Analysis of extending days on feed for increased profitability of cattle in Iowa feed lot

by

Sean Moore

B.S., Iowa State University, 2012

A THESIS

Submitted in partial fulfillment of the requirements

for the degree

MASTER OF AGRIBUSINESS

Department of Agricultural Economics

College of Agriculture

KANSAS STATE UNIVERSITY

Manhattan, Kansas

2024

Approved by:

Major Professor
Dr. Jason Bergtold

ABSTRACT

Feeding cattle in a feed lot for the appropriate number of days is critical to the success of a cattle operation. Changes in starting weight of feeder calf, corn price, packer grids, and live cattle futures prices all impact the profitability of growing a steer from calf to finish. The purpose of this thesis is to analyze historical five area weekly live cattle prices over a 10-year period, as well as build a spreadsheet model that helps to optimize the number of days on feed for cattle to improve livestock enterprise profitability. Historical weekly data was collected, and statistical tests were performed to determine if there is significant differences in select target weeks over time to assess if revenue gains can be made by feeding longer. A spreadsheet model was then built to incorporate live cattle futures markets, average daily gain, dressing percentage, and packer grids to assess targeted days on feed for cattle to aid in the decision-making process of what the most desirable number of days on feed is for a given year to help optimize livestock returns. Sensitivity analyses were performed to determine what effects corn price fluctuations would have on overall net returns at predetermined days on feed. Sensitivity analysis on December live cattle futures was also completed to determine at what point extended days on feed result in higher returns. The results of this model are of interest to medium-sized privately owned feedlots that are looking to determine what weight they should buy feeder calves at and for how long they should feed them.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

I would like to thank my wife and family for the sacrifices they had to make while I was juggling a full-time job, school, and trying to be a husband and Dad at the same time. The support given by my wife so that I was able to complete schoolwork is what made this possible.

I also would like to thank the Kansas State University Master of Agribusiness program faculty and staff for having a program that is catered to the agricultural industry and for working professionals in the industry. Being part of a program that cares about you as a student while understanding we all have lives outside of school is absolutely why this program and its students are successful. It is also necessary to thank the other members of the 2024 cohort who helped with encouragement and challenging ideas as we all worked through this together.

Lastly, I would like to thank my employer, Marel, for giving me the ability to pursue my further education in getting my master's degree, and for allowing the flexibility for me to attend a program that had in person on campus sessions.

CHAPTER I: INTRODUCTION

HB Farms is a century farm located in Iowa that feeds approximately 2500 head of cattle. These cattle are raised in a feed lot year-round and sold on negotiated contracts to packers such as Tyson Foods, JBS, Cargill, Creekstone, and others. The mission of the farm is to finish healthy, high grade, high yielding cattle that earn the most profit for the farm. The starting weight of feeder calves and the days on feed (DOF) for the cattle will determine their exit weight, as well as when they are sold to market. Live cattle markets, as well as feeder cattle markets, have an effect on when feeder cattle are purchased and when those same cattle will be marketed for slaughter. The decisions of when to purchase feeder calves and sell live cattle directly impact the returns from cattle production.

1.1 Background

Cattle markets are in a constant state of change, from week to week, month to month, and year to year. Understanding the historical changes and cycles in these markets, such as when they typically experience seasonal highs and seasonal lows, can help a grower make decisions on when to purchase feeder cattle and when they should target cattle to be sold for slaughter. From historical data, we are able to see what times of year live cattle markets typically experience their highs and lows. The optimal time to sell live cattle is going to fluctuate from year to year, but much of the time, it will fall into a very short time frame of usually two to three weeks.

Feeder cattle that are purchased in mid to late October will arrive on farm in late November or early December. Typically, in this operation, feeder cattle stay in the feed lot for approximately 310 days, making them ready for market at approximately week 40, around early October, depending on when exactly the cattle arrive on farm. Historical markets tell us that later in the year there are seasonal highs where live cattle will command

higher prices, so a producer must decide on whether or not to extend the DOF for the cattle with the purpose of increasing weight and marketing later in the year (around week 48) to increase returns from cattle production.

