8-2024

Balancing the Scales: Evaluating Variables of Greatest Impact to Profit Margins When Finishing Cattle

Ryan Bake
Utah State University

BALANCING THE SCALES: EVALUATING VARIABLES OF GREATEST IMPACT TO PROFIT MARGINS WHEN FINISHING CATTLE

By

Ryan Bake

A thesis submitted in partial fulfillment

of the requirements for the degree

of

Master of Science

in

Agribusiness

Approved:

Dillon Feuz, Ph.D.
Major Professor

Ryan Feuz, Ph.D.
Committee Member

Ryan Larsen, Ph.D.
Committee Member

Utah State University
Logan, Utah

2024

ABSTRACT

Balancing the Scales: Evaluating Variables of Greatest Impact to Profit Margins when Finishing Cattle

By

Ryan Bake, Master of Science

Utah State University, 2024

Major Professor: Dr. Dillon Feuz

Department: Applied Economics

This study examines the risk associated with finishing cattle in a feedlot, specifically in the context of historically high cattle prices and quality grade grid marketing systems that have not adjusted to these elevated prices. The analysis also looks at performance factors that drive profitability differences in pens of cattle in a commercial feedlot, and how market factors also impact profitability. Regression analysis is used to determine the significance of performance variables such as: days on feed, average daily gain, feed conversion rates, and carcass characteristics on pen profitability. The impact of cattle breeding and pre-feedlot management of the cattle are also considered in the analysis. The outcomes of this research provide essential insights for stakeholders aiming to optimize economic gains in the contemporary cattle feeding industry.

Table of Contents

Chapter 1: Introduction………………………………………………………...…..Pages 3-7

Abstract…...……………………………………………………………...……...**Page 1**

- Summary of the research, findings, and significance.

Introduction…………………………………………………………………...**Page 1**

- Discussion of the problem statement and what prompted the research.

Literature Review…………………………………………………...…...**Pages 1-6**

- Overview of existing research and how this work contributes to the field.

Objectives……………………………………………………………...…...**Pages 6-7**

- Clear articulation of the research objectives and questions.

Chapter 2: Data, Procedures, & Methods…………………………….……….....Pages 8-23

Data…………………………………………………………………...……..**Pages 8-14**

- Description of data sources, collection methods, and data set features.

Descriptive Statistics……………………………………………...……..**Pages 15-18**

- Presentation of key statistical descriptions of the data, such as means, variances, etc.

Methods……………………………………………………………….…..**Pages 19-23**

- Explanation of the analytical methods and procedures used in the research.

Chapter 3: Results & Implications……………………………………...…….Pages 24-32

Results…………………………………………………………........**Pages 24-30**

- Detailed presentation of the findings from the research analysis.

Implications……………………………………………………...…...**Pages 30-32**

- Discussion of the significance of the findings, their implications for the field, and potential applications.

Chapter 4: References ……………………………………………………….……..Page 33

- Comprehensive listing of all sources cited in the research formatted according to the chosen citation style.

Chapter 5: Appendix…………………………………………….……………..Pages 34-36

Introduction Chapter

Abstract:

This study examines the risk associated with finishing cattle in a feedlot, specifically in the context of historically high cattle prices and quality grade grid marketing systems that have not adjusted to these elevated prices. The analysis also looks at performance factors that drive profitability differences in pens of cattle in a commercial feedlot, and how market factors also impact profitability. Regression analysis is used to determine the significance of performance variables such as: days on feed, average daily gain, feed conversion rates, and carcass characteristics on pen profitability. The impact of cattle breeding and pre-feedlot management of the cattle are also considered in the analysis. The outcomes of this research provide essential insights for stakeholders aiming to optimize economic gains in the contemporary cattle feeding industry.

Introduction:

The U.S. cattle industry is structured into three distinct segments: cow/calf production, stocker operations, and feedlots, each with unique challenges. Cow/calf producers focus on efficiently producing a calf annually per cow, striving to minimize costs while maintaining their breeding herds. Stocker operators specialize in purchasing weaned calves and providing them with opportunities to increase their frame size through low-input grazing on winter cover crops or crop residues. This growth phase is crucial for enabling the animal to achieve an optimal frame size suitable for finishing weight in feedlots.

The final segment, the feedlot, involves feeding cattle a high-calorie diet in confined spaces to reach finishing weights. As cattle are raised across various U.S. states, each with different breeds and climates, feedlots face the challenge of assembling uniform groups that perform consistently. Typically, cattle feeders purchase animals to optimize yard capacity and seek similar types to enhance feeding efficiency. While uniformity of cattle within a pen of cattle is necessary to increase feeding efficiency and likely increase feeding profitability, pens of cattle within a feedlot may differ considerably in beginning weight, breed type and ultimately feedlot performance.

The diversity in cattle types introduces significant analytical questions regarding how breed characteristics influence profitability in this sector. This analysis aims to explore these variables, providing insights into optimizing cattle production from economic and operational perspectives.

Literature Review:

The commercial cattle feeding industry has always involved a certain amount of risk due in large part to changing market conditions. Cattle performance within a feedlot is also variable based on prior cattle management, genetic differences of the cattle and external environmental conditions. There have been several studies in the past that have tried to quantify these different risk factors and determine which has the greatest impact on feedlot profitability.

In the year 2002, an analysis of days on feed was conducted at the University of Nebraska, emphasizing the inherent volatility of the cattle industry. (Feuz 2002) underscored that the commercial cattle feeding industry historically fluctuates in profitability, attributed to the volatile nature of commodity input prices and significant variations in the value of fed cattle. This historical context serves as a testament to the enduring challenges faced by cattle feeders and underscores the pressing need for continuous research and optimization strategies in the face of ever-evolving market conditions.

In the context of exploring factors influencing profitability in the cattle industry, the study conducted by Mark et al. (2000) provides comprehensive insights from a time frame set in the 1990's. The research analyzes data from over 14,000 feedlot pens, offering a detailed examination of how variables such as fed cattle prices, feeder cattle prices, corn prices, interest rates, and cattle performance metrics impact profit margins. It specifically compares whether efficiency metrics or price metrics have a greater impact on profitability. One of the pivotal findings is the dominant influence of cattle prices on profitability, highlighting the critical need for effective price risk management strategies among cattle feeders. Additionally, the variability in profit driven by corn prices and interest rates, although secondary, underscores the multifaceted nature of economic factors affecting the sector. This paper serves as a crucial reference in understanding the dynamic interplay between market forces and animal performance, providing a layered perspective on risk management practices essential for maintaining profitability in the cattle feeding industry.

Furthermore, the study's analysis reveals that the impact of these economic factors varies significantly with the sex of the cattle, their placement weight, and the timing of their market entry. For instance, the influence of feeder cattle prices is notably more substantial during the spring and fall placements, whereas corn price fluctuations are most impactful in the third quarter. This heterogenous impact suggests that tailored risk management approaches could enhance profitability across different segments of the cattle market. This exploration into the dependencies and interactions between various economic variables and their effect on profitability lays a foundation for variables to consider in this analysis, under present day circumstances.

Given the current market dynamics where cattle feeders are experiencing abnormal highs in the price of finished cattle, there is a significant opportunity to reconsider the strategic approach to feeding durations. Extending the days on feed can potentially increase meat supply per head, thus enhancing profit margins. However, the crux of maximizing these benefits hinges on the efficiency of average daily gain during these extended feeding periods.

Historically, as evidenced in the study by Feuz (2002) titled, "A Simulated Economic Analysis of Altering Days on Feed and Marketing Cattle on Specific Value-Based Pricing Grids," the focus was on analyzing the economic impact under lower market conditions. The study employed simulations to evaluate various grid pricing systems, comparing groups of cattle fed for two weeks longer or shorter than usual. Key assumptions about average daily gain, dressing percentage, yield grade, and carcass weight were factored in to estimate returns under each scenario. The findings suggested that cattle fed for an additional two weeks were generally more profitable under a combined commodity and quality grid pricing system.

A more recent study on factors impacting feedlot profitability was conducted by (Janzen et al. 2016). The focus of this study was to compare the relative impact of profitability factors in 2005-2013 to the results published by Mark et al. based on data from the early 1990's. The study sourced individual data from cattle fed in Iowa with 25000 observations. The model included variables such as Fed Cattle (live) price, Feeder Cattle price, corn price, Average Daily Gain, Sex, In-weight, feed conversion, and interest rates to predict variability in Profit per Head. The results concluded that metrics measuring animal efficiency i.e., average daily gain, feed conversion etc. were having a larger impact on profitability relative to output and input priced than was found in the research conducted by Mark et al. (2000) while price metrics were still the driving factors of risk for profitability.

The implications of the study by Mark et al. (2000) are important to consider for the purpose of this analysis, as it will be crucial to include both price metrics and efficiency metrics in the model to examine impacts on profitability. Also important to note were the conclusions that feeder price does not have a significant difference on profitability between steers and heifers, but Jansen et al. (2016) used feeder cattle prices from the CME that do not differentiate the slide between steer and heifer feeder cattle prices that exist in the cash market. This analysis will include actual cash-based steer and heifer slides by weight class to determine whether steers are overvalued for their performance compared to heifers, in the feeder cattle market. Today, with cattle prices at much higher levels, the potential to extend feeding days beyond the additional two weeks explored by Feuz (2002) may present even more significant profit opportunities. This scenario underscores the need to utilize contemporary data from cattle fed at varying lengths to truly understand the impacts on average daily gain, changes in carcass weight, and quality grade. This will not only provide insights into the optimal feeding durations but also help pinpoint the most profitable time to market the additional finished pounds. Such an approach is crucial for cattle feeders to make informed decisions that capitalize on current market conditions and enhance profitability.

This study will analyze pen level data from cattle fed in 2010 to 2023 with differing breed and background characteristics, employing statistical regression. The results will shed light on the impact of grid system marketing, high cattle prices, and varying breed and background characteristics on profitability. The incorporation of feed prices and their volatility in today's market are crucial components of this analysis aimed at providing robust, informed strategies to stakeholders for optimizing economic returns in these dynamic market conditions.

Building on established research, this study seeks to examine the economic effects of extended Days on Feed (DOF) and the change in animal efficiency metrics on feeder cattle profitability using real-world data. As cattle fed in the data set used for this analysis had an average out weight of 1400 pounds and an average number of DOF at 204, twenty years ago, cattle were fed on average anywhere from 90 to 175 days (Bertelsen). In the analysis by Mark et al. (2000) average out weight for fed cattle used in the study was 1178 pounds with an average number of DOF at 131. The industry trend since then has been to feed longer, packing on more pounds with hopes of increased profits. Open questions remain within the industry on the extent to which increasing DOF is optimal. Notable contributions from (Crawford) have documented the physiological changes in cattle weight composition because of longer DOF, pointing out both enhancements in meat quality and potential risks of carcass discounts. Furthermore, the research by Galyean et al. (2023) elaborates on the impact of extended DOF on carcass attributes (efficiency metrics), particularly within the context of currently high beef prices. The analysis by Gaylean et al. used DOF as the dependent variable across multiple trials to explore its influence on profitability-affecting factors. The findings confirmed that longer DOF generally improves quality grades but reduces Average Daily Gain (ADG), however these effects were not directly translated into economic outcomes. By leveraging real-world data, this analysis aims to extend these insights by quantitatively assessing the direct economic implications of longer DOF in today's commercial feedyards compared to the past.

Such an approach is vital for optimizing feedlot management in today's fluctuating market and ensuring that feedlot operators can make informed decisions that enhance profitability while managing risks associated with extended feeding periods. This study hopes to bridge the gap between physiological data and economic realities, providing actionable guidance for the cattle feeding industry.

Objectives:

Main Objective:

What are the key factors influencing profitability in today's market characterized by high cattle prices, and the comparison of efficiency, quality, and price metrics in terms of their impact on profitability per head? Additionally, how has the industry trend of extending days on feed influenced efficiency and quality metrics and subsequently affected profitability per head?

