.194	2.684
Avg. All Ent. BEP at 450 pounds (live)	$/cwt.	96.98^{a}	97.087^{ab}	103.719^{ab}	100.78^{ab}	104.44^{ab}	111.558^{b}
Standard Error		3.43	3.569	2.472	2.344	2.71	3.315
Avg. All Ent. BEP at 450 pounds (muscle grid)	$/cwt.	88.878	87.178	93.576	95.62	97.795	98.241
Standard Error		3.97	4.131	2.861	2.713	3.136	3.836

a,b,c,d Means in the same row for the same item with a different superscript letter differ (P>.05).

Table 20. Regression Results.

	Back. ADG	Pasture ADG	Feedlot ADG
Explanatory Variable	Parameter Estimate	Parameter Estimate	Parameter Estimate
Intercept	0.892**	2.441**	3.333**
	(0.275)	(0.147)	(0.348)
Small Frame	-0.467*	-0.125	-0.046
	(0.254)	(0.114)	(0.147)
Medium Frame	Base	Base	Base
Large Frame	-0.012	0.13	-0.074
	(0.211)	(0.114)	(0.147)
# 1 Muscle Score	-0.25	0.011	-0.068
	(0.182)	(0.095)	(0.123)
# 2 Muscle Score	Base	Base	Base
Atoka Sale	-0.509*	-0.521**	-0.085
	(0.288)	(0.135)	(0.184)
Hugo Sale	0.121	-0.09	-0.373**
	(0.209)	(0.105)	(0.136)
Paris Sale	0.551	-0.253	0.047
	(1.241)	(0.26)	(0.336)
McAlester	Base	Base	Base
Thin Flesh	-0.546*	-0.142	-0.189
	(0.278)	(0.141)	(0.182)
Lt-medium Flesh	0.168	0.208*	0.333**
	(0.229)	(0.11)	(0.144)
Medium Flesh	Base	Base	Base
Black Hide	0.069	0.233**	-0.103
	(0.217)	(0.113)	(0.148)
Non-Black Hide	Base	Base	Base
Horns	0.248	0.252**	-0.106
	(0.188)	(0.103)	(0.136)
No Horns	Base	Base	Base
Bull	-0.604**	-0.092	0.011
	(0.175)	(0.094)	(0.122)
Steer	Base	Base	Base
Medicine Cost ($/hd.)	-0.058	-0.004	0.027**
	(0.03)	(0.01)	(0.013)
Backgrounding ADG (Pounds/Day)	N/A	-0.072	-0.03
	N/A	(0.046)	(0.06)
Pasture ADG (Pounds/Day)	N/A	N/A	0.169
	N/A	N/A	(0.12)
Feedlot Medicine Cost ($/hd.)	N/A	N/A	0.013
	N/A	N/A	(0.051)
Adjusted R^2	0.142	0.124	0.086

* significant at the 10% level. ** significant at the 5% level.

Table 21. Regression Results.

	Feed Efficiency
Explanatory Variable	Parameter Estimate
Intercept	8.612
	(0.289)
Small Frame	-0.434**
	(0.086)
Medium Frame	Base
Large Frame	0.916**
	(0.092)
# 1 Muscle Score	-0.436**
	(0.076)
# 2 Muscle Score	Base
Atoka Sale	-0.007
	(0.109)
Hugo Sale	-0.117
	(0.091)
Paris Sale	-0.018
	(0.215)
McAlester Sale	Base
Thin Flesh	-0.311**
	(0.118)
Lt-medium Flesh	-0.075
	(0.093)
Medium Flesh	Base
Black Hide	0.149
	(0.094)
Non-Black Hide	Base
Horns	-0.11
	(0.085)
No Horns	Base
Bull	0.128*
	(0.073)
Steer	Base
Backgrounding ADG (Pounds/Day)	-0.027
	(0.037)
Pasture ADG (Pounds/Day)	-0.186**
	(0.076)
Feedlot ADG (Pounds/Day)	-0.227**
	(0.057)
Medicine Cost ($/hd.)	-0.019**
	(0.009)
Adjusted R^2	0.64

* significant at the 10% level. ** significant at the 5% level.

Table 22. Regression Results.

	Quality Grade	Yield Grade
Explanatory Variable	Parameter Estimate	Parameter Estimate
Intercept	-0.344	7.136**
	(2.358)	(1.674)
Small Frame	0.086	-0.067
	(0.171)	(0.131)
Medium Frame	Base	Base
Large Frame	0.042	0.102
	(0.182)	(0.139)
# 1 Muscle Score	0.028	-0.192**
	(0.12)	(0.091)
# 2 Muscle Score	Base	Base
Atoka Sale	0.178	-0.046
	(0.149)	(0.115)
Hugo Sale	0.073	-0.02
	(0.125)	(0.096)
Paris Sale	-0.132	0.074
	(0.285)	(0.219)
McAlester Sale	Base	Base
Thin Flesh	-0.17	-0.06
	(0.162)	(0.127)
Lt-medium Flesh	-0.253**	-0.007
	(0.126)	(0.098)
Medium Flesh	Base	Base
Black Hide	-0.22*	0.008
	(0.126)	(0.098)
Non-Black Hide	Base	Base
Horns	0.141	-0.223
	(0.12)	(0.09)
No Horns	Base	Base
Bull	-0.066	-0.025
	(0.106)	(0.082)
Steer	Base	Base
Days on Feed (Days)	-0.005**	-0.0004
	(0.003)	(0.003)
Feedlot ADG (Pounds/Day)	0.029	-0.028
	(0.165)	(0.126)
Feed Efficiency (Feed/Gain)	0.16	-0.06
	(0.13)	(0.1)
Harvest Weight (Pounds)	0.001	0.000004
	(0.001)	(0.001)
Adjusted Fat Thickness (Inches)	-0.236	3.11**
	(0.53)	(0.275)
Overall Maturity	0.01**	0.0004
	(0.003)	(0.002)

Yield Grade/ Quality Grade	-0.123	-0.073
	(0.125)	(0.074)
Dressing Percentage (%)	2.455	-8.194**
	(3.224)	(2.353)
Medicine Cost ($/hd.)	0.004	0.002
	(0.011)	(0.008)
Feedlot Med. Cost ($/hd.)	0.012	-0.015
	(0.043)	(0.033)
Adjusted R^2	0.17	0.648

* significant at the 10% level. ** significant at the 5% level.

Table 23. Regression Results.

	Harvest Weight
Explanatory Variable	Parameter Estimate
Intercept	220.287
	(236.067)
Small Frame	-86.675**
	(14.981)
Medium Frame	Base
Large Frame	73.182**
	(16.842)
# 1 Muscle Score	-31.765**
	(11.711)
# 2 Muscle Score	Base
Atoka Sale	-13.428
	(14.983)
Hugo Sale	26.391**
	(12.296)
Paris Sale	12.314
	(28.631)
McAlester Sale	Base
Thin Flesh	-54.185**
	(15.837)
Lt-medium Flesh	-9.553
	(12.835)
Medium Flesh	Base
Black Hide	14.341
	(12.755)
Non-Black Hide	Base
Horns	2.784
	(12.146)
No Horns	Base
Bull	-7.738
	(10.689)
Steer	Base
Days on Feed (Days)	1.09**
	(0.319)
Feedlot ADG (Pounds/Day)	138.879**
	(9.687)
Feed Efficiency (Feed/Gain)	19.271
	(12.978)
Adjusted Fat Thickness (Inches)	64.84
	(52.918)
Overall Maturity	0.267
	(0.308)
Quality Grade	7.65
	(9.69)

Yield Grade	0.072
	(12.653)
Dressing Percentage (%)	294.589
	(323.695)
Medicine Cost ($/hd.)	0.026
	(1.095)
Feedlot Med. Cost ($/hd.)	0.41
	(4.372)
Adjusted R^2	0.825

* significant at the 10% level. ** significant at the 5% level.

Table 24. Regression Results.

Adjusted Actual Profit for Stocker Enterprise ($/hd.)	
Explanatory Variable	Parameter Estimate
Intercept	-777.67**
	(307.521)
Small Frame	21.13**
	(6.899)
Medium Frame	Base
Large Frame	-12.934**
	(4.27)
# 1 Muscle Score	1.20
	(9.628)
# 2 Muscle Score	Base
Atoka Sale	-10.184**
	(4.471)
Hugo Sale	1.779
	(3.537)
Paris Sale	-6.147
	(10.844)
McAlester Sale	Base
Thin Flesh	0.859
	(4.70)
Lt-medium Flesh	5.199
	(3.66)
Medium Flesh	Base
Black Hide	2.91
	(3.674)
Non-Black Hide	Base
Horns	-11.697**
	(3.475)
No Horns	Base
Bull	-4.905
	(3.078)
Steer	Base
Adjusted Purchase Price ($/cwt.)	-1.331**
	(0.481)
Pasture ADG (Pounds/Day)	-6.761*
	(3.928)
May 1 Weight (Pounds)	0.609**
	(0.03)
Medicine Cost ($/hd.)	-1.167**
	(0.351)
Stocker Sale Price ($/cwt)	6.162*
	(3.43)
Adjusted R^2	0.897

* significant at the 10% level. ** significant at the 5% level.