The decision to extend DOF is typically going to be made towards the end of the second ration of feed, which is the grow ration. This ration is typically started in April prior to moving the cattle to a finish ration. Once cattle are moved to the finish ration, these cattle will go to market in 150 to 170 days. When deciding to extend the DOF, yardage costs need to be factored in as these are the fixed costs that add to the daily cost of cattle being in the feed lot and include all fixed and non-feed operating costs such as taxes, insurance, depreciation, interest, labor, bedding, fuel, and depreciation (Walker 2020). Bondurant et al. (2016) stated that "Extending the feeding period increases the risk of receiving discounts for overweight carcasses and increased yield grades (YG) while also have increased likelihood of receiving premiums for higher quality grades (QG) due to fat deposition as cattle continue to be fed (p.91)." This aspect of the packer grid discounts will also need to be factored in along with the added yardage cost and added feed costs when deciding to keep the cattle on feed longer.

1.2 Problem Statement

Extending DOF for cattle may bring additional quality grades and a higher hot carcass weight (HCW), yield grade discounts, and added yardage and feed costs. As a result, a pertinent question for producers is: Does it make economic sense to keep cattle on feed for an additional 28 to 56 days to be able to sell when the market is historically at a seasonal high? Thus, the purpose of this thesis is to evaluate the economics of adding DOF for cattle in a feed lot, and how it is influenced by yardage costs, feed costs, and historical livestock prices.

1.3 Research Objectives

Research objectives include:

1. Collection and analysis of 5 area weekly live cattle historical data series on pricing for dressed steers free on board (FOB) from 2013 to 2023 to understand monthly trends in live cattle markets.
2. Build a spreadsheet model to assess impacts on profitability of having cattle 310, 338, and 366 DOF that accounts for interest, corn prices, feeder cattle purchase weight and price, live cattle futures, yardage costs, and average daily gain.
3. Conduct sensitivity analysis for December live cattle futures and corn prices to determine optimal DOF.

1.4 Contribution

The research conducted in this thesis builds off several existing research topics that look at the economics of extending the DOF for cattle in a feed lot setting. This thesis expands on this topic by examining the historical weekly trends in live cattle markets over a 10-year period to help identify when the optimal time to market cattle is based on an October purchase of feeder calves. The spreadsheet model built in this thesis will then use the futures markets for the optimal weeks of the year to market cattle in order to help maximize the profitably by finding the ideal DOF for a feeder calf. The model will also show the impact of selling on a flat contract or on the grid to further aid in the decision of how many days on feed to have.

1.5 Thesis Outline

This chapter, chapter one, gives the background information about the need for the analysis of the historical data on live cattle markets and what the outcome of the thesis will be. Chapter two provides a literature review, looking at the economic impact of extending

DOF in steers, carcass gain, calculating yardage costs, and selling on a live weight versus carcass weight basis. The third chapter will discuss economic theory behind the thesis, the historical market data for the past 10 years, methods that were used to analyze the data, and development of the spreadsheet model for assessing DOF decisions and conducting sensitivity analyses. Chapter four will discuss the results of data analysis, the model and the sensitivity analyses, and how it could be applied on farm to extend cattle DOF. The final chapter, Chapter V, will present conclusions on what the best practice for the feed lot may be.

CHAPTER II: LITERATURE REVIEW

Livestock production and profitability is affected by many factors including economic influences, such as interest rates, inflation, fuel costs, feed costs, and production factors, including feed lot conditions and weather patterns, such as temperature and drought conditions. The owner of a mid-size feedlot cannot control interest rates, live steer futures or weather patterns, but they can work to optimize their gains based on market conditions. How long a steer is on feed directly impacts its exit weight from the feed lot at the time of sale. Different rations and their effects on daily gain, as well as feeder calf and live cattle pricing will impact the profitability of the operations. If a grower is able to understand these factors and when the best time to market live cattle is, they can better optimize their decision for choosing an optimal DOF for their cattle.