Sub Objective 1:

- How does breed type and sex impact profit per head, changes in animal efficiency metrics, and the accuracy of the steer-heifer slide in the feeder cattle market?

Sub Objective 2:

- How does pre-feedlot management impact profit per head in the context of variables that represent background for an animal before entering the feedlot?

Sub Objective 3:

- How do timing and seasonality of fed cattle prices affect profitability?

Sub Objective 4:

- How does initial weight impact profit per head and the metrics that drive profit, by placement weight intervals?

Sub Objective 5:

- How does extended DOF affect profitability per head when feeding cattle.

This comprehensive study aims to evaluate the impact of price and efficiency metrics on profitability, as well as the changes in animal biometrics that might influence economic returns, particularly in the context of the industry trend toward extended days on feed. This research will also delve into how breed attributes interact with profitability, providing a deeper understanding of the genetic factors at play.

Additionally, the study will explore potential seasonality trends in the market for finished cattle, which could inform optimal timing for selling. A comparative analysis between the profitability of feeding heifers versus steers will also be conducted to determine if sex plays a significant role in economic outcomes.

Driven by a commitment to enhance industry knowledge, this research is designed to support improved decision-making and develop practical solutions that could revolutionize traditional cattle feeding practices. By identifying and quantifying these various elements, the study aims to offer actionable insights that help producers maximize profitability while adapting to market dynamics and biological realities.

The data underlying this analysis is particularly noteworthy because it sources cattle from a consistent set of ranches nationwide, often resulting in lighter-weight animals upon arrival.

Data, Procedures, & Methods Chapter

This chapter will initially describe the unique data set that will be used for the analysis. The procedures used to determine average profit per head for each pen of cattle in the data set will then be explained, including a definition of profit used for this analysis. Lastly, the method used to analyze the factors that have a significant impact on feedlot pen profitability will be outlined.

Data:

In this analysis, a single dataset provided by a private company in the United States will be utilized. The company, which has requested anonymity, operates a substantial feedlot in western Kansas and sources all its animals from its own operations. The dataset covers a span from 2010 to 2023, offering a comprehensive view of all cattle produced by the company and finished at their feedlot.

The data is organized at the 'pen-level', meaning it presents averages for cattle grouped in the same pen. Each lot is assigned a unique ID, where the first two digits indicate the year, the animals were fed, and the subsequent digit denotes their sex. Notably, all animals included in the dataset for the specified time are sourced consistently each crop year from the same ranch and herd, ensuring a unique uniformity in the data. This uniformity is reflected in the pen-level observations, through grouping by breed, in-weight, and origin, factors that are known to enhance performance in the feedlot. The dataset contains seventy-six variables of both continuous and categorical types.

The dataset encompasses three distinct breed types, with each breed further segmented by sex. The Brahman category represents a unique three-eighths Brahman cow, a product of a three-breed cross developed by the company. These animals are genetically adapted to withstand the heat and insect stress typical in southern regions. The Angus category is derived from three-eighths Brahman heifers crossed with Black Angus bulls, a breeding strategy aimed at calving ease and producing a terminal animal. The British category includes cattle from cooler climates, exhibiting Bos Taurus influences in their pedigree primarily Angus and Simmental. The dataset encompasses total observations of 5769 lots, averaging 113 head per lot, cumulatively representing over 650,000 individual animals fed across the span of more than a decade (see ***Table 1***).

Table 1: *Sum of Pen-level: Observations & Individual Hd / Pen by Breed and Sex*

Breed	Total # Pen-Level Observations (Heifer)	Total # Pen-Level Observations (Steer)	Total # Pen-Level Observations (Combined)	Sum of Individual Hd / Pen (Heifer)	Sum of Individual Hd / Pen (Steer)	Sum of Individual Hd / Pen (Combined)
ANGUS	445	473	918	49601	55292	104893
BRAHMAN	723	1473	2196	88166	161441	249607
BRITISH	1012	1643	2656	115277	182905	298182
Total Sum	**2180**	**3589**	**5769**	**253044**	**399638**	**652682**

As mentioned earlier, the industry trend in cattle feeding since the time that Mark et al. completed his study has been to feed longer. This leads to heavier Out-Weights and increased pounds of beef marketed, likely increasing profits per head. Average In-Weight, Out-Weight, and Head Count per pen is displayed in ***Table 2***.

Table 2: *Average of Pen-level: In-Weight, Out-Weight & Hd / Pen by Breed and Sex*

Breed	In-Weight (Heifer)	In-Weight (Steer)	In-Weight (Combined)	Out-Weight (Heifer)	Out-Weight (Steer)	Out-Weight (Combined)	Hd / Pen (Heifer)	Hd / Pen (Steer)	Hd / Pen (Combined)
ANGUS	607	622	615	1223	1324	1275	111	117	114
BRAHMAN	631	662	652	1220	1340	1301	122	110	114
BRITISH	640	619	627	1257	1356	1318	114	111	112
Total Avg	**631**	**637**	**635**	**1238**	**1345**	**1305**	**116**	**111**	**113**

While this data bears similarities to panel data, given that the cattle fed each year originate from consistent ranches, it is crucial to note the distinction: each year's data represents a unique crop year since these cattle are raised with a terminal purpose in mind. It could be classified as repeated cross- sectional data, due to the nature of the animals being harvested each year at the end of the production period.

As previously mentioned, the profit per head metric is pivotal in understanding the outcomes of this analysis. For the purposes of this analysis references to the terms *Profit / Hd*, *profit*, or *profit per head* represent returns from operations feeding cattle on a per individual basis. The terms do not include opportunity cost or overhead costs. Key animal biometric variables were used to determine the profit per head for an individual animal in a pen-level observation. The calculation for profit per head is shown in ***Figure 1***.

[Profit / Hd] = [Avg Total Rev] – [Total Feedlot Cost] – [Cost Feeder Animal]

- ***[Avg Total Rev]*** *= [Adj HCW Price] x [Avg Carcass Weight]*
- ***[Total Feedlot Cost]*** *=* ***[Total Cost of Gain]*** *+ [Yardage / Hd] + [Processing / Vet Med / Hd]*
    - ***[Total Cost of Gain]*** *=* ***[Total Feed Cost]*** */ [Total Avg Lbs Gained*
        - ***[Total Feed Cost]*** *= [Price of Feed Ration] x [Dry Matter Intake (Lbs)] x [Days on Feed]*
- ***[Cost Feeder Animal]*** *= [Price Feeder Cattle] x [Avg In-weight]*

Figure 1: *Flow Chat of Variable Calculation: Profit / Hd*

To achieve this, the profit per head metric integrates historical market data, feed costs, and cattle performance metrics. The main objective of this analysis is to identify the impacts of variables that affect profit per head. This involved analyzing historical price data for feed inputs, feeder cattle, and live cattle. The historical prices were used to drive Profit/Hd and were averaged across the years 2010-2023 to fit the span of the original dataset for the analysis.

The profit / Hd metric uses the variables shown in ***Table 3*** as a part of the computing process.

Table 3. List of Variables used to compute Profit / Hd

Variable	Classification	Mean	SD
Profit per Head	Continuous	41.86	70.21
Total Feedlot Cost	Continuous	204.02	43.53
Feed Cost	Continuous	501.0%	66.16
Cost Feeder Animal	Continuous	209.36	5.26
Feeder Cattle Price	Continuous	168.77	16.51
Avg Total Revenue	Continuous	1750.24	120.33
Adj. Hot Carcass Weight Price	Continuous	209.36	5.26
Base Hot Carcass Weight Price	Continuous	205.39	3.98
Dry Matter Intake (Lbs)	Continuous	19.79	2.66
Avg Daily Gain (lbs)	Continuous	3.22	0.45
Days on Feed	Continuous	204.02	43.53
In-Weight (Lbs)	Continuous	634.60	133.33
Out-Weight (Lbs)	Continuous	1304.70	89.77
Dressing Percentage	Continuous	64.3%	0.01
Avg Hot Carcass Weight (Lbs)	Continuous	836.23	57.26
% Cert. Angus Beef	Continuous	15.5%	0.13
% Prime	Continuous	2.3%	0.04
% Choice	Continuous	74.56%	0.13
% Select	Continuous	21.10%	0.13
% Ungraded / No Roll	Continuous	0.97%	0.03
% Yield Grade 1	Continuous	6.64%	0.07
% Yield Grade 2	Continuous	36.60%	0.13
% Yield Grade 3	Continuous	42.18%	0.10
% Yield Grade 4	Continuous	12.9%	0.09
% Yield Grade 5	Continuous	1.5%	0.02
% Heavies	Continuous	0.94%	0.03

To calculate *Cost Feeder Animal*, feeder cattle prices needed to be determined. To address the variations in market prices influenced by different weight classes and to analyze the profitability differences between heifers and steers, the concept of a "price slide" was utilized. This method was based on data from the Kansas Feeder Cattle Auction Summary (Combined Auction KS. LMIC 2024), incorporating records from the year 2010 to 2023. The analysis began by calculating the average prices for feeder steers and heifers ranging from 400 to 1000 pounds.

A regression analysis (*see **Table 4)*** was then performed with the price as the dependent variable. The model included weight and weight squared to capture the non-linear effect of weight on price, along with a dummy variable to denote sex (heifer), and additional terms for heifer weight and heifer weight squared to specifically assess the impact of sex on price variations by weight.

Table 4: Regression Output: Steer vs Heifer Slide Price & Equation			
N Observations:	12		
Adj R-squared:	99.8%		
Variable	Parameter Estimate (Price)	Significance	Std. Error
	Model 1		
Weight (Wt)	-0.309071	***	0.022056
Weight Squared (Wt2)	0.000145	***	1.57E-05
Dummy Heifer (Hfr)	-76.712500	***	10.47504
Heifer Weight (HfrxWt)	0.152714	***	0.031193
Heifer Weight Squared (HfrxWt2)	-0.000089	***	2.22E-05
Constant	310.756250	***	7.406971
Note: *p**pp<0.01***			
Regression Equation:			
Price = 310.75625 - 0.30907143 * Wt + 0.00014464 * Wt2 - 76.7125 * Hfr + 0.15271429 * HfrxWt - 0.00008929 * Hfrxwt2			

Using the price equation derived from this regression, the prices for feeder cattle were calculated from the primary dataset based on the *in-weight* of each observation, applying market-based adjustments for weight classes. The results, which are illustrated in ***Figure 2***, delineate the price slide between steers and heifers by weight class, providing a detailed view of how market prices adjust according to both weight and sex in feeder cattle. This approach allows for a nuanced understanding of price dynamics and profitability in the cattle market. The findings show that heifers are discounted on a nonlinear scale, with a price difference of almost $30 / cwt less than steers at lighter weights (400 Lbs) and $12 / cwt at a heavier weight (800 Lbs). This price slide is apparent because on average steers perform better in the feedyard and finish at heavier weights compared to heifers. The key is understanding to what degree the discount for heifers in the feeder cattle market is aligned with their "underperformance" and therefore reduced profits in the yard.