Table 25. Regression Results.

	Average Profit from Feeder Enterprise (Sold on Liveweight Basis)	Average Profit from Feeder Enterprise (Sold on Muscle Grid)
Explanatory Variable	Parameter Estimate	Parameter Estimate
Intercept	-995.191**	-2149.838**
	(119.359)	(167.365)
Small Frame	25.524**	36.029**
	(2.564)	(3.254)
Medium Frame	Base	Base
Large Frame	-1.539	-19.485**
	(2.307)	(5.37)
# 1 Muscle Score	-20.616**	-48.312**
	(3.916)	(6.275)
# 2 Muscle Score	Base	Base
Atoka Sale	1.272	-3.894
	(1.869)	(2.724)
Hugo Sale	0.683	1.795
	(1.452)	(2.553)
Paris Sale	-3.887	8.35*
	(3.301)	(4.561)
McAlester Sale	Base	Base
Thin Flesh	2.891	-0.063
	(1.947)	(3.627)
Lt-medium Flesh	-0.524	0.124
	(1.464)	(2.226)
Medium Flesh	Base	Base
Black Hide	0.021	-4.315*
	(1.494)	(2.445)
Non-Black Hide	Base	Base
Horns	-1.484	-2.913
	(1.387)	(1.925)
No Horns	Base	Base
Bull	-2.397*	3.979**
	(1.226)	(1.845)
Steer	Base	Base
Adjusted Purchase Price ($/cwt.)	3.508**	10.157**
	(1.338)	(1.798)
May 1 Weight (Pounds)	-0.833**	-0.864**
	(0.017)	(0.028)
Feed Efficiency (Feed/Gain)	-9.986**	-15.85**
	(1.467)	(2.842)
Feedlot ADG (Pounds/Day)	19.517**	2.061
	(2.315)	(4.501)
Harvest Weight (Pounds)	0.538**	0.615**
	(0.014)	(0.03)

Live Price\ Base Price ($/cwt.)	7.762**	5.761**
	(0.609)	(0.625)
Quality Grade	1.728	-58.208**
	(1.11)	(1.535)
Yield Grade	4.712**	-15.619**
	(1.444)	(1.974)
Dressing Percentage (%)	74.367**	1224.161**
	(36.926)	(59.704)
Overall Maturity	0.087**	-0.113
	(0.036)	(0.08)
Adjusted Fat Thickness (Inches)	-25.11**	11.267
	(6.082)	(9.413)
Adjusted R^2	0.993	0.993

* significant at the 10% level. ** significant at the 5% level.

Table 26. Regression Results.

	Adjusted Average Profit for All Enterprises (Sold on Liveweight Basis)	Adjusted Average Profit for All Enterprises (Sold on Muscle Grid)
Explanatory Variable	Parameter Estimate	Parameter Estimate
Intercept	-677.308**	-929.658**
	(127.462)	(243.351)
Small Frame	37.848**	38.106**
	(6.226)	(9.656)
Medium Frame	Base	Base
Large Frame	-17.129**	-27.606*
	(6.092)	(16.071)
# 1 Muscle Score	3.88	4.996
	(3.812)	(5.811)
# 2 Muscle Score	Base	Base
Atoka Sale	-7.678	-6.735
	(5.092)	(7.626)
Hugo Sale	-4.457	0.157
	(4.007)	(7.141)
Paris Sale	-19.164**	-11.90
	(8.958)	(13.576)
McAlester Sale	Base	Base
Thin Flesh	8.501	-0.453
	(5.289)	(10.086)
Lt-medium Flesh	7.754*	4.684
	(4.036)	(6.233)
Medium Flesh	Base	Base
Black Hide	3.429	5.084
	(4.109)	(7.12)
Non-Black Hide	Base	Base
Horns	-9.511**	-9.545*
	(3.966)	(5.546)
No Horns	Base	Base
Bull	-7.294**	-3.726
	(3.381)	(5.495)
Steer	Base	Base
Adjusted Purchase Price ($/cwt.)	-2.153**	-2.125**
	(0.473)	(0.688)
Feb. 12 Weight (Pounds)	-0.267**	-0.164*
	(0.048)	(0.084)
Pasture ADG (Pounds/Day)	-27.037**	-15.432*
	(4.604)	(8.002)
Feed Efficiency (Feed/Gain)	-19.868**	-26.543**
	(4.141)	(8.012)
Feedlot ADG (Pounds/Day)	-0.573	2.468

	(6.178)	(13.508)
Harvest Weight (Pounds)	0.638**	0.567**
	(0.037)	(0.09)
Quality Grade	3.381	-55.608**
	(3.009)	(4.657)
Yield Grade	5.004	-14.85**
	(3.899)	(5.617)
Dressing Percentage (%)	304.26**	1510.535**
	(100.904)	(163.878)
Overall Maturity	0.01	-0.091
	(0.10)	(0.231)
Adjusted Fat Thickness (Inches)	-17.40	6.67
	(16.505)	(27.204)
Medicine Cost ($/hd.)	-1.096**	-0.819
	(0.354)	(0.521)
Live Price \ Base Price ($/cwt.)	4.259**	0.09
	(1.622)	(1.76)
Adjusted R^2	0.94	0.928

* significant at the 10% level. ** significant at the 5% level.

Chapter 5

Implications and Conclusion

Implications and Conclusions

The 1979 USDA feeder cattle grades were implemented to help producers predict the harvest weight and yield grade at which a carcass will quality grade Choice. Some have suggested that the 1979 USDA feeder cattle grades were ineffective in predicting these outcomes. Thus, in 2000, new USDA feeder cattle grades were instituted. The data from this experiment indicate that the new grades are effective. That is, the 2000 grades did aid in predicting harvest weight and yield grade at Choice quality grade in this study.

Performance characteristics of the cattle with varying frame sizes and muscle scores are not always notably different. The backgrounding, stocker, and feedlot ADG of the different groups of cattle differed little. Feed efficiency, days fed, and harvest weight were some traits that were quite variable, though. Small-framed cattle were more feed efficient than medium-framed cattle, which were more feed efficient than large-framed cattle. Likewise, # 1 muscled cattle were more feed efficient than # 2 muscled cattle. Large-framed cattle were fed longer and were heavier at harvest than medium-framed cattle, which were fed longer and were heavier at harvest than small-framed cattle. # 2 muscled cattle were heavier at harvest than # 1 muscled cattle, but were not fed significantly longer. Again, these results are consistent with the objectives of the USDA feeder cattle frame scores.

There were many differences in carcass characteristics due to various frame sizes and muscle scores. Dressing percentage, hot carcass weight, adjusted fat thickness, and rib-eye area had significant differences between frame sizes, while yield grade and hot carcass weight had significant differences between muscle scores. There were no differences in the quality grades for the frame size or muscle score groups. Quality grade is probably caused more by management and genetics than by frame size and muscle score.

The LS means results indicate that average profits between the groups of cattle were not significantly different. The only statistical differences in profits came from actual profits. This information is biased, though, because of the changes in the overall cattle market during the time between the different harvest dates. Average profits were similar for cattle of different frame sizes and muscle scores. These LS means results would lead one to believe that cattle prices at the stocker and feeder phases were efficient in this experiment.

The regression results might lead one to believe the stocker and feeder cattle markets are inefficient. Small-framed cattle had an adjusted actual stocker enterprise profit of $21.13 more than medium-framed cattle and large-framed cattle had an adjusted actual stocker enterprise profit of $12.93 less than medium-framed cattle. Frame size and muscle score variables were also significant for adjusted average feedlot profit. Small-framed cattle had a higher profit than medium-framed cattle and large-framed cattle had a lower profit than medium-framed cattle. Also, # 2 muscled cattle had higher profit than # 1 muscled cattle. Adjusted average profit for all enterprises was different for cattle varying in frame size and muscle score. Small-framed cattle had higher profits than medium-framed cattle and medium-framed cattle had higher profits than large-framed cattle. Though not significant, # 1 muscled cattle had higher profits than # 2 muscled cattle.

These results differ from the LS means results. Regression results should be more accurate, though, since regression holds constant other factors affecting profits, unlike the LS means statistics. So, the regression results indicate that greater profit can be made producing small # 1 muscled cattle. Stocker and feedlot prices are economically inefficient since a greater profit can be made producing one type of calf instead of another.