Extending the feeding period for fed cattle increases the risk of receiving discounts for overweight carcasses and increased yield grades, but it also increases the likelihood of bringing premiums for higher quality grades, since fat deposition increases the longer cattle are fed (Bondurant, et al. 2016). Bondurant et al. (2016) states that the economic benefits of extending DOF eventually level off, because the cost of conversion gradually increases as the body weight of a steer increases, even though the dressing percentage continues to increase. For a grower, discounts for yield grades or overweight carcasses can have a significant impact on the bottom line and the profitability for that animal, which may not be offset by the premium brought by a higher quality grade or the added pounds on the carcass. Once an animal reaches maturity, the carcass composition will shift from adding muscle at a faster rate, to adding fat at a higher rate, while the overall feed efficiency declines (Melroe 2023).

Another consideration is that the packer grid fluctuates throughout the year, bringing discounts and premiums to a carcass that are above or below a standard based on a set of quality specifications (Ward, Schroeder and Feuz 2017). For a grower that is extending DOF to increase HCW for the purpose of increasing dressing percentage and quality grade, they need to be aware of the potential impact on profitability of the carcass being discounted due to being overweight because the HCW is too high or greater than 1050lb, or from a yield grade discount from having back fat thickness greater than .5 inches. If a producer can understand the impact of grid pricing and is able to control their yardage costs, then extending DOF to market at optimal future prices may bring additional profitability.

For a grower, understanding what their yardage costs are can help them make the decision if the additional DOF are economical. Yardage cost is the non-feed cost per head for every day that an animal is in the feed lot. Yardage costs should cover all fixed and non-feed operating costs such as taxes, insurance, depreciation, interest on long term assets, labor, bedding, veterinary costs, fuel, utilities, and miscellaneous costs (Walker 2020). Controlling these costs through sharing resources, manure credits for manure being used as fertilizer, and extending the use of machinery past the point of full depreciation can enable a grower to minimize the yardage cost and increase profitability by extended DOF (Walker 2020).

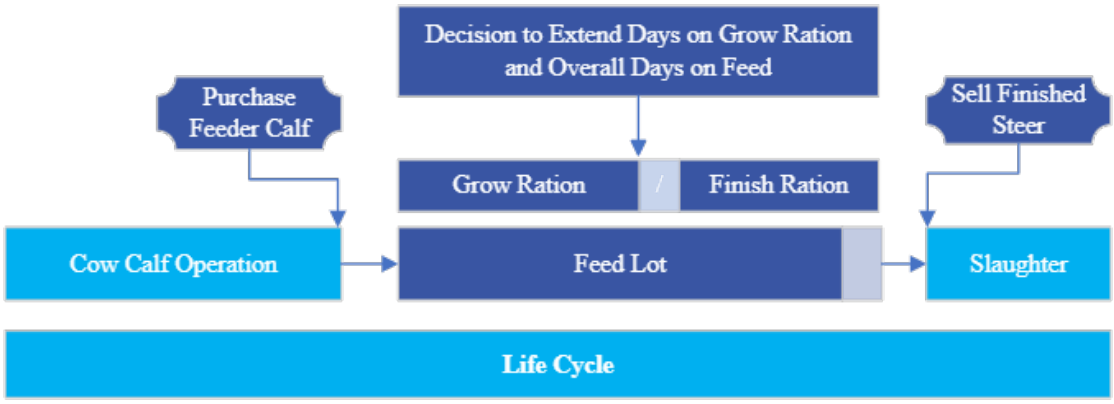
CHAPTER III: DATA AND METHODS

In this chapter, the conceptual framework for the model will be reviewed. The data that was collected for live cattle prices for years 2013 to 2023, and the methods used to analyze this data for statistical significance will also be described. Finally, the spreadsheet model developed to examine per head profitability of different DOF will be discussed and described, along with the assumptions made, the data used for the model, the software used to build the model, and the method used for the sensitivity analysis.