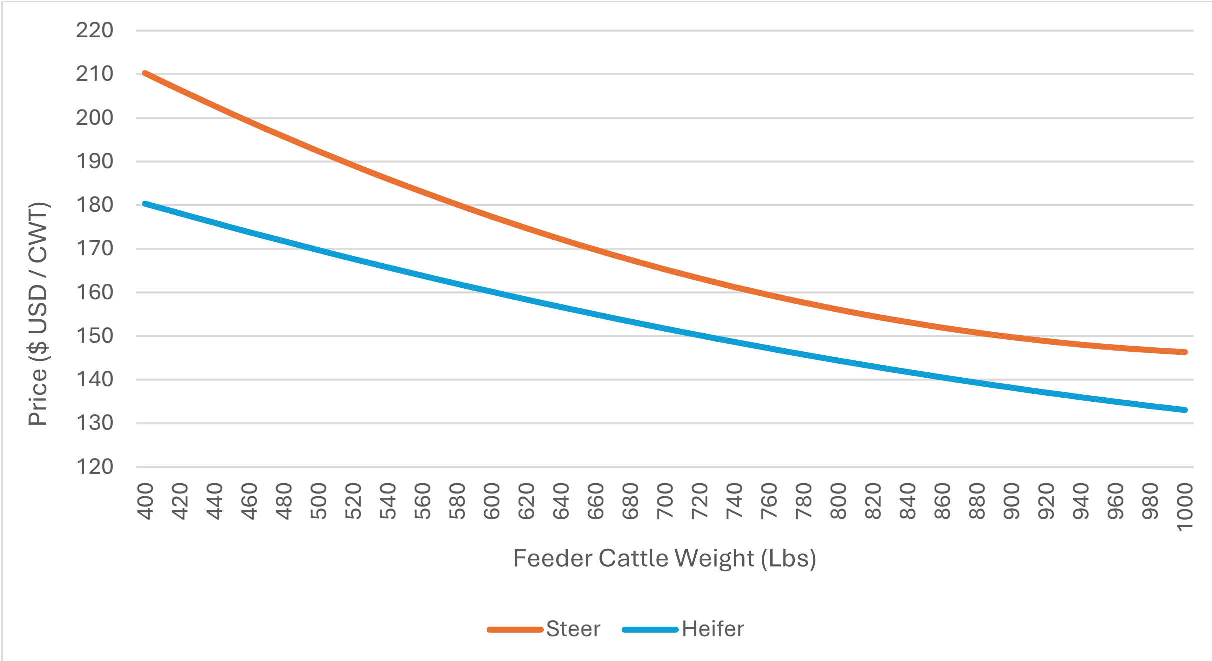

Figure 2: *Kansas - Average Feeder Cattle Prices by Weight Class $ / CWT (2010-2023)*

To expound upon parts of the flow chart ***Figure 1***, it is important to understand the methodology behind two metrics, Price of Feed Ration as well as Adjusted Hot Carcass Weight Price (Adj HCW). The ration price is needed to determine the cost of feeding the animal for the duration of its DOF in the lot until finished weight.

As previously mentioned, a potential limiting factor to the profitability of extending DOF is the marginal cost of feeding that animal one more day and the change in the associated average daily gain. As corn is the driving input for most commercial feedlot rations (92%) the historical prices for grain corn in dollars/bushel were converted to a price per ton by dividing 2000 (lbs in 1 ton) by 56 (lbs in 1 bushel of corn) and then multiplying the result by the price of flaked grain corn in dollars/bushel (USDA-NASS) for a total of $185.00 per dry ton. This tonnage price was then

Table 5: *Ration Calculator: Adjusted to Dry Matter Content*

Ingredients				% of Ration		
Name	**Moisture %**	**Price/Ton**	**Dry Matter Price/Ton**	**Dry Matter**	**As Fed**	**Price/Ton**
Alfalfa Hay	10.00%	$ 200.00	$ 222.22	3.00%	3.00%	**$ 6.67**
Flaked Corn	22.00%	$ 185.00	$ 237.18	69.00%	68.99%	**$ 163.65**
Silage	65.00%	$ 50.00	$ 142.86	4.00%	4.02%	**$ 5.71**
Dried Distillers Grains	10.00%	$ 265.00	$ 294.44	2.00%	2.00%	**$ 5.89**
Finish Supplement	5.00%	$ 285.00	$ 300.00	3.00%	2.99%	**$ 9.00**
High Moisture Corn	27.00%	$ 185.00	$ 253.42	17.00%	17.01%	**$ 43.08**
Fat	2.00%	$ 1,020.00	$1,040.82	2.00%	2.00%	**$ 20.82**
					Dry Matter - Price/Ton	**$ 254.82**

used in a ration calculator to determine a dry matter price per ton (see ***Table 5***). Converting to a price per ton of dry matter accounts for differing levels of moisture content across the ingredients in the ration, and at the end of the day cattle eat until their dry matter dietary needs are met. This approach makes it possible to use the DMI variable for each observation to calculate the individual cost of feeding through the duration of their time at the feedlot. Because corn makes up over 90 percent of the ration fed to the animals a static price was used for the other ingredients that make up the remaining 10 percent as corn is the main driver of volatility in ration price. The dry matter tonnage price ($254.82) was then used to calculate the *Total Feed* Cost based on the *Dry Matter Intake (Lbs/day)* variable per observation. A yardage fee was assessed at $0.65 multiplied by number of DOF per observation along with $22.00 per head for veterinary services. The summation of these two costs, and *Total Feed Cost,* equates to the *Total Feedlot Cost*.

To explore the presence and effects of seasonality on the marketing of fed cattle, data from (Mo182 Kansas Fats. LMIC 2024) were employed. Monthly historical prices corresponding to the time frame covered in the dataset were analyzed to calculate an average live price for each month of the year. This methodology aimed to capture potential seasonal fluctuations in cattle pricing. Following this, the *base live cattle price* for each month was divided by the *base hot yield threshold* from the sample grid pricing system utilized in the analysis (*see **Table 5***). This calculation resulted in the *base hot carcass price*. This step was crucial as it adjusted the live cattle price to a standardized measure that reflects the value after processing, providing a clearer picture of market dynamics on a carcass basis. The calculated *base hot carcass*, and *base live cattle prices* are presented in ***Figure 3***. This visual representation helps illustrate any seasonal trends in pricing, highlighting specific months where prices might peak or dip, which is instrumental for strategic planning and market analysis in the commercial cattle feeding industry.

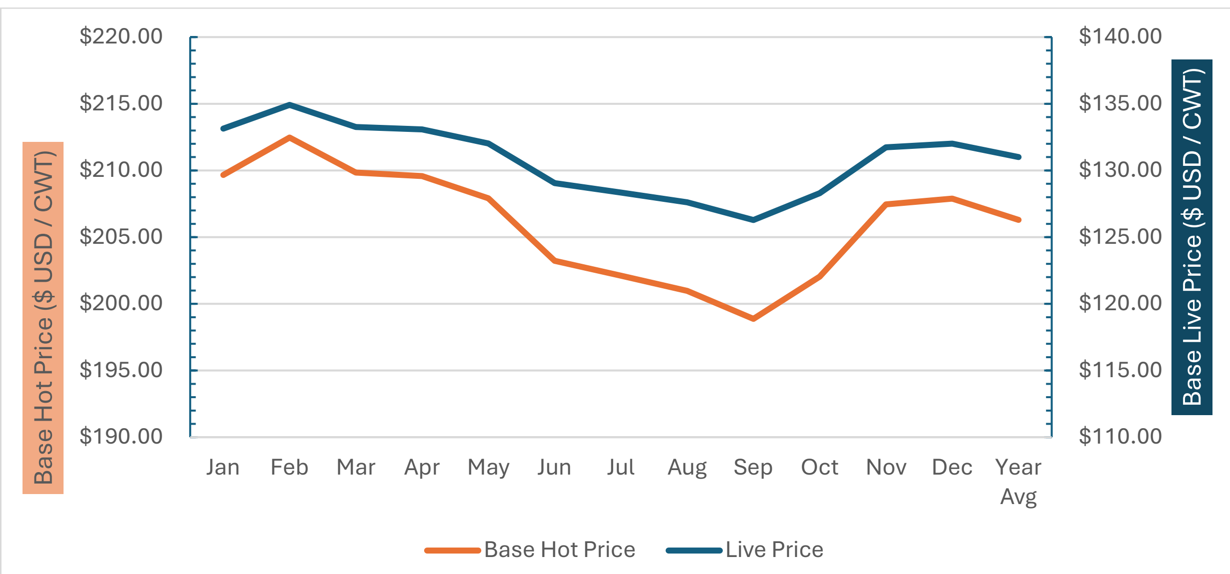

Figure 3: *Kansas - Monthly Average Base Live & Hot Cattle Prices $ / CWT (2010-2023)*

To determine the *Average Total Revenue*, the *base live price* from ***Figure 3*** was used based on the *Closedate_Month* the observation was harvested. A grid uses current market prices for live cattle and a standard *hot yield threshold* negotiated in the contract to establish a base *hot carcass price*. This base price is then adjusted through a series of premiums and discounts dependent upon the biometrics of the cattle harvested.

Table 6: *Quality Grade – Grid Pricing System: Adj. Hot Carcass Price Calculation*

Category	Prem/Disc	Base Threshold	Example Acutal	Realized Prem/Disc	Base Live Price
Quality Grade - Prime	$ 20.00	1.12%	5.61%	$ 0.90	$ 131.00
Quality Grade - Choice	$ 25.00	62.31%	85.34%	$ 5.76	**Hot Yield Threshold**
Quality Grade - Ungraded	$ (8.00)	0.97%	0.00%	$ -	63.5%
Certified Angus Beef	$ 4.00	0%	39.15%	$ 1.57	**Base Hot Carcass Price**
Yield Grade 1	$ 4.00	9.83%	0.00%	$ -	$ 206.30
Yield Grade 2	$ 2.50	37.79%	19.60%	$ -	**Sum Prem/Disc**
Yield Grade 4	$ (7.00)	11.51%	21.27%	$ (0.68)	$ 7.54
Yield Grade 5	$ (14.00)	1.19%	0.00%	$ -	**Adj. Hot Carcass Price**
Heavies	$ (15.00)	0.26%	0.00%	$ -	$ 213.84

The *Adjusted Hot Carcas Price* (Adj HCW) is another critical metric that is unique to every observation in the data set. This metric is an output of the quality grade grid pricing system. A quality grade grid pricing system is an integral mechanism within the beef industry, aiming to align the value of beef carcasses with their quality attributes (see ***Table 6***). This system used by processors to contract with commercial feeders, meticulously categorizes carcasses based on a spectrum of quality grades and assigns a price adjustment of premiums or discounts correlating to each grade.

The initial step in this process is establishing a base price reflective of an average carcass. The base live price is then divided by a standard *hot yield threshold* or *dressing percentage* (DP - percent of live weight marketable) and this yields a *base hot price*. Subsequently, premiums are added for carcasses exceeding the base quality criteria, while discounts are applied to those that fall short. For instance, carcasses graded as "Prime" or "Choice" due to superior marbling bring a premium, while those with less desirable traits, such as being "Ungraded" or "Hard Bone," may incur a discount. A *base threshold* is established for each category. Every pen of cattle that is harvested is tracked and recorded, noting the percentage of the pen that falls into various quality and yield grades. Any amount from the actual percentage exceeding the base threshold is multiplied by the premium or discount. For example, in ***Table 6***, 5.61% of a hypothetical pen cattle graded prime. This sample grid states that the processor expects every pen of cattle they harvest to have at the minimum 1.12% of cattle grade “Prime,” thus anything exceeding the threshold will be paid a premium.

The sum of the premiums and discounts is added to the *base hot carcass price*. The result is an *Adjusted Hot Carcass Price*, which is the final price of the animal dressed, accounting for these adjustments. The Adj HCW price is then multiplied by the avg carcass weight of the pen that was harvested to determine *Average Total Revenue*. This system not only incentivizes producers to enhance meat quality but also enables a nuanced approach to pricing that can directly affect profitability. When exploring the impacts of extending days on feed, this pricing system becomes especially pertinent, as longer feeding periods could potentially improve quality grades (Galyean et al.), thereby influencing the overall profitability of the operation.

Descriptive Statistics:

To explore the data and become familiar with the variables that will be used in the analysis of factors that affect profit per head, descriptive statistics provide quality insights. The scatter plot for DOF against Profit_Hd (***Figure 4***) reveals a dispersed relationship, suggesting a complex interplay between feeding duration and profitability, with evidence of a slightly negative linear trend.