In conclusion, buying bargains can substantially increase profitability. In this case, small # 1 cattle were cheaper than they should have been as evidenced by the difference between the actual purchase prices and the breakeven purchase prices. Depending on the time of day, the cattle auction, and the cattle market, certain types (i.e. frame sizes, muscle scores, etc.) of cattle may become inefficiently priced and opportunities are available to profit from these situations. Producers should be aware of this and procure and market their cattle accordingly.

The experimental design for this study will be repeated another two years. Additional data may remove some of the variation in weather and market seasonality to clarify the final results. More research needs to be done to corroborate this research, though. The efficiency of price differences between steers and heifers should be examined as well as other factors. This experiment had a procurement period of 78 days. Future research should try to narrow the time period in which cattle are procured. Cattle should be weighed on small-grain pasture at least two more times to more accurately track the growth of cattle on pasture. Also, future research should include accurate grading of flesh scores, breed type, and possibly gut fill of cattle to measure the efficiency of the cattle market in pricing these traits as well.

Bibliography

Adams, N.J., G.C. Smith, J.W. Savell, Z.L. Carpenter. "Frame Size and Muscling Effects on Cattle Performance and Carcass Characteristics." Texas Agr. Exp. Stn. College Station, TX. PR – 3818 p. 162-164.

Anderson, K.B. "Coordinative Efficiency of Grades and Standards for Feeder Cattle." Ph.D. Oklahoma State University, Dept. of Agricultural Economics. 1980.

Anderson, J.D., C.E. Ward, S.R. Koontz, D.S. Peel, J.N. Trapp. "Experimental Simulation of Public Information Impacts on Price Discovery and Marketing Efficiency in the Fed Cattle Market." *J. Agr. Resour. Econ.* 23(1998):262-278.

Armstrong, S.L., J.W. Wilton, W.C. Pfeiffer, L.R. Schaeffer. "Influence of Variations in Biological and Economical Parameters on Beef Production Net Returns." *J. Anim. Sci.* 68(1990):1857-1866.

Atkinson, A.C., A.N. Donev. *Optimum Experimental Designs*. Oxford, G.B.: Oxford University Press, 1992.

Buccola, S.T. "An Approach to the Analysis of Feeder Cattle Price Differentials." *Amer. J. Agr. Econ.* 62(1980):574-80.

Callow, E.H. "Comparative studies of meat. VII. A Comparison between Hereford, Dairy Shorthorn, and Friesan steers on four levels of nutrition." *J. Agr. Sci.* 56(1961):265.

Camfield, P.K., A.H. Brown, Z.B. Johnson, C.J. Brown. "Effects of Growth Type on Carcass Traits of Pasture-or Feedlot-Developed Steers." *J. Anim. Sci.* 77(1999):2437-2443.

Camfield, P.K., A.H. Brown, P.K. Lewis, L.Y. Rakes, Z.B. Johnson. "Effects of Frame Size and Time-on-Feed on Carcass Characteristics, Sensory Attributes, and Fatty Acid Profiles of Steers." *J. Anim. Sci.* 75(1997):1837-1844.

Dolezal, H.G., J.D. Tatum, F.L. Williams Jr. "Effects of Feeder Cattle Frame Size, Muscle Thickness, and Age Class on Days Fed, Weight, and Carcass Composition." *J. Anim. Sci.* 71(1993):2975-2985.

Greene, W.H. *Econometric Analysis*. Upper Saddle River, NJ: Prentice Hall, 2000.

Grona, A.D., J.D. Tatum, K.E. Belk, G.C. Smith, F.L. Williams. "An Evaluation of the USDA Standards for Feeder Cattle Frame Size and Muscle Thickness." *J. Anim. Sci.* 80(2002):560-567.

Grossman, S., J.E. Stiglitz. "On the Impossibility of Informationally Efficient Markets." *Amer. Econ. Rev.* 70(1980):393-408.

Kennedy, P. *A Guide to Econometrics*. Cambridge, MA: MIT Press, 1998.

Langemeier, M., T. Schroeder, J. Mintert. "Determinants of Cattle Finishing Profitability." *S. J. Agr. Econ.* 24(1992):41-48.

Lawrence, J.D., Z. Wang, D. Loy. "Elements of Cattle Feeding Profitability in Midwest Feedlots." *J. Agr. Appl. Econ.* 31(1999):349-357.

Ludwig, C. "Frame Size and its Relationship to Feedlot and Carcass Performance." Beef Cattle Science Handbook 1983. v. 19 p. 1067-1074.

May, S.G., W.L. Mies, J.W. Edwards, F.L. Williams, J.W. Wise, J.J. Harris, J.W. Savell, H.R. Cross. "Effect of Frame Size, Muscling Score, and External Fatness on Live and Carcass Value of Beef Cattle." *J. Anim. Sci.* 70(1992):3311-3316.

McCarthy, F.D., D.R. Hawkins, W.G. Bergen. "Dietary Energy Density and Frame Size Effects on Composition of Gain in Feedlot Cattle." *J. Anim. Sci.* 60(1985):781-790.

Mintert, J.R., F.K. Brazle, T.C. Schroeder, O. Grunewald. "Factors Affecting Auction Prices of Feeder Cattle." KSU Cooperative Extension Service. 1988.

Oltjen, J.W., W.N. Garret. "Effects of Body Weight, Frame Size, and Rate of Gain on the Composition of Gain of Beef Steers." *J. Anim. Sci.* 66(1988):1732-1738.

Sartwelle, J.D., F.K. Brazle, J.R. Mintert, T.C. Schroeder, M.R. Langemeier. "Buying and Selling Feeder Cattle, The Impact of Selected Characteristics on Feeder Cattle Prices." KSU Cooperative Extension Service. 1996.

Schroeder, T.C., M.L. Albright, M.R. Langemeier, J. Mintert. "Factors Affecting Cattle Feeding Profitability." *J. Amer. Soc. Farm Man. Rur. Appr.* 57(1993):48-54.

Schroeder, T.C., J. Mintert, F. Brazle, O. Grunewald. "Factors Affecting Feeder Cattle Price Differentials." *West. J. Agr. Econ.* 13(1988):71-81.

Selwyn, M.R. *Principles of Experimental Design for the Life Sciences*. New York, NY: CRC Press, 1996.

Smith, S.C., D.R. Gill, S.C. Jones, B.A. Gardner. "Effect of Selected Characteristics on the Sale Price of Feeder Cattle in Eastern Oklahoma." 1998. OSU Fact Sheet. [Online] Available at http://ansi.okstate.edu/RESEARCH/1998rr/18.html (5/26/00)

Smith, G.C., J.D. Tatum, F.L. Williams, J.W. Savell. "Frame Size and Muscling vs Apparent Breed type as Criteria for Sorting Feeder Cattle." Texas Agriculture Experiment Station. PR-4693. (1990):4690-4729.

Stigler, G.J. "The Economics of Information." *J. Polit. Econ.* 69(1961):213-25.

Tatum, J.D., H.G. Dolezal, F.L. Williams, R.A. Bowling, R.E. Taylor. "Effects of Feeder Cattle Frame Size and Muscle Thickness on Subsequent Growth and Carcass Development. II. Absolute Growth and Associated Changes in Carcass Composition." *J. Anim. Sci.* 62(1986 I):121-131.

Tatum, J.D., B.J. Klein, F.L. Williams Jr., R.A. Bowling. "Influence of Diet on Growth Rate and Carcass Composition of Steers Differing in Frame Size and Muscle Thickness." *J. Anim. Sci.* 66 (1988):1942-1954.

Tatum, J.D., F.L. Williams, R.A. Bowling. "Effects of Feeder Cattle Frame Size and Muscle Thickness on Subsequent Growth and Carcass Development. An Objective Analysis of Frame Size and Muscle Thickness." *J. Anim. Sci.* 62(1986 II):109-120.

Tatum, J.D., F.L. Williams, R.A. Bowling. "Effects of Feeder Cattle Frame Size and Muscle Thickness on Subsequent Growth and Carcass Development. III. Partitioning of Separable Carcass Fat." *J. Anim. Sci.* 62(1986):132-138.

Trenkle, A. "Effects of Sorting Steer Calves on Feedlot Performance and Carcass Value." 2001 Beef Research Report-Iowa State University. A.S. Leaflet R1740.

Troxel, T.R., S. Gadberry, S. Cline, J. Foley, G. Ford, D. Urell, R. Wiedower. "Improving the Value of Feeder Cattle." University of Arkansas Cooperative Extension Service.