3.1 Conceptual Framework

The ability to evaluate and solve the question concerning the economic feasibility of extending DOF requires a complete understanding of the decision process and timeline to finishing fat cattle. The process of buying feeder calves, placing them into a feed lot to add weight, and selling on the live cattle market for slaughter is a process that can take six to twelve months depending on the starting weight of the calves, and the desired exit weight of the finished cattle. The exit weight is influenced by things such as the rations fed, time of year or weather patterns for that year, regional location of the feed lot, and the final processing plant where the cattle are marketed. Figure 3.1 illustrates the decision flow. The first decision is made by the grower to purchase a feeder calf. The calf is then transported to the farm, where it is put onto a grow ration to add weight. At approximately 150 DOF, the grower must make the decision to either add days to the grow ration, which will increase the total number of DOF, or to transition to a finish ration. After the steer is started on the finish ration, it will be marketed approximately 150 days later. The decision to add additional DOF is influenced by the futures markets for the time of sale, yardage costs, and feed costs.

Figure 3.1: Optimal Days on Feed Decision Flow



The areas in figure 3.1 that are shaded in dark blue are the primary part of the cycle that this thesis will focus on. The areas in light blue represent the overall life cycle of the animal, including the time before feeder calf is purchased and after during the harvest of the animal. The pale blue sections represent the potential additional days for the grow ration, and the potential additional days over all for the entire time in the feed lot.

3.2 Live Cattle Price Analysis

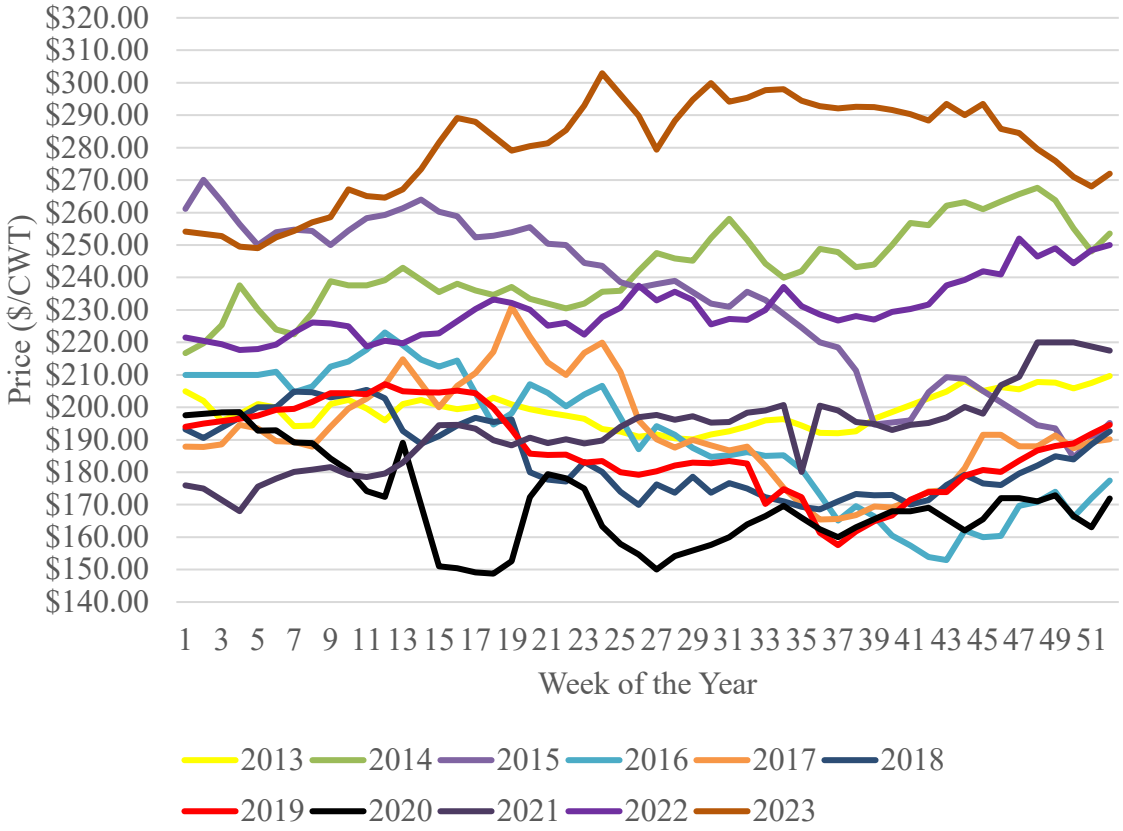
As previously mentioned, part of the purpose of this thesis is to examine the weekly trends in cattle pricing and evaluate what week of the year the optimal time to market cattle is, based off the assumption of purchasing feeder calves in late October and targeting to have them on feed for a minimum of 310 days and a maximum of 366 days.