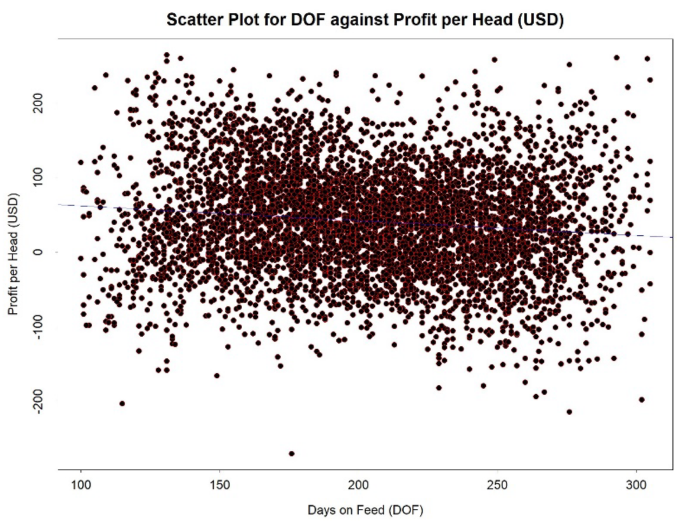

Figure 4: *Scatter plot DOF vs Profit / Head*

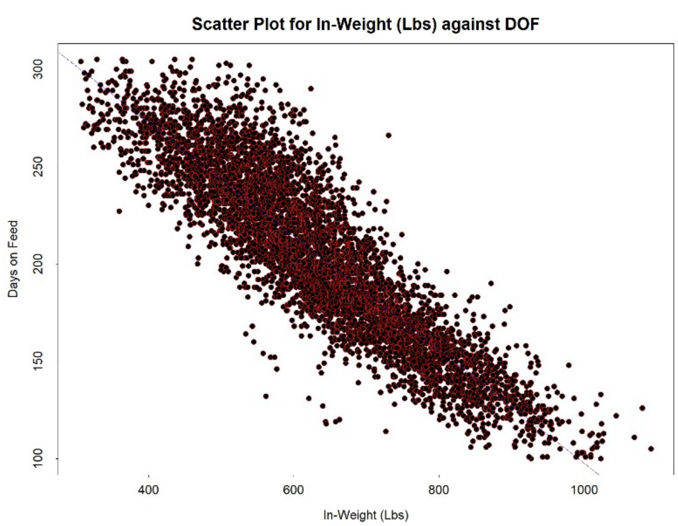

Figure 5: *Scatter plot DOF vs In-Weight (Lbs)*

Similarly, the scatter plot for DOF against In-weight illustrates a decrease in initial weight with increased feeding days, indicating that cattle entering the feedlot at higher weights tend to have shorter feeding periods (***Figure 5***).

Figure 6 Represents a scatterplot of Out-weight against profit per head. This plot shows a linear trend of increasing profits with heavier sale weights. This may explain the industry trend of longer DOF, which ultimately leads to heavier Out-weight.

Average Daily Gain (ADG) is another key metric for this analysis. As variable that represents performance and efficiency in the feedyard, it was included the study by Mark et al. There is a clear positive linear trend in the scatterplot of ADG against profit per head (***see Figure 7***).

The boxplot of DOF conditional on breed category unveils significant variability in feeding durations among breeds, with some breeds tending to have longer feeding periods than others. This underscores the influence of breed-specific growth patterns and market preferences on feeding strategies (***Figure 8***).

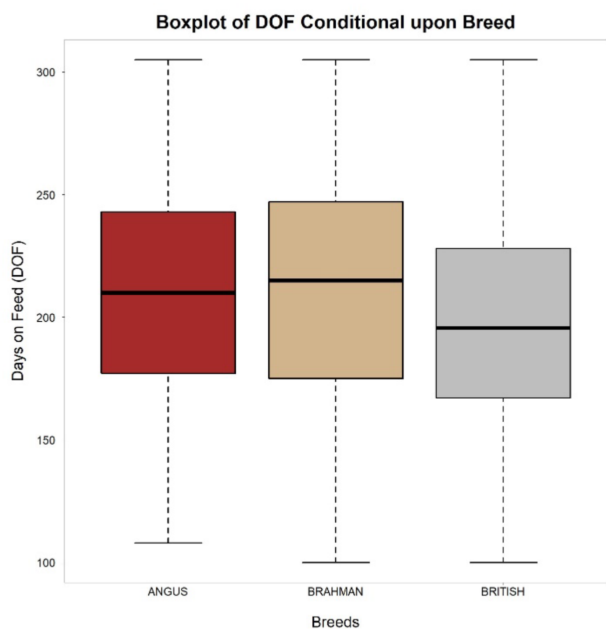

Figure 8: *Boxplot of Days on Feed by Breed*

Additionally, the following variables are all critical to this analysis for calculation of profit per head and use to control for in the regression model. The histograms of each offer a graphical summary of their distributions: (see **Appendix**)

Average Hot Carcass Weight (Avg HCW) (***Figure 9***), Dry Matter Intake (DMI lbs/day) (***Figure 10***), Days on Feed (DOF) (***Figure 11***), In-weight (***Figure 12***), Out-weight (***Figure 13***), Profit_Hd (***Figure 14***)

The Avg HCW histogram displays a bell-shaped distribution, suggesting a consistent carcass size across the dataset. The DMI histogram suggests a range of feed intakes, hinting at the diverse feeding regimes employed. The histograms of In-weight and Out-weight provide insight into the range of weights at entry and exit, shedding light on the growth experienced by the cattle during their time in the feedlot. Noteworthy is the wide range of in-weights from 300 -1000 lbs which will create a large variation in DOF.

The correlation analysis within the dataset provides valuable insights into the relationships between Days on Feed (DOF) and key variables such as Profit per Head, In-weight, and Out-weight. The negative correlation of -0.121 between DOF and Profit_Hd, while relatively modest, suggests that longer feeding periods may be associated with lower profits per head. This could reflect the increased costs of feeding over extended periods or the diminishing returns in weight gain efficiency, aligning with the scatter plot that did not suggest a positive trend.

A much stronger negative correlation of -0.897 between DOF and In-weight indicates a robust inverse relationship (see ***Figure 5***); cattle with higher initial weights tend to have shorter feeding durations. This relationship is visually supported by the scatter plot of DOF against In-Weight, where a trend of decreasing initial weights with longer feed days is evident, possibly suggesting a strategy to optimize the feeding period based on the animal's entry weight. Similarly, the correlation of -0.281 between DOF and Out-weight suggests that as DOF increases, the Out-weight of the cattle only slightly decreases. This could imply a point of diminishing returns where extended feeding does not correspond to proportional weight gains, which could be reflective of biometric limits in weight gain efficiency.

In the context of ***Figure 9-13***, these correlations further substantiate the nuanced relationship between the duration of feeding and both the physical growth metrics and the financial outcomes of the cattle. The histograms for Avg HCW, DMI, In-weight, Out-weight, and Profit-Hd provide a backdrop for understanding the distribution of these variables across the dataset. Collectively, these descriptive analyses set the stage for more nuanced regression modeling, allowing for an informed approach to assessing the impact of dummy variables for thresholds of DOF on profit per head. By appreciating the breadth of the data through these visualizations, we gain crucial context for the subsequent causal investigation.

To assess the impact on profitability based on the background of feeder animals before they enter the finishing yard, the dataset categorizes the calves' pre-feedlot experiences into five distinct backgrounds. Each background represents a different pre-feedlot management strategy, which is crucial for understanding the initial condition and potential performance of the calves in the feedlot. Here is a breakdown of these categories:

1. **BAWLCF:** This category includes calves that are sent directly to the feedyard from the ranch without prior weaning elsewhere. They are weaned the day they are shipped to the yard, entering the feedlot at their weaning weight, which typically ranges from 400-600 pounds.

2. **GRASS:** Represents calves that are weaned and then moved to a stocker operation, where they are allowed to graze on spring or fall pasture. This background is intended to allow calves to grow their frames naturally.
3. **WHEAT:** Like the GRASS option, but specifically involves calves grazing on winter wheat cover crops.
4. **GROWYD:** This option pertains to calves that are shipped to a facility similar to a feedlot, where they are fed a low-input complete ration in a pen for several months.
5. **PRECON:** Calves in this category are weaned on the ranch and preconditioned with pasture and grain, aiming for a heavier shipping weight as they enter the feedlot.

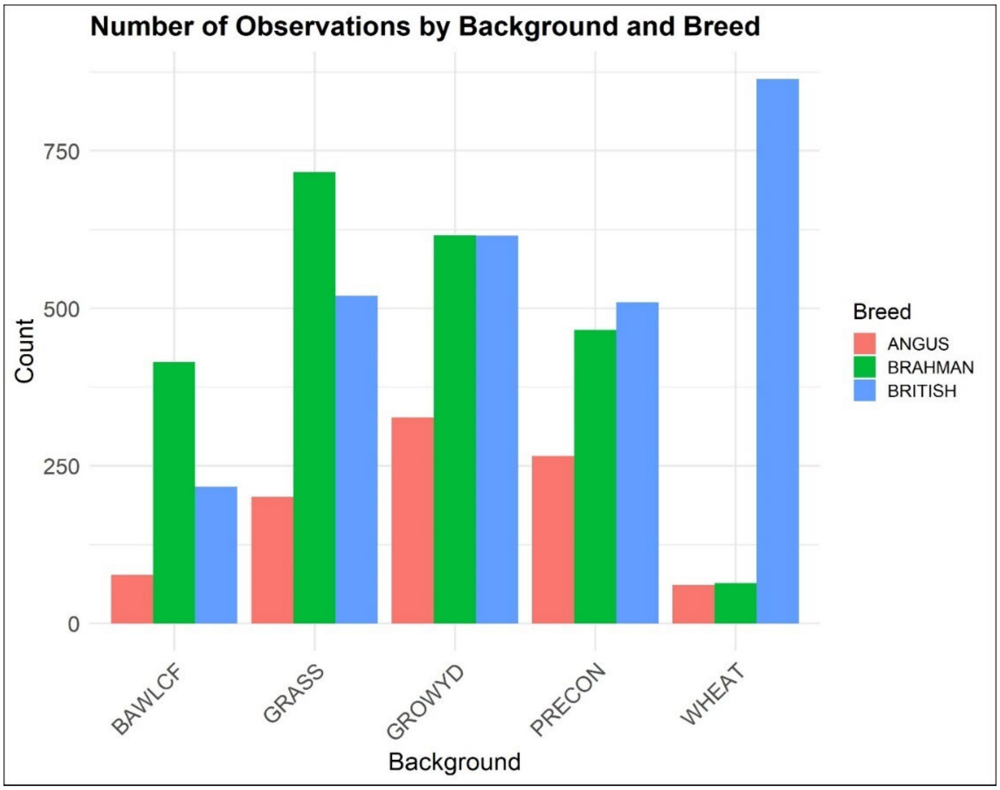

Figure 14: *Count of Observations by Background and Breed*

To visually analyze the distribution and potential influence of these background types, a bar chart has been created to depict the number of observations by each background type for the various breeds found in the dataset (shown in **Figure 14**). This visualization helps in identifying which backgrounds are most consistently used across different breed types, with notable consistency in the categories of Grass, Grow yard, and Preconditioning.

This aspect of the analysis is vital, as it allows for the examination of how different pre-feedlot management strategies might affect the calves' growth, health, and subsequent profitability in the finishing phase. Understanding these dynamics can provide valuable insights into optimal management practices that could enhance overall profitability in cattle feeding operations.

Methods:

In the analytical framework of the current study, certain variables have been selected for their relevance as efficiency metrics within the cattle feeding profitability model. These variables are indicative of genetic factors, breeding quality, and performance within the feedyard environment. In alignment with precedent research by Mark et al., average daily gain and dry matter conversion are considered key efficiency metrics. These variables have historically been utilized as indicators of feedyard performance and efficiency, which is why they have been incorporated into this model. Also employed by previous studies are the price metrics of feeder cattle price, and feed cost. The Adj. HCW variable is comparable to the fed cattle price used in other studies, however it reflects a price driven by the quality metrics of fed cattle.

Additionally, dressing percentage and various quality metrics have been included to provide a foundational understanding of the relationship between extended days on feed and cattle performance. This inclusion is based on findings from studies such as those conducted by Gaylean et al., which established a correlation between extended feeding periods and improvements in both dressing percentage and meat quality metrics. Such variables are crucial for assessing the direct and indirect impacts on profitability, offering a comprehensive view of how incremental feeding days contribute to economic outcomes in cattle production.