Turner, S.C., J. McKissick, N.S. Dykes. "Reputation Selling in Feeder Cattle Teleauctions." *Rev. Agr. Econ.* 15(1993):9-19.

USDA. 2000. "U.S. Standards for Grades of Feeder Cattle." Agricultural Marketing Service. October 2000. AMS-586.

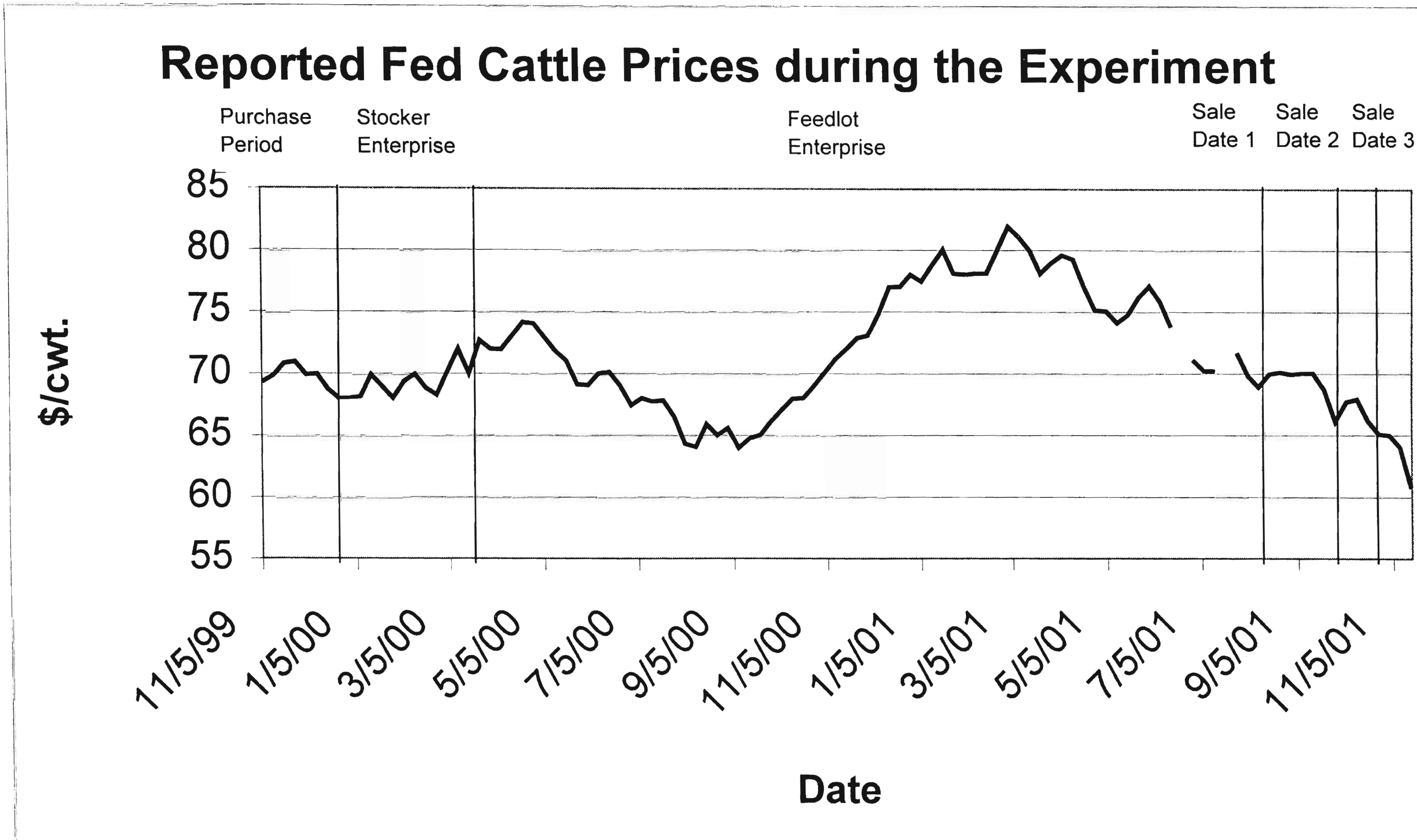
Ward, C.E., T.C. Schroeder, D.M. Feuz. "Grid Pricing of Fed Cattle: Risk and Information." Oklahoma State University Extension Fact Sheets WF-561. Oklahoma Cooperative Extension Service.

Williams, C.L., M.R. Langemeier, J. Mintert, T.C. Schroeder. "Profitability Differences between Steers and Heifers." Kansas State University Cooperative Extension Service. MF-1075. 1993.

Yandell, B.S. *Practical Data Analysis for Designed Experiments*. New York, NY: Chapman & Hall, 1997.

APPENDIX

Appendix Figure 1.



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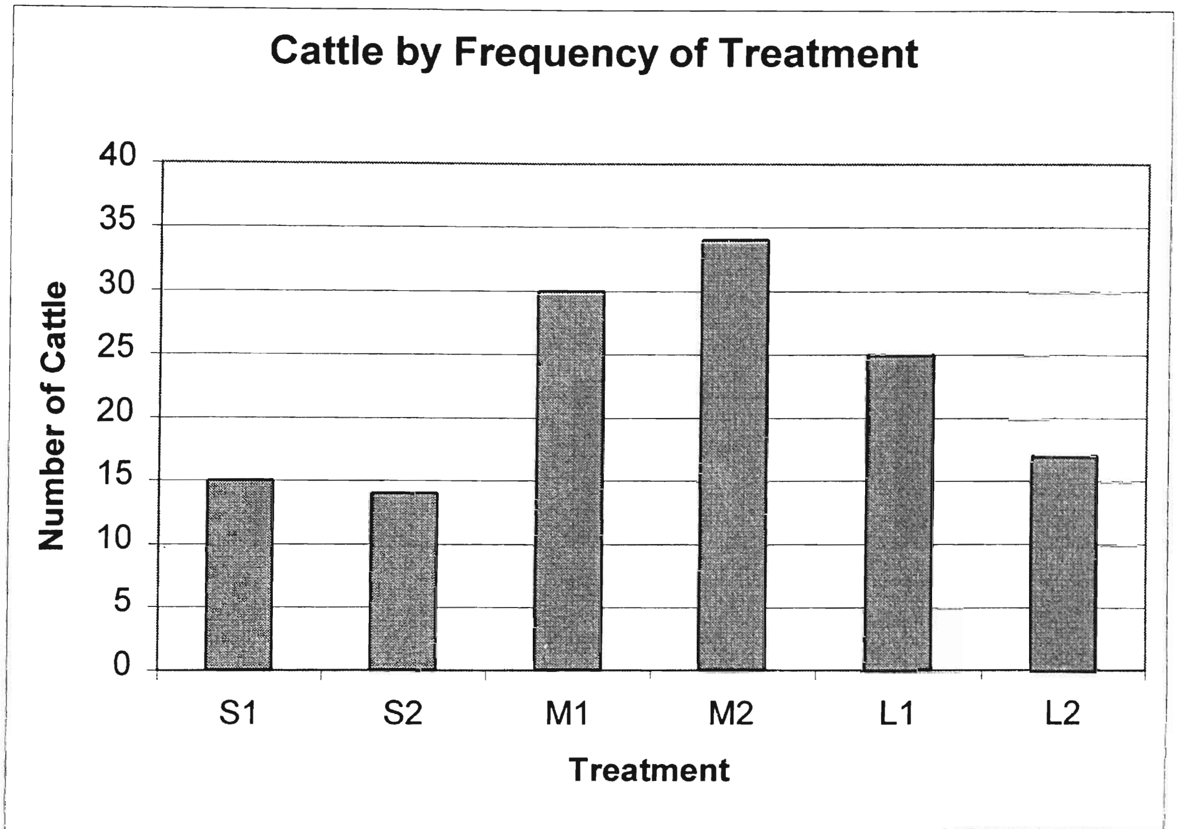
Appendix Figure 4.