3.2.1 Data

Data on historical live cattle prices is available from the United States Department of Agriculture, Agricultural Marketing Service (USDA AMS) in the Datamart for Livestock Mandatory Price Reporting under the 5-area weekly direct slaughter cattle (United States Department of Agriculture Agricultural Marketing Services 2023). Summarized data for all livestock information including pricing, volume, weights, grid pricing, etc. can be found on the USDA AMS website. The data for the 5-area weekly

dressed FOB Steers was pulled from the USDA Datamart website and inserted into an Excel spreadsheet for analysis. The 5-area weekly data was used in favor of the Iowa weekly data due to excessive gaps of time in data in the Iowa data series. In this report, there were instances in which a value for the dressed price was absent. For the purpose of the thesis, Excel was used to fill the missing data on the chart with a line of best fit. As seen in Figure 3.2, it appeared that in most years dressed cattle prices had a spike towards the end of the year, near weak 48.

Figure 3.2: 5 Area Weekly Direct Slaughter Cattle Prices (Dressed Steers FOB)



Source: (United States Department of Agriculture Agricultural Marketing Services 2023)

3.2.2 Statistical methods

One of the objectives was to statistically analyze the historical trends in live cattle pricing. More specifically, compare week 40 of each year to week 48 of the same year between 2013 and 2023. By purchasing feeder calves in mid to late October, with them arriving on farm in mid to late November, and an approximate minimum DOF of 310 days, this gives an initial target market date of week 40. The maximum DOF of 366 days gives a final market date of approximately week 48. By completing a statistical analysis of the prices of week 40 vs week 48, we will be able to see if week 48 is provides a potentially better revenue opportunity or timing for marketing cattle. Utilizing a T-test, we assess if there is a statistically significant difference of live cattle prices from week 40 to week 48. If

the T-test for this comparison results in an associated p-value less than .05, then there is a statistical difference at the 95% confidence level that week 48 carries higher prices on average compared to week 40.