Table 7. List of Metrics Types for use in Analysis

Efficiency Metrics	**Quality Metrics**	**Price Metrics**
Avg Daily Gain (lbs)	% Cert. Angus Beef	Adj. Hot Carcass Weight Price
Dry Matter Conversion	% Prime	Feeder Cattle Price
Dressing Percentage	% Yield Grade 4	Feed Cost
	% Yield Grade 5	

In this study the first objective is to identify the factors that affect profits per head and the magnitude of their impact with respect to lengthier feeding periods than the analyses conducted by (Mark et al. 2000) and (Janzen et al. 2016). Regressing cattle feeding efficiency metrics, price metrics, and quality metrics on profit per head. The inclusion of that control for breed, sex, background, and seasonality will help answer sub objectives outlined in the introduction. These variables will form the basis of my primary hypothesis (H1) that each will show a significant difference in the outcome of profit per head. The following ***Table 8*** represents the variables in the first model.

Table 8. List of Variables - Factors Affecting Cattle Feeding Profit/ Hd (USD) using Average Daily Gain & Days on Feed			
Variable	**Classification**	**Mean**	**SD**
Profit per Head (Dep Var.)	Continuous	41.86	70.21
Days on Feed	Continuous	204.02	43.53
Avg Daily Gain (lbs)	Continuous	3.22	0.45
Dry Matter Conversion	Continuous	6.16	0.54
Adj. Hot Carcass Weight Price	Continuous	209.36	5.26
Breed Angus	Categorical	15.9%	-
Breed British	Categorical	46.0%	-
Sex Steer	Categorical	62.2%	-
Dressing Percentage	Continuous	64.3%	0.01
% Cert. Angus Beef	Continuous	15.5%	0.13
% Prime	Continuous	2.3%	0.04
% Yield Grade 4	Continuous	12.9%	0.09
% Yield Grade 5	Continuous	1.5%	0.02
Summer Months	Categorical	41.3%	-
Background Grass	Categorical	23.7%	-
Background Growyard	Categorical	26.5%	-
Background Pre-Condition	Categorical	21.3%	-
Background Wheat	Categorical	16.7%	-

To test this hypothesis, the corresponding null hypothesis (H0) is established, which posits that each of the variables in ***Table 8*** have no effect on profits per head. This null hypothesis represents a scenario where there is no relationship, or a zero relationship, between the said variable and profitability. During statistical testing, this null hypothesis is what will be evaluated against. Should the analysis reveal that the data significantly contradict the null hypothesis, it would then support the alternative hypothesis that said variables are indeed associated with impacts to profits. The first Regression uses ADG, and the second utilizes the variable DOF. They could not be included in the same model due to a problem with multicollinearity.

As a part of the analysis, the regression equation to represent the variables in the model looks like the following for Model 1 of ***Table 9***:

Profit Hd it = $\beta 0$ + $\beta 1$*(**Avg Daily Gain i**) + $\beta 2$*(**Dry Matter Conversion i**) +

$\beta 3$*(**Adj. Hot Carcass Weight Price i**) + $\beta 4$*(**Breed Angus i**) +

$\beta 5$*(**Breed British i**) + $\beta 6$*(**Sex Steer i**) + $\beta 7$*(**Dressing Percentage i**) +

β8*(**% Cert. Angus Beef i**) + β9*(**% Prime i**) + β10*(**% Yield Grade 4 i**) +

β11*(**% Yield Grade 5 i**) + β12*(**Summer Months i**) + β13*(**Background Grass i**) +

β14*(**Background Growyard i**) + β15*(**Background Pre-Condition i**) +

β16*(**Background Wheat i)** + ***ε it***

- ***Profit_Hd_it-*** is the profit per head for observation i at time t.
- ***Average_Daily_Gain_i*** - is an efficiency metric, measuring Lbs of weight gain per day for an observation i.
    - A second regression (in ***Table 10)*** follows this same equation, only switching ***Average_Daily_Gain_i*** for use of the variable ***Days on Feed i.*** Which represents the number of days an observation i was on feed.
- ***Dry_Matter_Conversion_i*** – is an efficiency metric that represents the feed conversion (a biometric used when feeding cattle) for observation i.
- ***Adj_Hot_Carcass_Weight_Price_i*** – is a price metric that represents the price per cwt of the hot carcass for observation i.
- ***Breed_i*** - represents a series of dummy variables for each cattle breed in the dataset, Compared to the base (***Breed_Brahman_i***).
- ***Sex_Steers_i*** - is a dummy variable for the sex of the cattle as compared to the base (***Sex_Heifers_i***)
- ***Dressing_Percentage_i*** - is an efficiency metric that represents the dressing percentage (a biometric used when feeding cattle) for observation i.
- ***%_Cert_Angus_Beef_i*** – is a quality metric that represents the percentage of the observation i that qualifies as Certified Angus Beef.
- ***%_Prime_i*** – is a quality metric that represents the percentage of the observation i that grades Prime.
- ***%_Yield_Grade_4_i*** – is a quality metric that represents the percentage of the observation i that yields grade 4.
- ***%_Yield_Grade_5_i*** – is a quality metric that represents the percentage of the observation i that yields grade 5.
- ***Summer_Months_i*** – represents a dummy variable that denotes cattle marketed/harvested in months June through September for observation i.
- ***Background_**** - denotes backgrounding history category dummy variables as compared to the base (***Background_Bawling_Calf_i***).

- ***β0*** - is the constant term.
- ***β1*** to ***β16*** - are the coefficients to be estimated.
- ***ε_it*** is the error term for observation i at time t.

All the variables in both Models are expected to be positively related to Profit / Hd except for Dry Matter Conversion and Summer Months. As Dry Matter Conversion decreases (i.e., improves), profit is expected to increase (Mark et al. 2000). Summer Months are expected to be negative relative to profit due to potential seasonal lows in the base live price of fed cattle. Breed Angus and British are expected to be positive in their coefficient parameters as these breed types are typically more efficient in the feedyard compared to Brahman influenced cattle as the base case. Yield Grade 4 and 5 are expected to be positive, as Gaylean et al. highlighted a noticeable increase in yield grades 4 and 5 with prolonged feeding periods, reflecting greater carcass fatness, thus potentially increasing quality metrics and profit per head. Sex Steers is also expected to be positive relative to profit as steers typically perform more efficient in the feedyard and finish at heavier weights compared to heifers (Janzen et al. 2016).

As it is difficult to compare variables with different units of measure and following the procedures of Mark et al. and Janzen et al. Standardized Beta Coefficients were computed to compare metrics using the following equation:

$$\beta \text{ SBC} = (\beta i \times \sigma X i) / \sigma Y$$

Where:

- β SBC is the standardized beta coefficient.
- βi is the raw (unstandardized) regression coefficient from the regression model for the i^{th} independent variable X
- σX is the standard deviation of the i^{th} independent variable X.
- σY is the standard deviation of the dependent variable Y.
- SBC is computed by multiplying the beta coefficient for the i^{th} independent variable by the standard deviation of the i^{th} independent variable, all divided by the standard deviation of the dependent variable (Profit / Hd) (Janzen et al. 2016).

To compare the SBC to each other within the same model and determine whether they were statistically different, t-values were computed using the following equation at the five percent significance level:

$$t = (\beta i - \beta j) / SEi$$

Where :

- t is the t-value of the comparison for two independent variables within the same model
- The j^{th} independent variable is subtracted from the i^{th} independent variable which is all. divided by the standard error (SE) of the i^{th} independent variable (Janzen et al. 2016)

To compare SBC across different models t-values were also calculated following a similar procedure show below:

$t = (\beta i,k - \beta i,l) / SEi,k$

Where :

- *k* denotes the first model for the i^{th} independent variable, and *l* denotes the second model for the same i^{th} independent variable

Results & Implications Chapter

Results:

The comparative analysis of the regression models aimed at evaluating the influence of efficiency, quality, and price metrics on Profit per Head (Profit / Hd) yields compelling insights. Model 1 emerges as a robust model for several reasons. Foremost among them is the explanatory power of Model 1, as indicated by its Adjusted R-squared value of 78.1%.

Table 9. Regression Output: Factors Affecting Cattle Feeding Profit / Head (USD) using Average Daily Gain

N Observations:	5,768	5,768			
Adj R-squared:	77.8%	78.1%			
Variable	Parameter Estimate (Profit_Hd)		Significance	Std. Error	SBC
	Model 1				
Avg Daily Gain (lbs)	53.158		***	-1.659	0.3407
Dry Matter Conversion	-59.238		***	-1.188	0.4556
Adj. Hot Carcass Weight Price	6.415		***	-0.153	0.4806
Breed Angus	2.977		*	-1.727	-
Breed British	11.547		***	-1.52	-
Sex Steer	-57.932		***	-1.089	-
Dressing Percentage	783.511		***	-49.249	0.1172
% Cert. Angus Beef	44.959		***	-6.153	0.0839
% Prime	60.259		***	-13.942	0.0318
% Yield Grade 4	24.546		***	-7.513	0.0311
% Yield Grade 5	169.976		***	-25.672	0.0552
Summer Months	-7.219		***	-1.476	-
Background Grass	4.528		**	-2.012	-
Background Growyard	-4.546		***	-1.657	-
Background Pre-Condition	6.071		***	-1.732	-
Background Wheat	3.865		*	-1.976	-
Constant	-1,594.34		***	-50.284	-

Note: Significance of Parameter Coefficients - *** = .01, ** = .05, * = .10

Note: Significance of SBC - All efficiency & quality metrics are significant compared to price metrics at the .01 level

Regression output in ***Table 9*** details how different metrics influence profitability within the context of cattle feeding operations, as measured by Profit per Head (Profit / Hd). The regression output, which takes Average Daily Gain into account, reveals nuanced insights into the relative importance of various metrics. Notably, the price metric, represented by Adjusted Hot Carcass Weight (Adj. HCW) price, holds a slightly more substantial impact on profitability with a Standardized Beta Coefficient (SBC) of .48. This suggests that changes in the Adj. HCW price have a slightly stronger association with profit variations than the efficiency metric of Dry Matter Conversion, which possesses an SBC of .45.

Following closely is the Average Daily Gain, with an SBC of .34, affirming its significant yet slightly less pronounced role in driving profitability. These efficiency metrics play a critical role, but the difference in their SBCs points to a more complex relationship with profit outcomes than a singular focus on any one factor would suggest.

Additionally, quality metrics like the percentage of Certified Angus Beef (% CAB) and the percentage of Prime-grade meat (% Prime) also emerge as significant factors. These metrics, though influential, do not match the impact level of the efficiency factors, highlighting that while quality is undeniably important for profitability, it is the efficiency metrics that slightly edge out in terms of their contribution.

Similar findings stemmed from the Regression output of Factors Affecting Profit per Head using Days on Feed shown in ***Table 10***. The quality metrics had the smallest impact on profit per head overall. However, this output shows Dry Matter Conversion has driving a greater impact on profit compared to the price metric of Adj HCW price, with an SBC of .61 to .45 respectively. It is important to note that the impact of DOF (SBC .11) compared to ADG (SBC .34) from the first regression model is not as strong. This may be associated with the overall Adj R-squared for the model using DOF of 74.8% compared to the Regression using ADG which has an Adj R-squared of 78%.

The coefficient for DOF was opposite in sign for the prediction. This was a surprise as it suggests that all else constant, an additional day on feed for an observation leads to a loss of $0.18 in profit per head. However, it is important to note that in this regression model, in-weight is not accounted for (due to issues of multicollinearity); but ***Figure 4*** shows a slight trend that as DOF increases profit slightly decreases, and ***Figure 5*** demonstrates that as in-weight increases DOF also increases. This shows that by not controlling the large spread of in-weight with observations ranging from 300 lbs up to 1000 lbs there could be related bias to the coefficient for Days on Feed.