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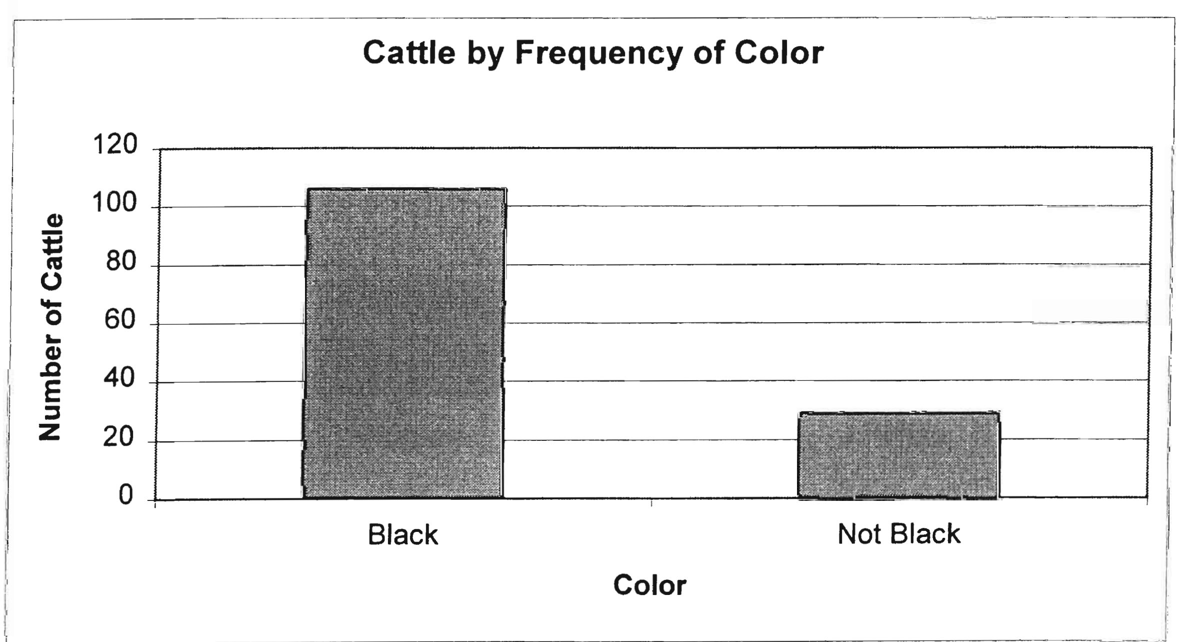

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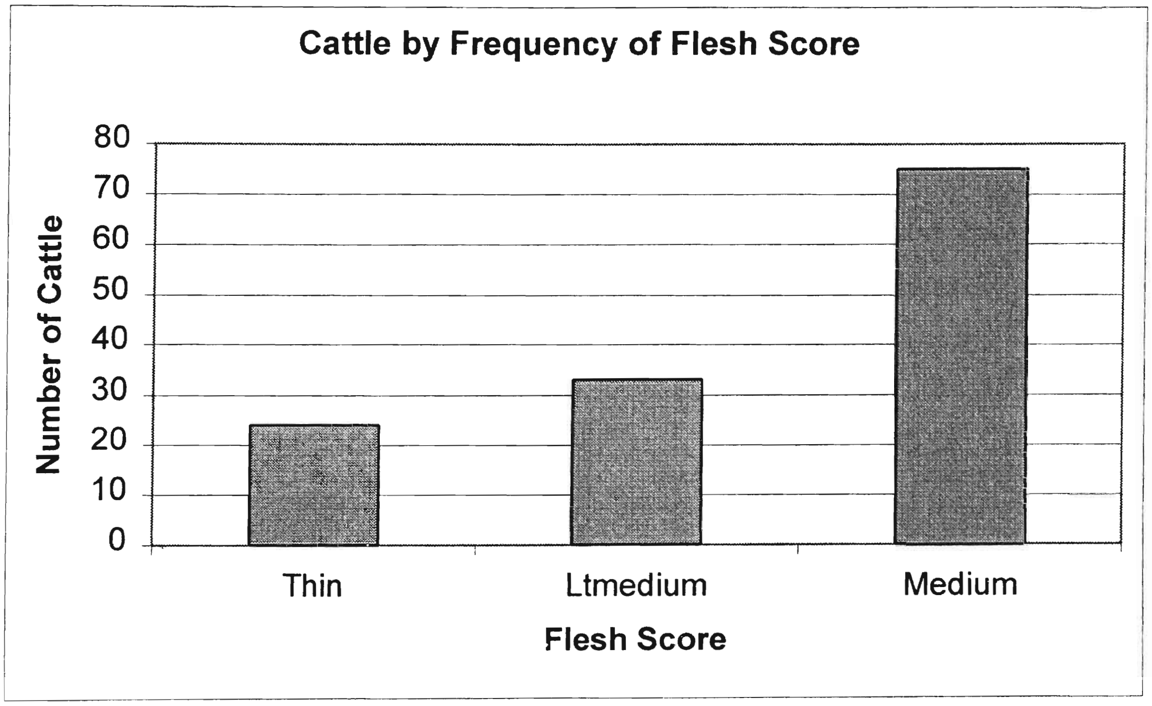

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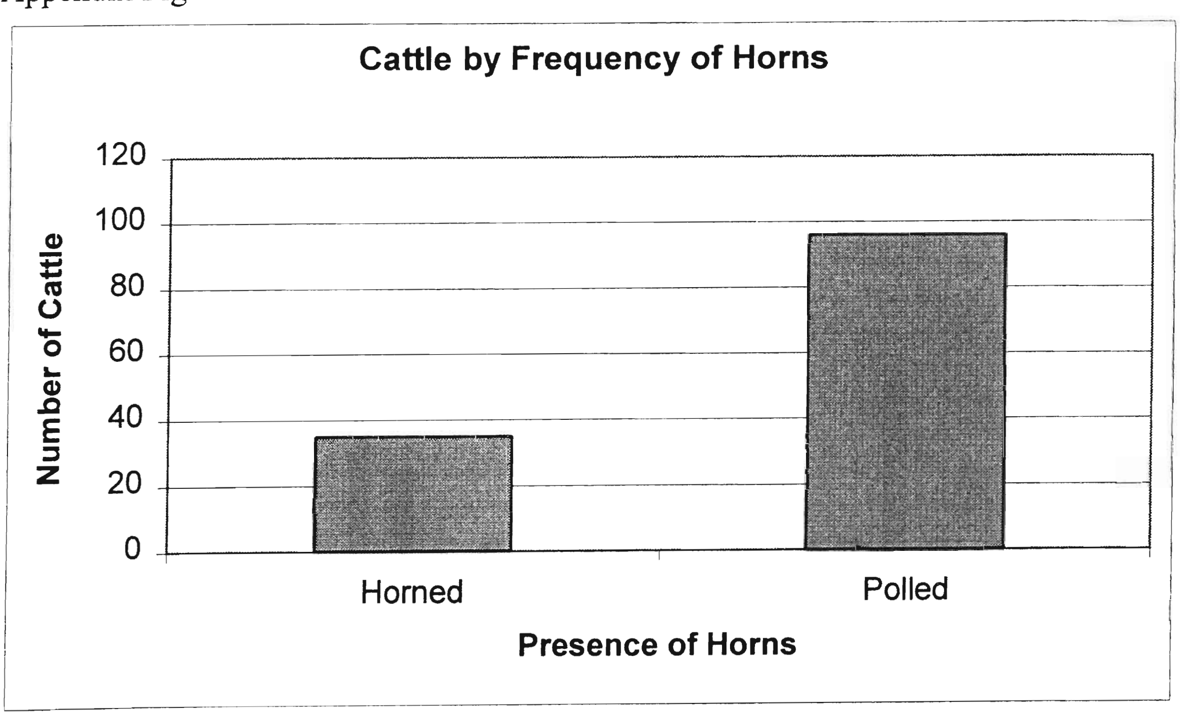