3.3 Spreadsheet Model

The spreadsheet model that is built will utilize live cattle futures prices from October and December (310 and 366 DOF), yardage costs, average daily gain, feed prices, starting weight, interest expenses, purchase price, and grid discounts and premiums to determine the economic performance of a steer at 310, 338, and 366 DOF. For this model, we are not including the first 14 days in the feed lot that a steer is on a starter ration as those 14 days are used to gain back weight lost during transport and transition. The model will thus have DOF of 296, 324, and 352. The model will be used to determine if it is profitable to add additional DOF. By using historical knowledge of HB Farm's operation's averages, the model starts with a starting calf weight of 525 pounds with a purchase price of $285.00/cwt, with a yardage cost of $0.35 per head per day, a corn price of $4.50/bu, 10% operating loan interest rate, and grid discounts and premiums of $15.71/cwt for overweight carcass (greater than 1050 pounds), a quality grade premium of $14.96/cwt, and a yield grade penalty of $11.92/cwt per pound for yield grades 4 and 5. Dressed futures prices for October 2024 are $291.78/cwt, estimated November dressed futures $294.59/cwt, and December dressed futures of $297.40/cwt (CME Group - Live Cattle Futures 2024). There are three total DOF in the model which are 296, 324, and 352. Each of these scenarios have a day on grow ration of 146, 174, and 202 respectively. All three scenarios have a contact days on the finish ration of 150 days. For 296 DOF the average daily gain (ADG) for the grow ration is 3.1lb and 3.6lb for the finish ration. 324 DOF and 352 DOF have ADG for the grow and finish rations of 3lb and 3.5lb, and 2.95lb and 3.4lb

respectively. The average daily gain rates were determined from experience on farm of an industry veteran. The dressing percentage for 296, 324, and 352 DOF are 63.54%, 64.59%, and 64.82% (Bondurant, et al. 2016). A sensitivity analysis will be performed to determine, based on the starting weight of the feeder calf, what the optimal DOF is. We will also complete a sensitivity analysis on corn prices to examine the impact that has on overall profitability of a steer.

3.3.1 Assumptions

In order for the model to give a realistic measure of profitability for a set DOF, several assumptions are made.

1. The first assumption that is made is that feeder calves will be purchased in October and will arrive in the feed lot approximately four weeks later. This method allows for a one-year cycle of the pens used for these cattle as sale of the finished cattle will happen 310 to 366 days later, allowing the replacement calves to move in as the previous generation exits.
2. The second assumption made is that corn prices account for approximately 46% of the feed costs per pound of gain. The equation used to estimate the percent of the ration that was corn prices was % Feed Cost (Corn) = Corn Cost per Head/Total Feed Costs per Head or %Feed Cost (Corn) = $279.62/$611.44. This information was derived from the Iowa State University Estimated Livestock Returns (L. Shulz 2023) spreadsheet.
3. The next assumptions that are made are for the October and December futures dressed pricing. These were calculated from the live cattle futures using a dress percentage of 63.54%. Live futures prices were not adjusted for varying weight ranges and used pricing for 1050lb – 1500lb live weight.

4. It was also assumed that basis pricing from the live futures prices to local Iowa pricing was $0.00.
5. The next areas that were assumed are the average daily gains from the grow and finish rations. These figures are based off experience in the field and estimated results from prior years of raising cattle with extended DOF.
6. Carcass dressing percentages are assumed to be 63.54% for 310 DOF, 64.59% for 338 DOF, and 64.82% for 366 DOF (Bondurant, et al. 2016). While the DOF in this model do not match directly with the DOF in the study (Nebraska Beef Cattle Reports 2016), it is representative of an increase in the DOF spread and the cattle carry a similar yet slightly lower carcass weight than in the model developed.
7. There is also an assumption that for the first 14 DOF, the feeder calves will be on a starter ration. This starter ration results in weight gain for weight lost during transport, and puts the calves back at even. Since this ration is constant regardless of total DOF, it will not impact the average daily gain of the steer, so it has been omitted from the model.
8. Since there is not live cattle futures prices for November available, we are using the average of October and December futures as an estimate for the 324 DOF target.
9. We assume for the sensitivity analysis that the steers will be sold on grid pricing. "Grid pricing consists of a base price with specified premiums and discounts for carcasses above and below a base or standard set of quality specifications" (Ward, Schroeder and Feuz 2017, p. 1).
10. The percentages of cattle that would receive discounts and premiums from the grid was assumed to be based on an average. The discount or premium was applied as a

percentage to represent the percentage of cattle in the lot that would receive the discount or premium. 310 DOF received an 8% premium from quality grade prime, 20% discount from yield grade 4/5, and 0% discount for overweight. 338 DOF received a 10% premium from quality grade prime, 22.5% discount for yield grade 4/5, and 0% discount for overweight. 366 DOF received a 12% premium for grading prime, 25% discount for yield grade 4/5, and 100% discount for overweight.