Table 10. Regression Output: Factors Affecting Cattle Feeding Profit / Head (USD) using Days on Feed				
N Observations:	5,768 5,768			
Adj R-squared:	73.1% 74.8%			
Variable	Parameter Estimate (Profit_Hd)	Significance	Std. Error	SBC
	Model 2			
Days on Feed	-0.187	***	-0.016	0.0000
Dry Matter Conversion	-80.241	***	-1.138	0.0000
Adj. Hot Carcass Weight Price	6.098		-0.163	0.0000
Breed Angus	8.114	***	-1.851	-
Breed British	21.880	***	-1.603	-
Sex Steer	-46.705	***	-1.108	-
Dressing Percentage	629.362	***	-53.522	0.0000
% Cert. Angus Beef	27.725	***	-6.592	0.0000
% Prime	43.732	***	-15.175	0.0000
% Yield Grade 4	52.960	***	-8.014	0.0000
% Yield Grade 5	213.966	***	-27.627	0.0000
Summer Months	-13.128	***	-1.588	-
Background Grass	30.680	***	-2.054	-
Background Growyard	1.769	-	-1.837	-
Background Pre-Condition	15.893	***	-1.842	-
Background Wheat	20.056	-	-2.092	-
Constant	-1113.820	***	-51.148	-
Note: Significance of Parameter Coefficients - *** = .01, ** = .05, * = .10				
Note: Significance of SBC - All efficiency & quality metrics are significant compared to price metrics at the .01 level				

The analysis of the regression model in ***Table 9*** provides a substantive test of the hypothesized relationships between various variables and Profit per Head (Profit / Hd) in the cattle feeding industry. The results enable us to decisively reject the null hypothesis for most of the variables under scrutiny, indicating that they have a statistically significant impact on profitability that is not due to random chance.

However, exceptions to this pattern arise with the variables Sex Steer and Background Growyard, both of which diverge from the expected positive relationship. Instead, their negative coefficients, -57.93 for Sex Steer and -4.54 for Background Growyard, suggest that ceteris paribus, being a Steer is associated with a decrease in profit per head by $57.93, and having a background in a growyard before transitioning to a finishing yard is associated with a reduction in profit per head by $4.54. Another view of the data as shown in ***Figure 15*** would support this parameter sign for Sex Steer to be negative.

With respect to the sub-objective of determining profit per head by sex, the negative coefficient associated with Sex Steer provides an intriguing perspective. The model accounts for the

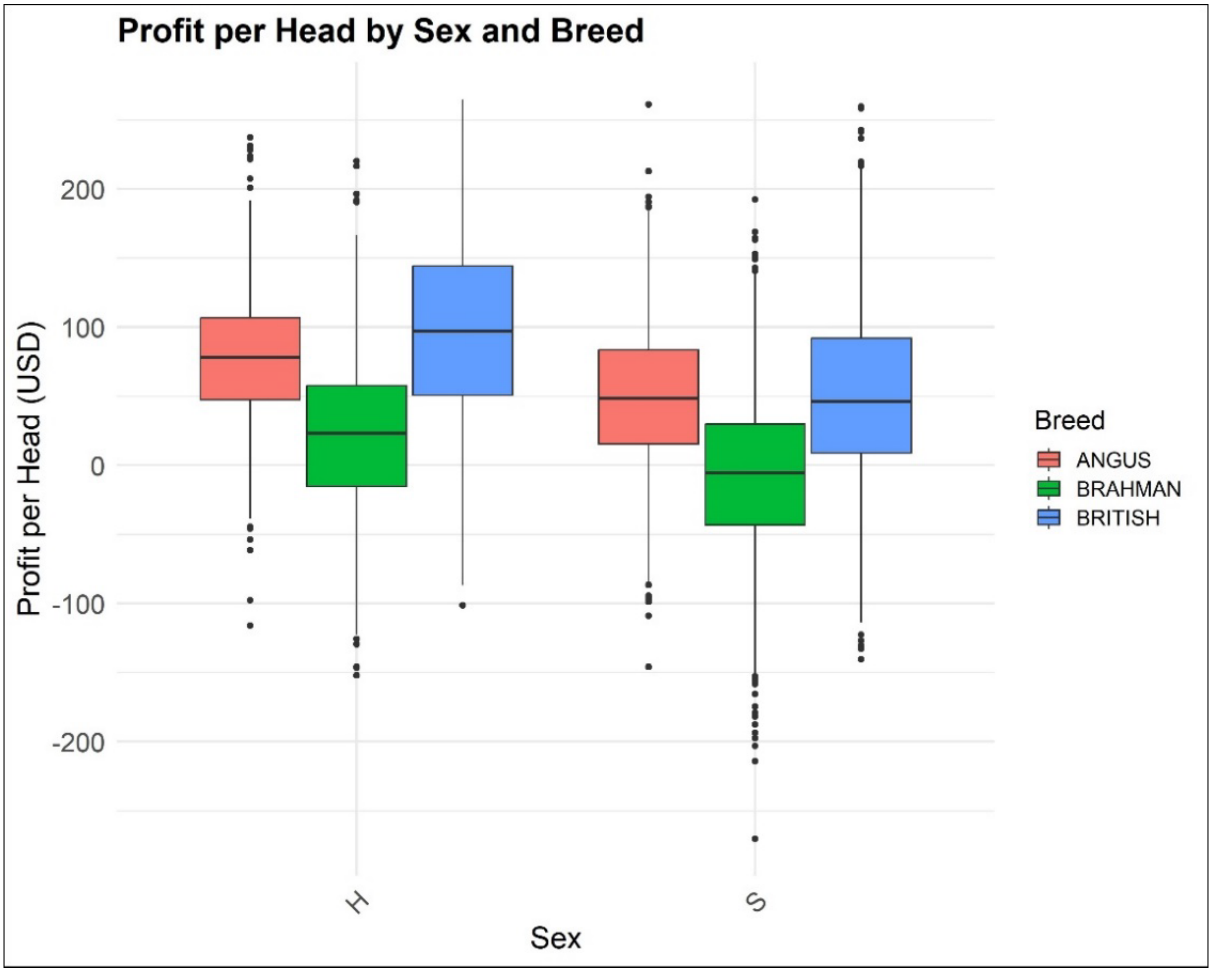

Figure 15: *Boxplot of Profit / Hd by Sex and Breed*

market's differential pricing between steers and heifers using feeder cattle prices (see ***Figure 2***), which reflects a cash market slide. Despite the commonly held view that steers tend to perform more efficiently in feedyards and achieve heavier finishing weights, the marketplace appears to impose a greater discount on heifers than their performance in the feedyard would justify. This suggests that the market may undervalue heifers relative to steers, not fully recognizing the potential economic contributions of heifers to the profitability per head. While steers are traditionally seen as yielding better yard performance, the market's pricing does not seem to compensate them proportionally, thereby affecting their profitability when compared to heifers.

The analysis of how an animal's background affects profitability per head reveals that, generally, cattle with some form of backgrounding experience tend to yield higher profits when compared to those sent directly to the feedyard as bawling calves. This trend holds true with the notable

exception of cattle from growyards. This outcome indicates that while backgrounding can enhance profitability, the specific conditions, and practices of growyards may not contribute positively to all cases.

The findings related to growyard background's impact on profit per head bring forth complex implications. The negative coefficient associated with growyard background underlines the need for a thorough examination of the growyard experience's specifics. It is imperative to acknowledge that the notion of a growyard experience is defined within the context of the dataset employed for this study. Such specificity of definition may not be reflective of the broader industry standards and thus could limit the applicability of the findings outside the dataset's originating business.

In the regression outputs, the variable 'Background Growyard' from ***Table 9*** do not possess the same positive sign as the other background variables, which suggests that, within this model, the growyard background does not have a positive impact on profit per head.

These contrasting results underscore the nuanced role that distinct types of backgrounding experiences play in influencing profit per head. Specifically, they highlight that the growyard experience—unique to this dataset—may have complex and multifaceted effects that differ from other backgrounding experiences. Therefore, when interpreting these results, one must carefully consider the nature of growyard practices and how they might diverge from other pre-feedlot strategies in terms of their economic outcomes.

Despite the lack of additional variables in the dataset to fully explain why a growyard background negatively impacts profit per head, analyzing the data by distinct types of background categories and their respective profitability outcomes can offer valuable insights. For example, as suggested in ***Figure 16***, viewing each background type alongside associated profit metrics helps elucidate the broader effects of various pre-feedlot experiences on financial outcomes.

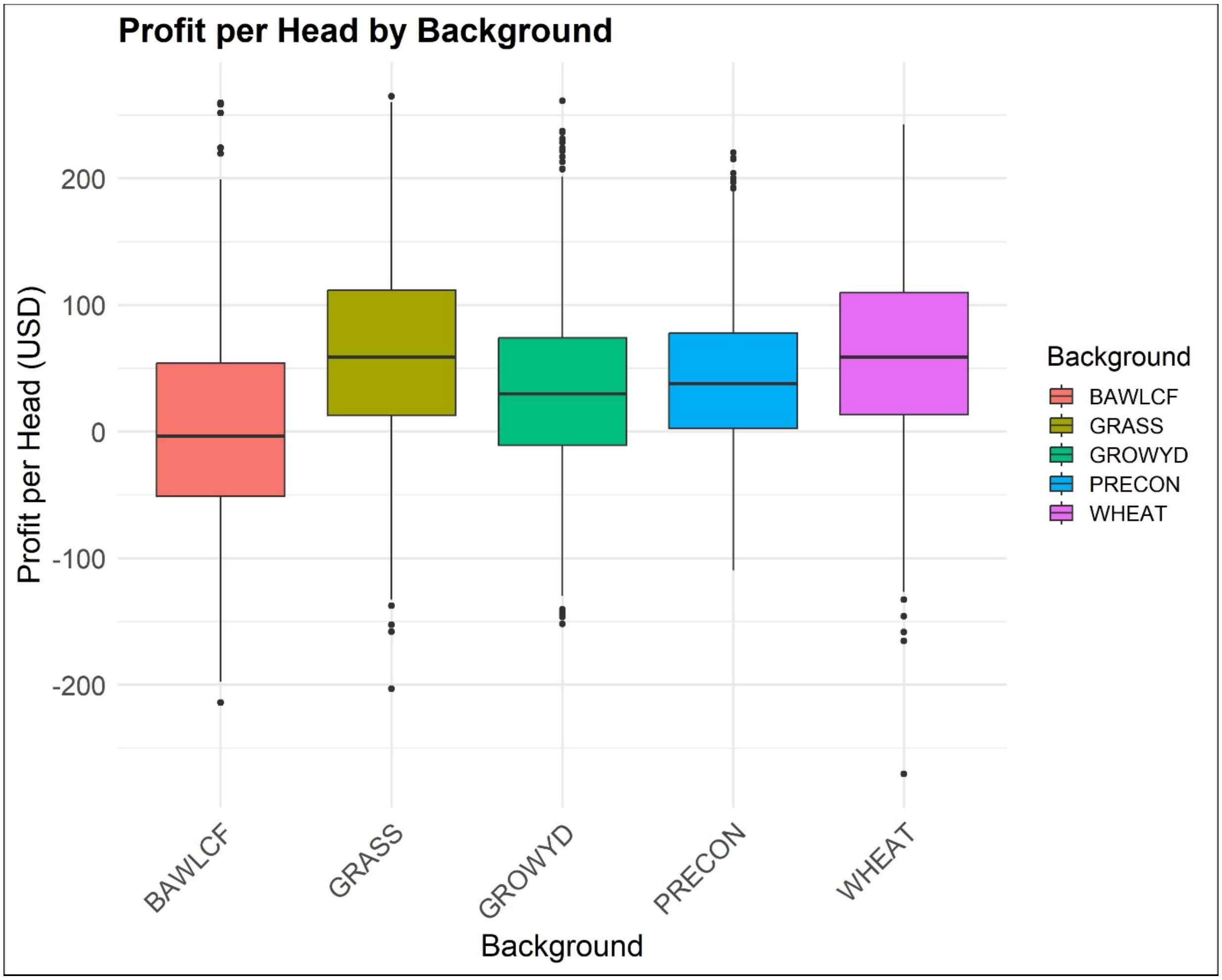

Figure 16: *Boxplot of Profit / Hd by Pre-feedlot Background Experience*

The last of the findings from the regression models displayed in ***Tables 9*** and ***10*** are the conclusions regarding the effect of seasonality on profit per head. Both returned a statistically significant negative sign on the coefficient for Summer Months, which represents marketing cattle in the months June through September. Following the stronger model, which uses ADG, suggests that all else equal marketing cattle in these months is associated with a decrease in profit per head of $7.21. This suggests that our hypothesis was correct, and the existence of seasonality is real in the marketing of fed cattle, also depicted in ***Figure 17.*** The decision to use the variable for Summer Months stemmed from a problem with multicollinearity of including a dummy variable for each month of the year with January as the base. There is a clear market low from May to September range, and seasonality peaks in the winter months with February as the highest.