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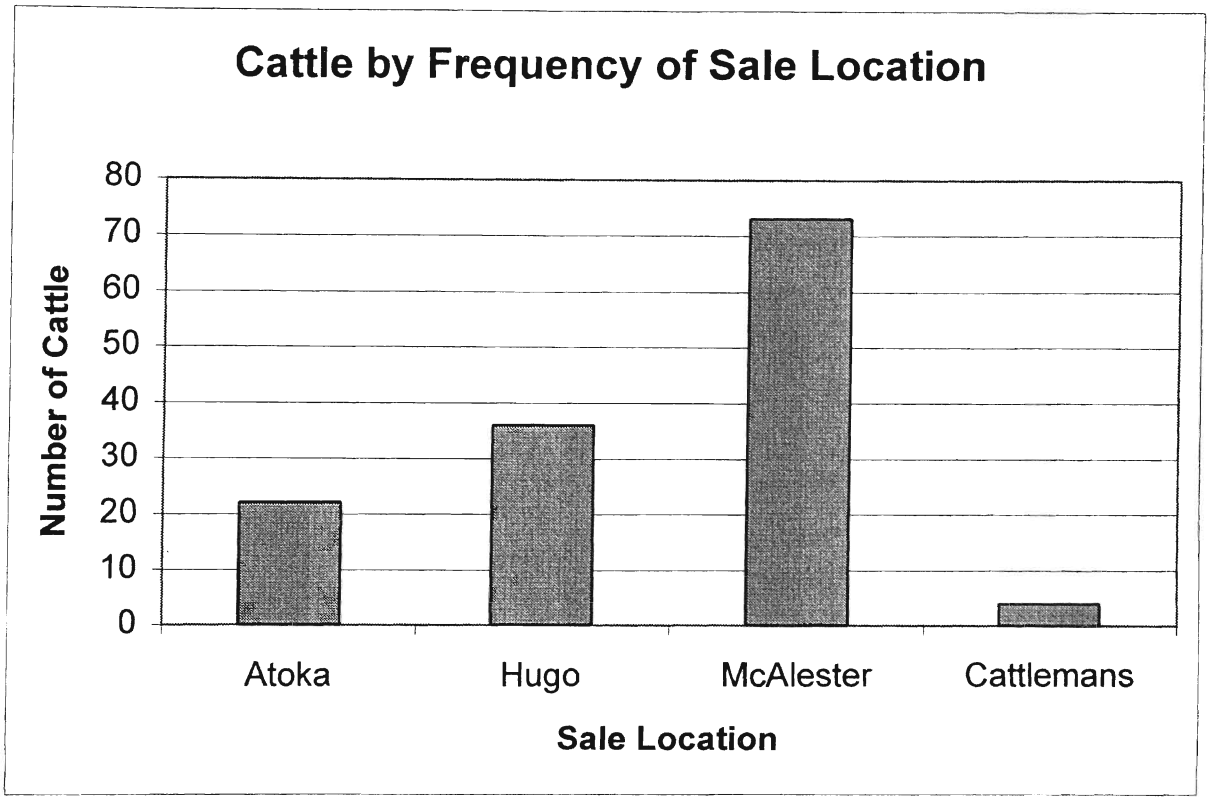

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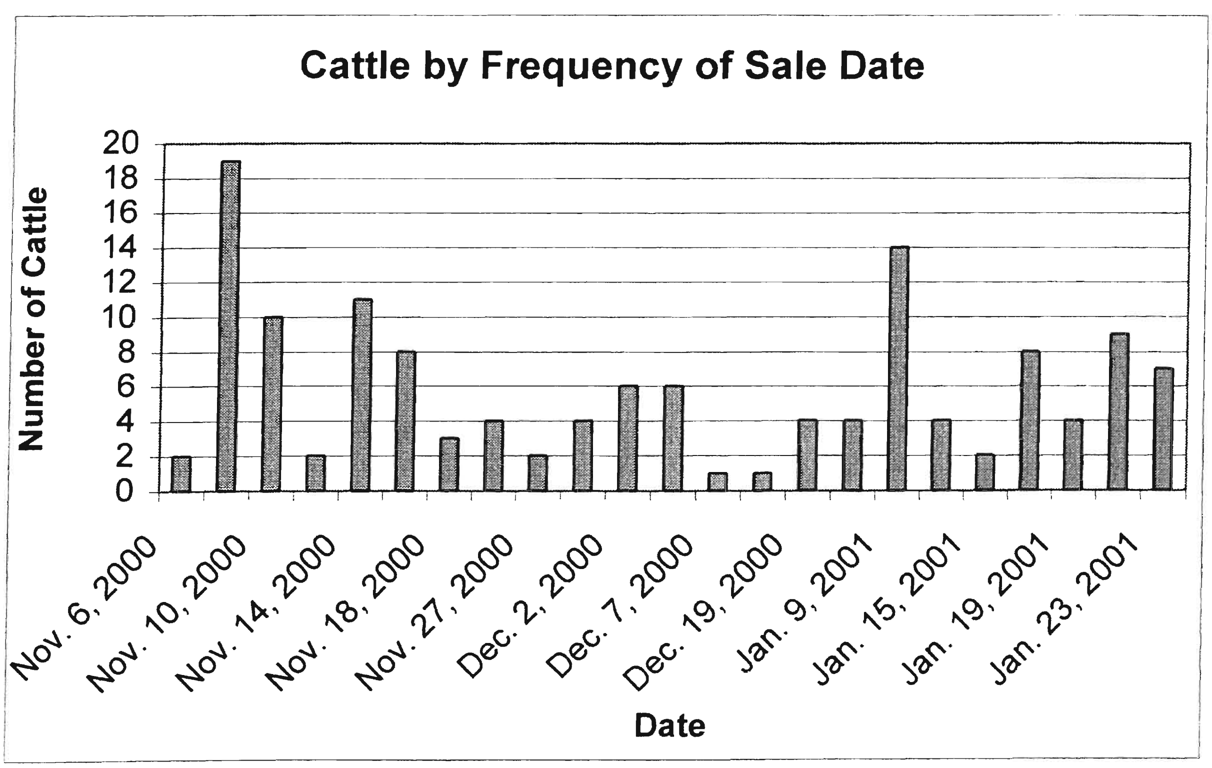

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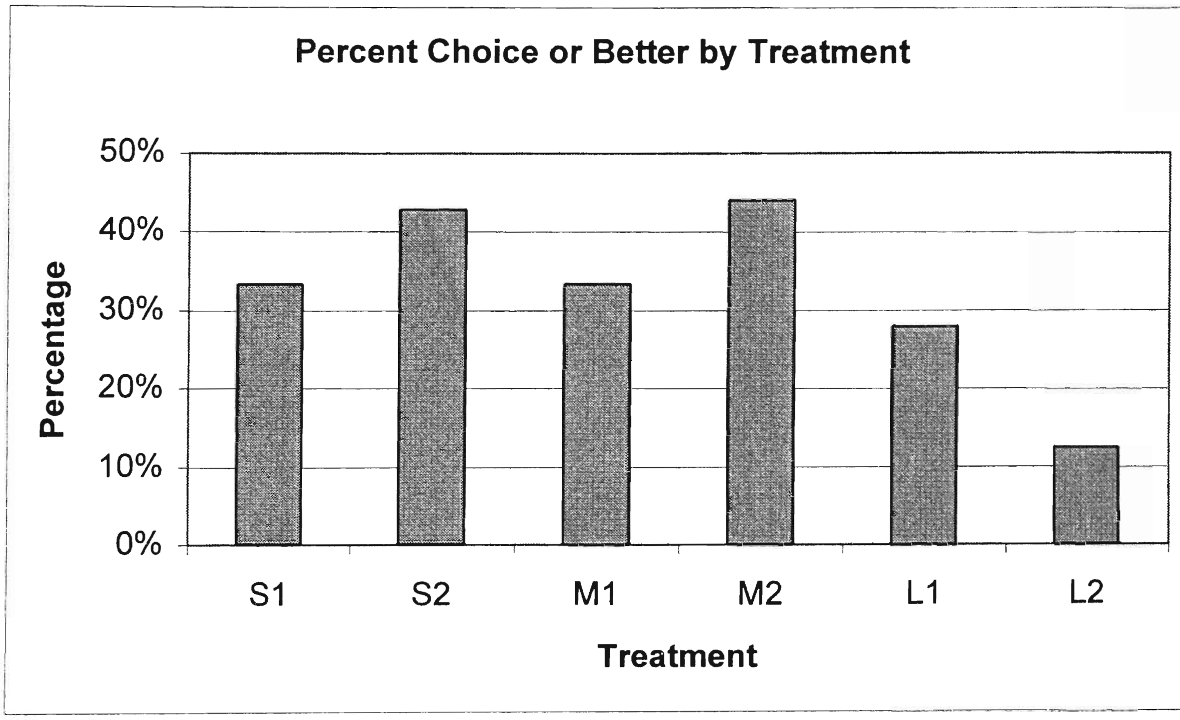