3.3.2 Data

Utilizing data acquired from the Estimated Livestock Returns website at Iowa State University (D. L. Shulz 2023) we are able to determine an average feed cost per hundred weight (cwt), along with what portion of that cost is driven by corn. With this information, we will be able to incorporate corn prices as a percent of the feed costs within our model. It's important to recognize that feed costs from the Estimated Livestock Returns is just a guide and not representative of exact costs. It is stated on the website from Iowa State University where the feed costs were derived from, "The data from the Iowa State University Estimated Livestock Returns serve as a general barometer of profitability and are not intended to represent any one operation, system, or firm" (L. Shulz 2023). The data used from the website assumes the purchase of feeder cattle in April of 2023 and marketing of these cattle in December of 2023 (L. Shulz 2023). This data is presented in Table 3.1.

Table 3.1: Estimated Returns to Finishing Steer Calves, Iowa

Estimated Returns to Finishing Steer Calves, Iowa		$/head
Purchased month		Apr-23
Sale month		Dec-23
560 lb Steer Calf		
Purchase price, $/cwt	$	251.91
Purchase cost, $/hd	$	1,410.72
Costs of Producing 1300 lb Finished Steer		
Feed costs		
Corn, $/hd	$	279.62
Modified distiller grain, $/hd	$	168.07
Hay, $/hd	$	119.86
Supplement & mineral, $/hd	$	43.89
Total, $/hd	$	611.44
Nonfeed costs		
Variable costs, $/hd	$	129.61
Operating interest, $/hd	$	93.08
Fixed costs, $/hd	$	79.70
Total, $/hd	$	302.40
Returns to Marketing 1300 lb Finished Steer		
Death loss, $/hd	$	30.85
Total Costs, $/hd	$	2,355.41
Breakeven price, $/live cwt	$	181.19
Selling price, $/live cwt	$	170.46
Sales value, $/hd	$	2,215.98
Profit (loss), $/hd	$	(139.43)
Manure credit, $/hd	$	15.90
Total profit (loss), $/hd	$	(123.53)

Source: (L. Shulz 2023)

The parameters that were used in the model, along with their values, units, and definitions can be found in Table 3.2.

Table 3.2: Extended Days on Feed Payback Model Parameters

Cell In Spreadsheet Model	Parameter	Value	Units	Description
C5	October Purchase Price[a]	$285.00	USD	$/cwt calf purchase price
D5	Starting Weight[b]	525	Pounds	Starting weight of calf
E5	Yardage Cost[b]	$0.35	USD	Cost per head per day
F5	Feed Cost/lb of Gain[c]	$0.8025	USD	Cost of feed per pound of gain
G5	Corn Price	$4.50	USD	Price per bushel
H5	Interest On Operating Loan[b]	10%	Percentage	Operating loan interest
I5	Heavy Discount[d]	$ (0.1571)	USD	Grid pricing for overweight carcass
J5	Quality Grade Premium[d]	$0.1496	USD	Grid pricing for prime grade
K5	Yield Grade Penalty[d]	$ (0.1192)	USD	Grid pricing for yield grade 4/5
L5	On Grid	1	integer	Using grid pricing or not
E6	Live Cattle Futures Oct[f]	$185.40	USD	October live cattle futures
I6	Live Cattle Futures Dec[f]	$188.97	USD	December live cattle futures
B8	Total Days on Feed[b]	296	Days	Total days on feed
B9	Total Days on Feed[b]	324	Days	Total days on feed
B10	Total Days on Feed[b]	352	Days	Total days on feed
C8	Days on Grow Ration[b]	146	Days	Total days on grow ration
C9	Days on Grow Ration[b]	174	Days	Total days on grow ration
C10	Days on Grow Ration[b]	202	Days	Total days on grow ration
D8	Days On Finish Ration[b]	150	Days	Total days on finish ration
D9	Days On Finish Ration[b]	150	Days	Total days on finish ration
D10	Days On Finish Ration[b]	150	Days	Total days on finish ration
E8	Average Daily Gain (Grow)[b]	3.1	Pounds	Average daily gain on grow ration
E9	Average Daily Gain (Grow)[b]	3	Pounds	Average daily gain on grow ration
E10	Average Daily Gain (Grow)[b]	2.95	Pounds	Average daily gain on grow ration