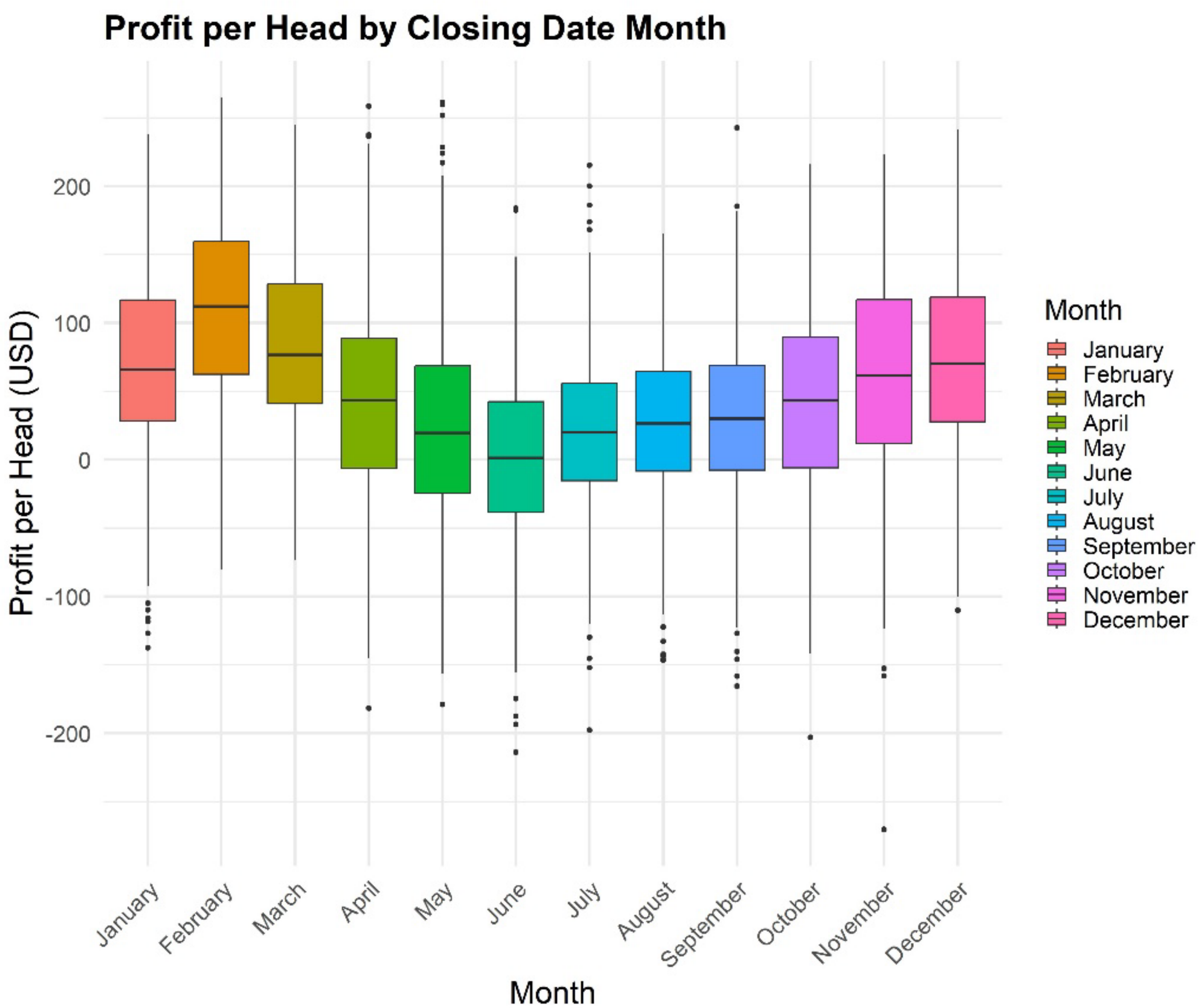

Figure 17: *Boxplot of Profit / Hd by Closedate Month*

To consider the impacts of longer DOF on profitability in a a group of cattle with similar characteristics the following regression was used with mean and standard deviation of variables in the model shown in ***Table 11*** and regression results are found in ***Table 12***. The group of cattle used for this analysis were British Steers withing 700 to 800 pound placement weights into the feedyard.

Table 11. Regression Variables - British Steers 700-800 Lbs

Variable	Classification	Mean	SD
Profit per Head	Continous	58.31	68.49
Days on Feed	Continous	167.59	12.85
Avg Daily Gain (lbs)	Continous	3.79	0.35

Dry Matter Conversion	Continous	5.96	0.40
Dressing Percentage %	Continous	0.63	0.01
Adj Hot Carcass Wt Price	Continous	209.04	5.76
Feeder Cattle Price	Continous	161.02	2.638
% Cert Angus Beef	Continous	16.00%	0.099
% Yield Grade 4	Continous	16.00%	0.085
% Yield Grade 5	Continous	1.70%	0.022
Summer Months	Categorical	35.90%	0.48
Backgrounding	Categorical	92.90%	0.256

Table 12. Regression Output: Factors Affecting Cattle Feeding Profit / Head (USD) - British Steers 700-800 Lbs

N Observations:	284			
Adj R-squared:	91.3%			
Variable	Parameter Estimate (Profit_Hd)	Significance	Std. Error	SBC
	Model 1			
Days on Feed	1.15	***	-0.134	0.216
Avg Daily Gain (lbs)	78.47	***	-6.386	0.396
Dry Matter Conversion	-69.65	***	-5.126	0.410
Dressing Percentage %	225.60	*	-134.967	0.030
Adj Hot Carcass Wt Price	8.13	***	-0.403	0.683
Feeder Cattle Price	-3.33	***	-0.575	0.128
% Cert Angus Beef	9.97	-	-16.042	0.014
% Yield Grade 4	30.94	-	-21.234	0.038
% Yield Grade 5	14.90	-	-73.146	0.005
Summer Months	-7.96	*	-4.508	0.056
Backgrounding	11.49	**	-5.318	0.043
Constant	-1338.76	***	-168.515	-

Note: Significance of Parameter Coefficients - *** = .01, ** = .05, * = .10

Note: Significance of SBC - All efficiency & quality metrics are significant compared to price metrics at the .01 level

The results in ***Table 12*** are conclusive for the variable DOF with its positive sign showing that for every day extended on feed, profitability for British steers with a placement weight between 700 and 800 pounds will on average increase by $1.15. The Adj. R-Squared for the model is very strong with explanatory power of 91.3%. It's also interesting to note the SBC for Days on Feed is

.213, the 4th highest in the model which shows the importance of considering length of feeding days when feeding cattle commercially. These results show evidence that based on high market prices for fat cattle and a grid pricing system that incentivizes quality grade, extending DOF can increase profits for commercial cattle feeders.

Implications:

This comprehensive analysis across several regression models elucidates the varied factors influencing profitability per head in cattle feeding, with a focus on efficiency, quality, and price metrics, as well as the impact of background experiences and seasonality. Here are the major findings summarized from the chapter:

1. **Model Selection and Effectiveness**:
   - The Regression model using Average Daily Gain is preferred to the model using the variable Days on Feed. This is due higher Adjusted R-squared as well as the implications of DOF and its negative sign. Because DOF is so closely dependent upon in-weight in this dataset, and the model didn't control for in-weight, the sign of the coefficient for DOF is not accurate.

2. **Influence of Metrics on Profitability**:
   - Efficiency metrics such as Average Daily Gain and Dry Matter Conversion show a strong impact on Profit / Hd, with significant but varying impacts.
   - Quality metrics like % Certified Angus Beef and % Prime also significantly affect profitability, though their impact is slightly lesser than efficiency metrics.
   - Price metrics remain the strongest impactors to profit, particularly Adjusted Hot Carcass Weight Price which has a notable but complex relationship with profitability, influenced by market dynamics and grading standards. Mark et al. and Janzen et al. both concluded the same, however the gap between price metrics impact to profit compared to efficiency metrics is much thinner than in previous studies conducted. Although the impacts of efficiency metrics on price are increasing, commercial feeder should continue to mitigate price risk, as it is still the main driver of profitability per head.
   - As a result, commercial feeders should continue to manage for the effects of efficiency metrics. Continued genetic improvements that yield positive change these metrics, and practices that improve cattle's feed efficiency are key to improving profitability per head.

3. **Background and Profitability**:
   - Cattle with some backgrounding experience generally yield higher profits compared to those sent to the feedyard as bawling calves, with the notable exception of those from growyards. This suggests that while backgrounding can be beneficial, the specific practices within growyards may not always contribute

positively, highlighting the need for a detailed examination of growyard conditions.
- The findings stress the non-uniform impact of different backgrounding experiences, indicating that the type of pre-feedlot experience can significantly alter profitability outcomes.
- Commercial feeders should given the option, consider the background history of feeder cattle they purchase to finish, as this characteristic can enhance profitability per head.

4. **Seasonality Effects**:
    - Seasonality plays a critical role, with cattle marketed during the summer months (June through September) showing a decrease in profit per head. This aligns with the hypothesis that seasonality affects cattle marketing, confirmed by significant negative coefficients for Summer Months in the regression models.
    - In the dataset analyzed, a significant 41% of cattle were marketed during the summer months of June, July, August, and September. Notably, these months constitute only 33% of the year, indicating an overrepresentation of summer sales by 8% compared to an even distribution throughout the year. The impact of this timing is highlighted in the regression results, where the coefficient for summer months in Model 2 from the Average Daily Gain (ADG) regression is -13.12. This figure suggests that, on average, cattle sold during the summer months generate $13.12 less profit per head than those sold in other months.
    - This discrepancy points to a strategic opportunity for the commercial feedyard. By adjusting their marketing strategy to reduce the proportion of cattle sold during the less profitable summer months, the feedyard could potentially enhance its overall profitability. Such an adjustment would involve either shifting the timing of sales to months with higher profit margins or modifying feeding and management practices to align the peak readiness of cattle for market outside the summer period. This strategic shift could help mitigate the seasonal impact on profits and capitalize on more favorable market conditions during other parts of the year.

5. **Challenges in Analysis**:
    - The analysis encounters issues such as multicollinearity when multiple time variables are included, necessitating the use of a single variable for Summer Months to capture the seasonal impact effectively.
    - The exploration of the effects of extended Days on Feed (DOF) on profitability was not comprehensively assessed across all breeds in this study apart from the regression results in ***Table 12*** due to dataset limitations, specifically the lack of variation in DOF all groups of cattle with similar in-weights. Consequently, the potential causal relationships and true implications of extended DOF on profit per head remain underexplored. To address this gap, future research could focus on a

more controlled study design. This would involve collecting data from a cohort of cattle that are fed for varying lengths of DOF but are homogeneous in terms of in-weights and breed. Such a study would allow for a clearer analysis of how extended feeding periods affect profitability, providing valuable insights into optimal feeding durations and their economic impacts. This approach would not only help isolate the effects of DOF from other confounding factors but also enhance the understanding of feed efficiency and growth patterns in relation to market and health outcomes, ultimately aiding stakeholders in making more informed management decisions.