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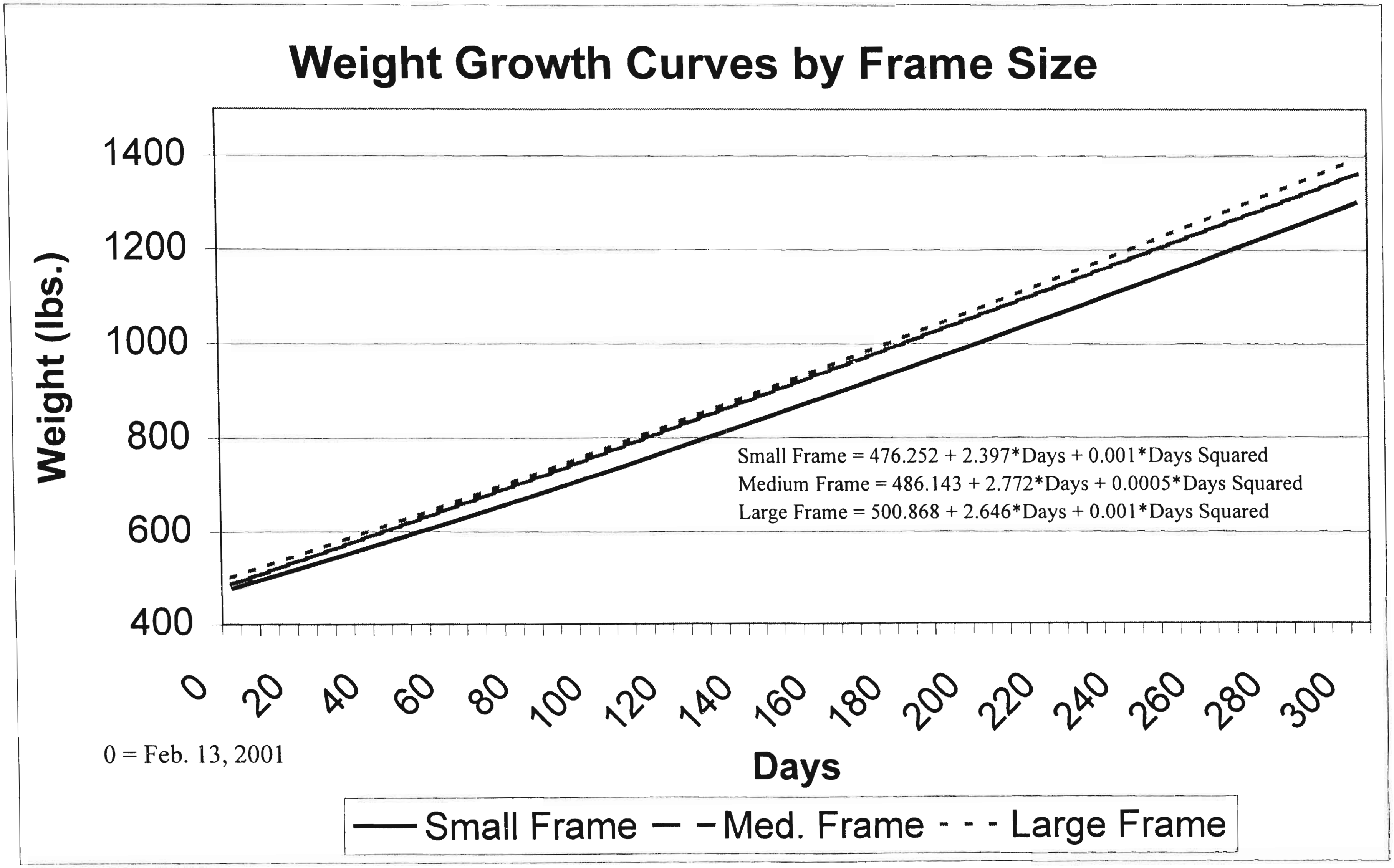

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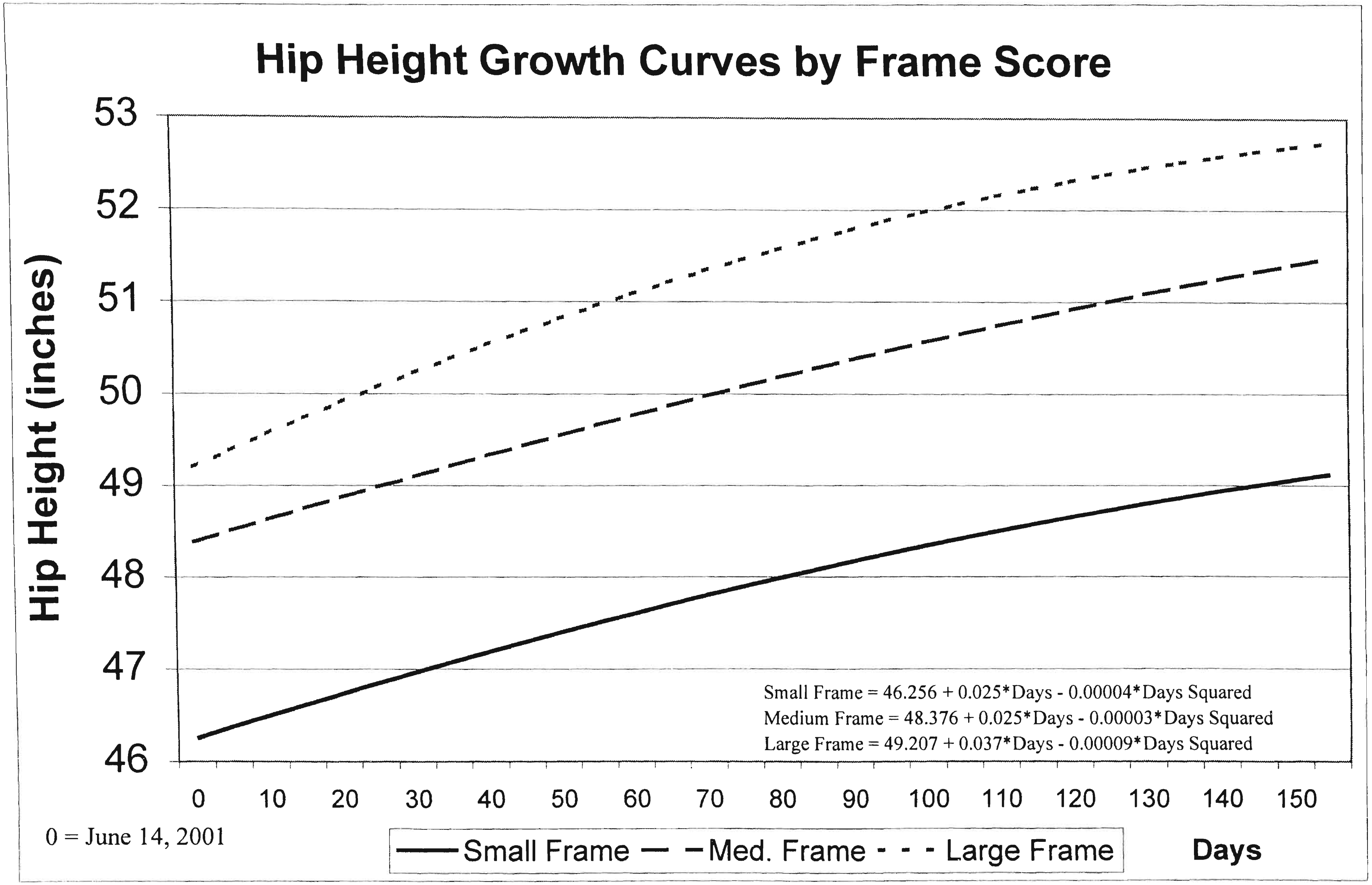

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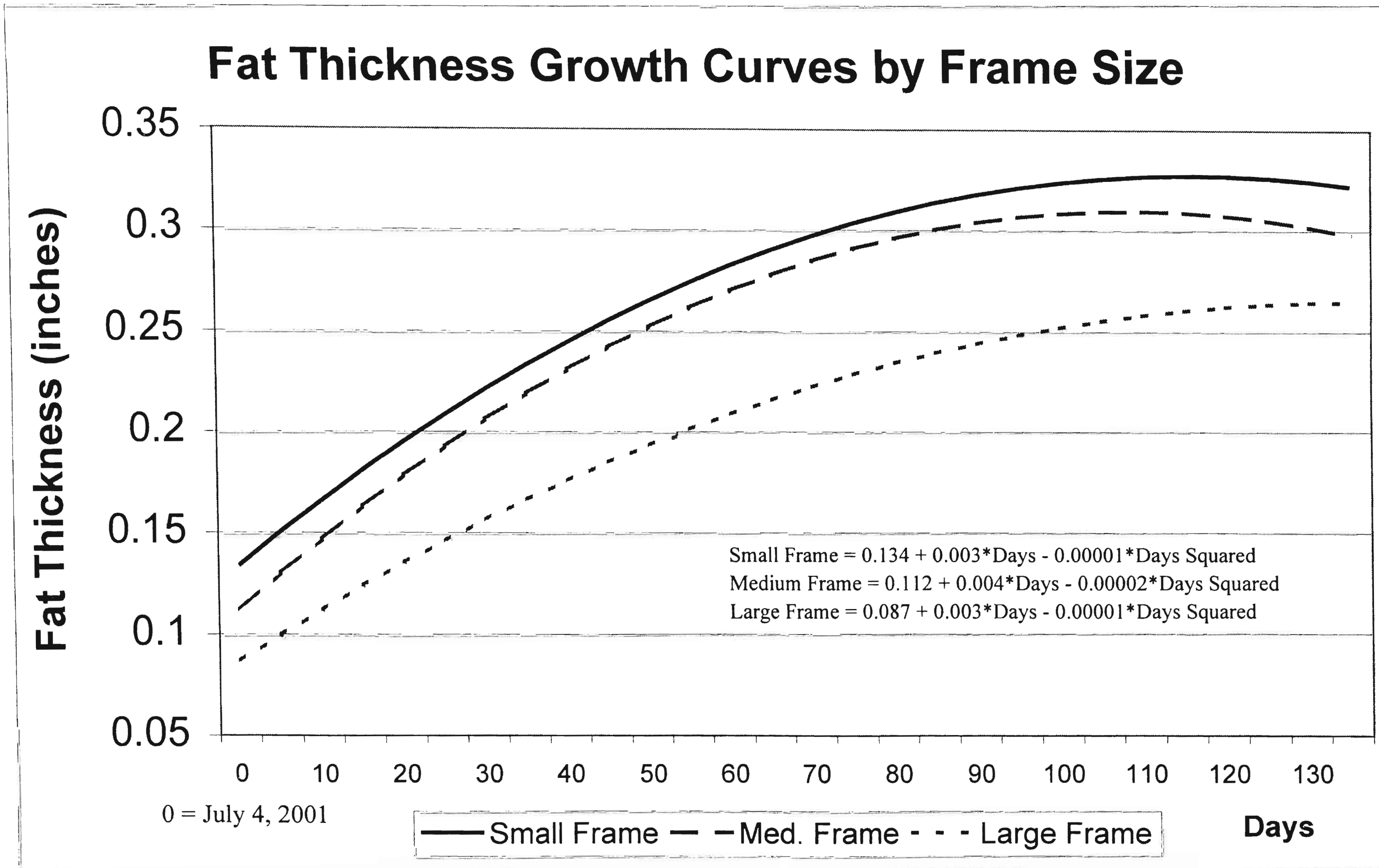