6. **Implications for Cattle Marketing**:
    - These findings underscore the importance of considering a range of factors from genetics and feed efficiency to market timing and backgrounding practices in optimizing profitability in cattle feeding operations.

This analysis provides valuable insights into the complex dynamics influencing profitability in cattle feeding. It highlights the multifaceted nature of the industry, underscoring the variety of factors—ranging from feeding durations and market timing to genetic and environmental considerations—that can significantly impact economic outcomes. By identifying these diverse levers, the study equips stakeholders with the knowledge needed to make informed decisions that could lead to enhanced profitability. These findings not only deepen our understanding of the economic forces at play in cattle feeding but also suggest practical strategies for industry participants to optimize their operations and financial performance.

References

Bertelsen, Brian. "The Economics of Days on Feed." *VP Field Operations*. Accessed at https://www.uspb.com/DocumentItem.aspx?ID=72[60†source].

"Combined Auction KS." *Livestock Marketing Information Center*, Livestock Marketing Information Center, 3 Jan. 2024, https://lmic.info/members-only/members-only-spreadsheets/spreadsheets-cattle/CombinedAuctionKS.xlsx. Accessed 29 Mar. 2024.

Crawford, Grant. (n.d.). Economics of extending days on feed. Merck Animal Health USA. Retrieved October 27, 2023, from https://www.merck-animal-health-usa.com/species/cattle/cattle-insights/beef/economics-extending-days-on-feed

Feuz, D. (2002). A Simulated Economic Analysis of Altering Days on Feed and Marketing Cattle on Specific Value-Based Pricing Grids. *Nebraska Beef Cattle Reports*. University of Nebraska - Lincoln. https://digitalcommons.unl.edu/animalscinbcr/260

Galyean, M. L., Nichols, W. T., Streeter, M. N., & Hutcheson, J. P. (2023). Effects of extended days on feed on rate of change in performance and carcass characteristics of feedlot steers and heifers and Holstein steers. *Applied Animal Science, 39*, 69-78. https://doi.org/10.15232/aas.2022-02366

Janzen, M. G., Riley, J. M., & Coatney, K. T. (2016). Recent Changes in Profitability Determinants for Cattle Feeders. *Proceedings of the Southern Agricultural Economics Association Annual Meeting*. Mississippi State University and Oklahoma State University.

"Kansas Monthly Weighted Average Cattle Report - Negotiated Purchases." *Agricultural Marketing Service*, U.S. Department of Agriculture, 8 Dec. 2023, www.ams.usda.gov/mnreports/ams_2687.pdf.

Mark, D. R., Schroeder, T. C., & Jones, R. (2000). Identifying Economic Risk in Cattle Feeding. *Journal of Agribusiness, 18*(3), 331-344 .

"Mo182 Kansas Fats." *Livestock Marketing Information Center*, Livestock Marketing Information Center, 3 Jan. 2024, https://lmic.info/members-only/members-only-spreadsheets/spreadsheets-cattle/Mo182KansasFats.xlsx. Accessed 29 Mar. 2024.

U.S. Bureau of Labor Statistics. "Producer Price Index by Commodity: Farm Products: Corn." *Federal Reserve Bank of St. Louis (FRED)*, 9 Dec. 2023, htps://fred.stlouisfed.org/series/WPU012202.

"USDA-NASS CORN, GRAIN - PRICE RECEIVED, MEASURED IN $ / BU" *National Agricultural Statistics Service*, United States Department of Agriculture, 30 November 2023, https://quickstats.nass.usda.gov/results/349487F2-CDCB-39CB-B39F-1D46CA91BDD5. Accessed 9 Dec. 2023.

Appendix

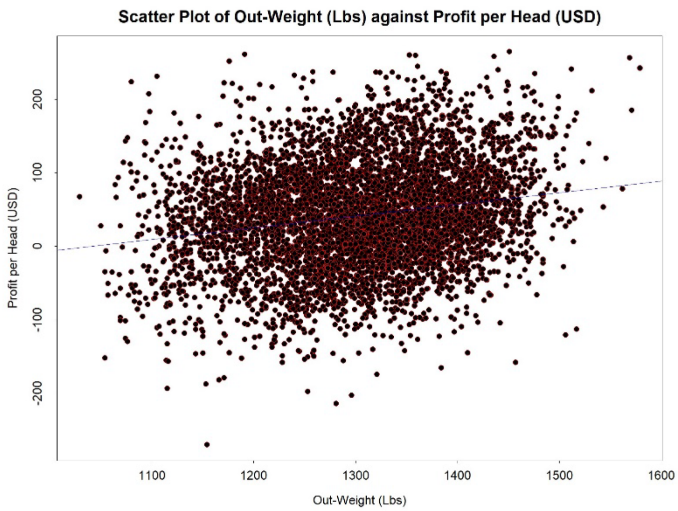

Figure 6: *Scatter plot DOF vs Profit / Hd*

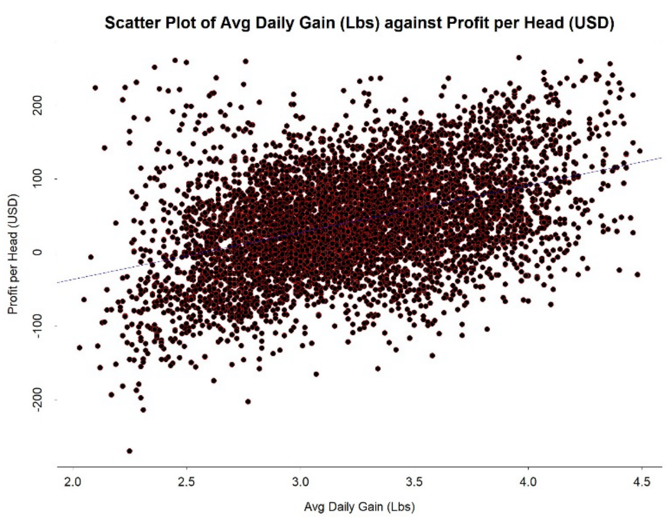

Figure 7: *Scatter plot ADG vs Profit / Hd*

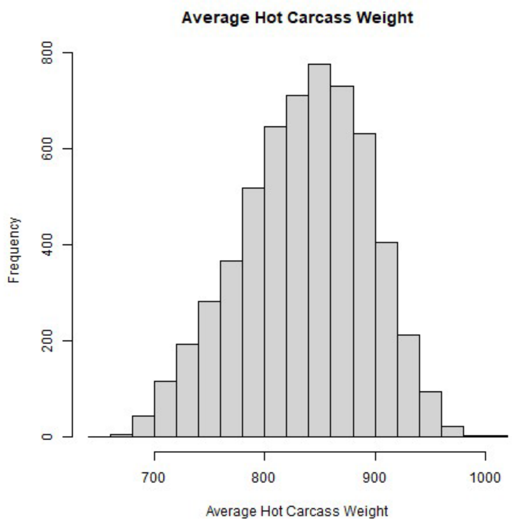

Figure 9*: Histogram of Average Hot Carcass Weight (Avg HCW)*

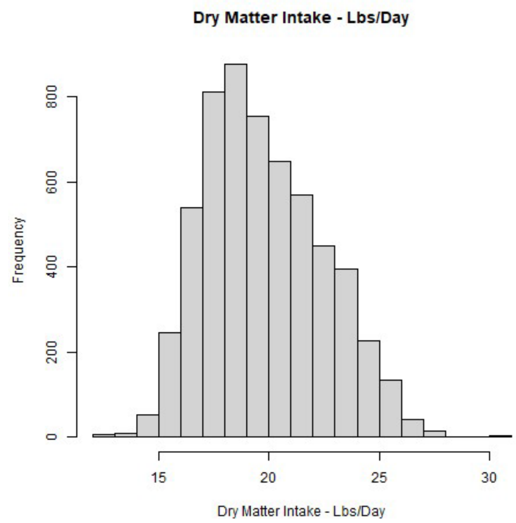

Figure 10: Histogram of Dry Matter Intake (DMI Lbs)

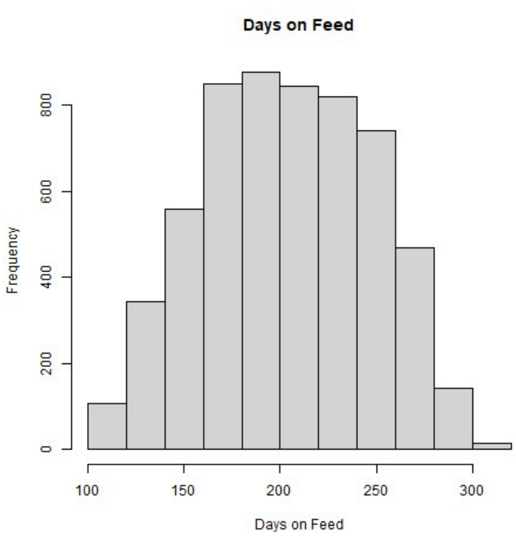

Figure 11: *Histogram of Days on Feed*

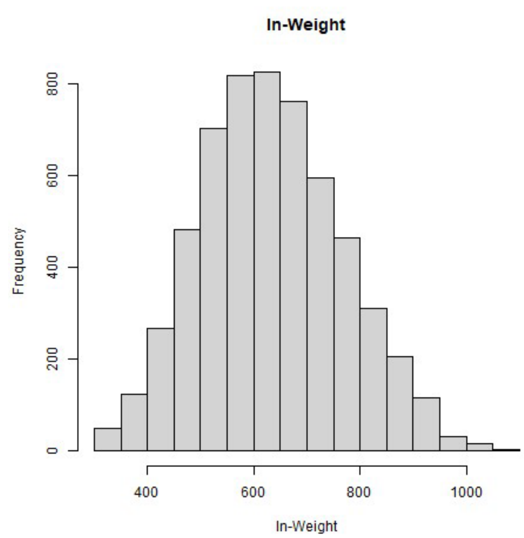

Figure 12: *Histogram of In-Weight (Lbs)*

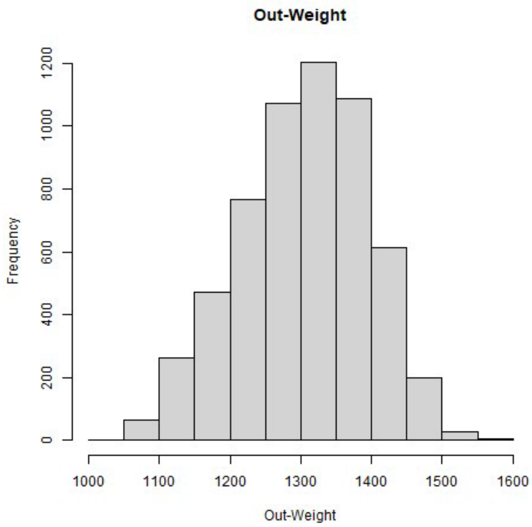

Figure 13*: Histogram of Out-Weight (Lbs)*

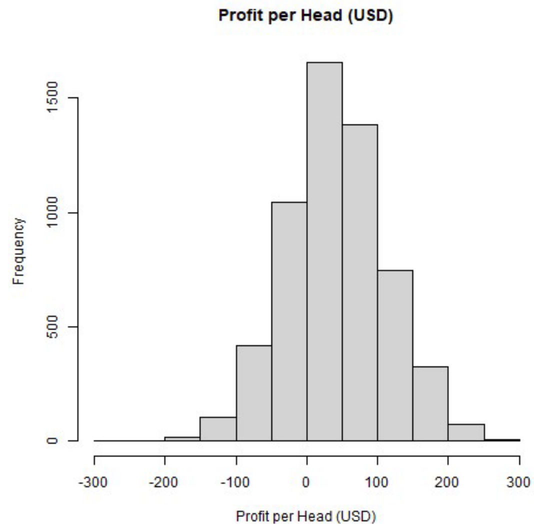

Figure 14: *Histogram of Profit / Hd (USD)*