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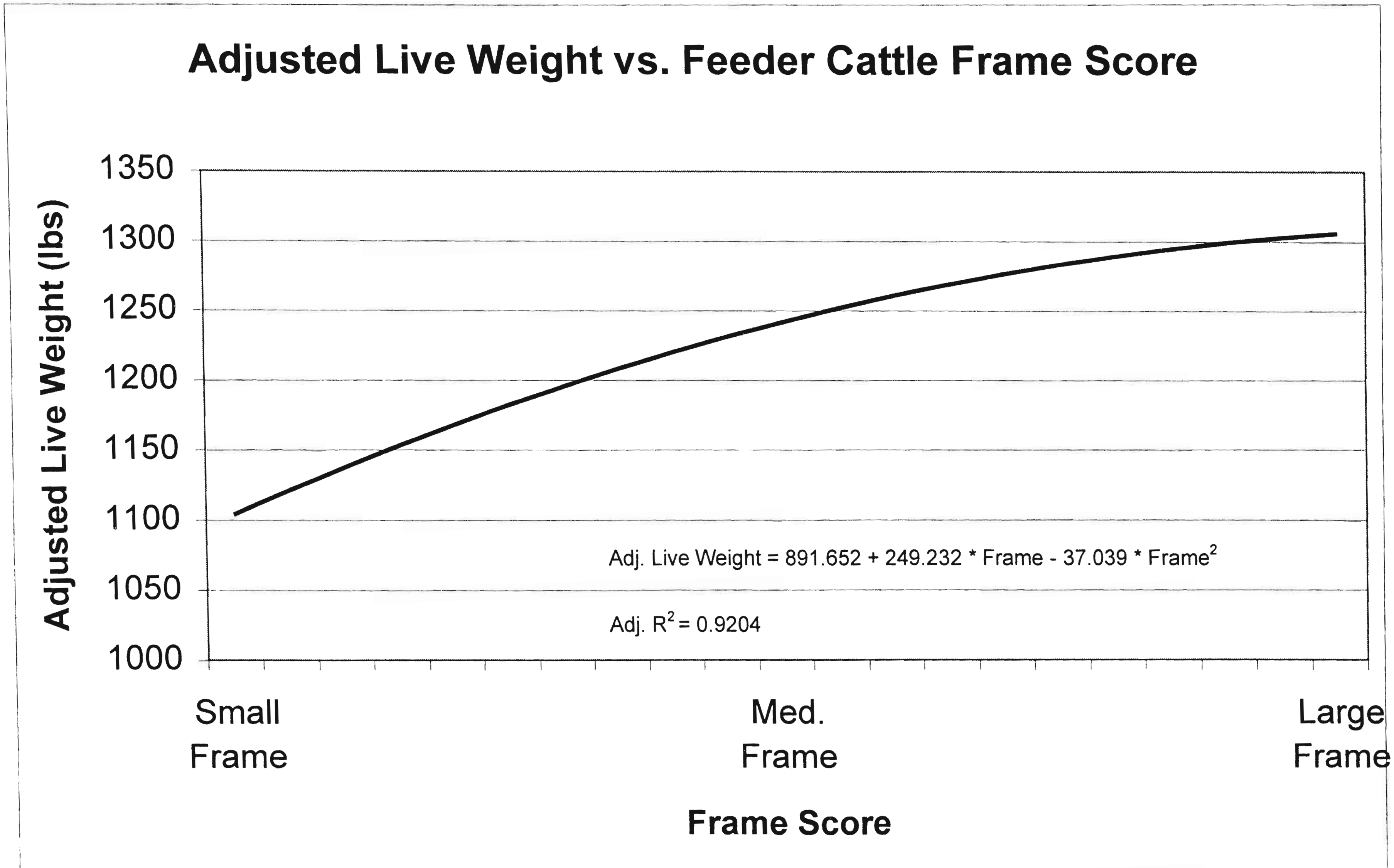

Appendix Table 1. Costs included in Profit.

Costs included in Profit Calculation	
Purchase Cost of Animal	$350.60-540.30
Preconditioning	$32.50-74.73
Pasture Cost	$23.40-86.70
Feedlot Processing	$5.59
Warmup Ration Cost	$41.56
Feed Cost	$98.49-218.34
Difference in Interest (8%)	$0-14.19
Total Cost	$660.21-952.72

Appendix Table 2.

Gelbvieh Muscle Grid (Specifications)

Category	Premium/Discount
Base Prices	$110.72, $105.92, $101.00
Prime	$6.00 / cwt. over Choice
Choice	% of Choice/Select Spread Compared to Plant Avg.
Select	% of Choice/Select Spread Compared to Plant Avg.
Standard	-$10.00 / cwt. under Choice
Utility	Market
YG 1	$4.00 / cwt.
YG 2	$1.50 / cwt.
YG 3	$0 / cwt.
YG 4	-$20.00 / cwt.
YG 5	-$25.00 / cwt.

Appendix Table 3.

Gelbvieh Muscle Grid (Averages of Dates sold)

Category	Premium/Discount
Prime	$9.08 / cwt.
Choice	$3.08 / cwt.
Select	-$5.19 / cwt.
Standard	-$15.19 / cwt.
Utility	-$53.88 / cwt.
YG 1	$3.67 / cwt.
YG 2	$1.50 / cwt.
YG 3	$0 / cwt.
YG 4	-$20.00 / cwt.
YG 5	-$25.00 / cwt.

Appendix Table 4.

National Average Grid (Averages of Dates sold)	
Category	Premium/Discount
Prime	$4.86 / cwt.
Choice	$0 / cwt.
Select	-$8.75 / cwt.
Standard	-$17.69 / cwt.
Utility	-$23.00 / cwt.
YG 1	$2.30 / cwt.
YG 2	$1.15 / cwt.
YG 3	-$0.09 / cwt.
YG 4	-$11.76 / cwt.
YG 5	-$18.63 / cwt.

Appendix Table 5.

Simulated Quality Grid	
Category	Premium/Discount
Prime	$14.00 / cwt.
Choice	$0 / cwt.
Select	-$6.43 / cwt.
Standard	-$26.43 / cwt.
Utility	-$50.00 / cwt.
YG 1 (Choice or Higher)	$5.00 / cwt.
YG 2 (Choice or Higher)	$3.00 / cwt.
YG 1	$1.00 / cwt.
YG 2	$0.50 / cwt.
YG 3	$0 / cwt.
YG 4	-$20.00 / cwt.
YG 5	-$25.00 / cwt.

Appendix Table 6.

Simulated Yield Grid	
Category	Premium/Discount
Prime	$4.00 / cwt.
Choice	$0 / cwt.
Select	-$6.43 / cwt.
Standard	-$16.43 / cwt.
Utility	-$50.00 / cwt.
YG 1	$6.00 / cwt.
YG 2	$3.00 / cwt.
YG 3	-$1.00 / cwt.
YG 4	-$20.00 / cwt.
YG 5	-$25.00 / cwt.

VITA 2

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