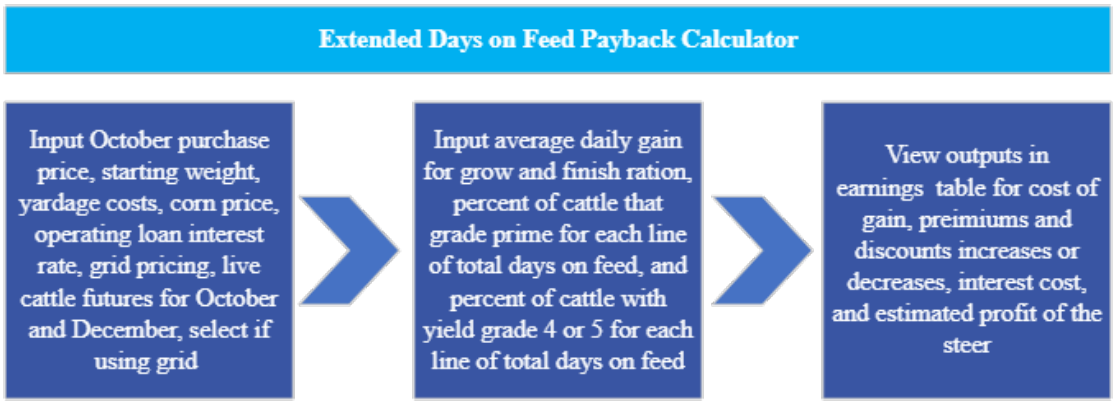
F8	Average Daily Gain (Finish)[b]	3.6	Pounds	Average daily gain on finish ration
F9	Average Daily Gain (Finish)[b]	3.5	Pounds	Average daily gain on finish ration
F10	Average Daily Gain (Finish)[b]	3.4	Pounds	Average daily gain on finish ration
I8	Dressing Percentage[e]	63.54%	Percentage	Dressing percentage of live weight
I9	Dressing Percentage[e]	64.59%	Percentage	Dressing percentage of live weight
I10	Dressing Percentage[e]	64.82%	Percentage	Dressing percentage of live weight
L8	% Grading Prime[b]	8%	Percentage	Percent of carcasses grading prime
L9	% Grading Prime[b]	10%	Percentage	Percent of carcasses grading prime
L10	% Grading Prime[b]	12%	Percentage	Percent of carcasses grading prime
M9	Yield Grade 4/6[b]	22.5%	Percentage	Percent of carcass with yield grade 4/5
M8	Yield Grade 4/5[b]	20%	Percentage	Percent of carcass with yield grade 4/5
M10	Yield Grade 4/7[b]	25%	Percentage	Percent of carcass with yield grade 4/5
D14	Days on Feed[b]	296	Days	Number of days on feed
D15	Days on Feed[b]	324	Days	Number of days on feed
D16	Days on Feed[b]	352	Days	Number of days on feed

[a] Source: (United States Department of Agriculture Agricultural Marketing Services 2023)
[b] Source: (Moore 2024)
[c] Source: (L. Shulz 2023)
[d] Source: (United States Department of Agriculture Market News Service 2023)
[e] Source: (Bondurant, et al. 2016)
[f] Source: (CME Group - Live Cattle Futures 2024)

3.3.3 Spreadsheet Model Development

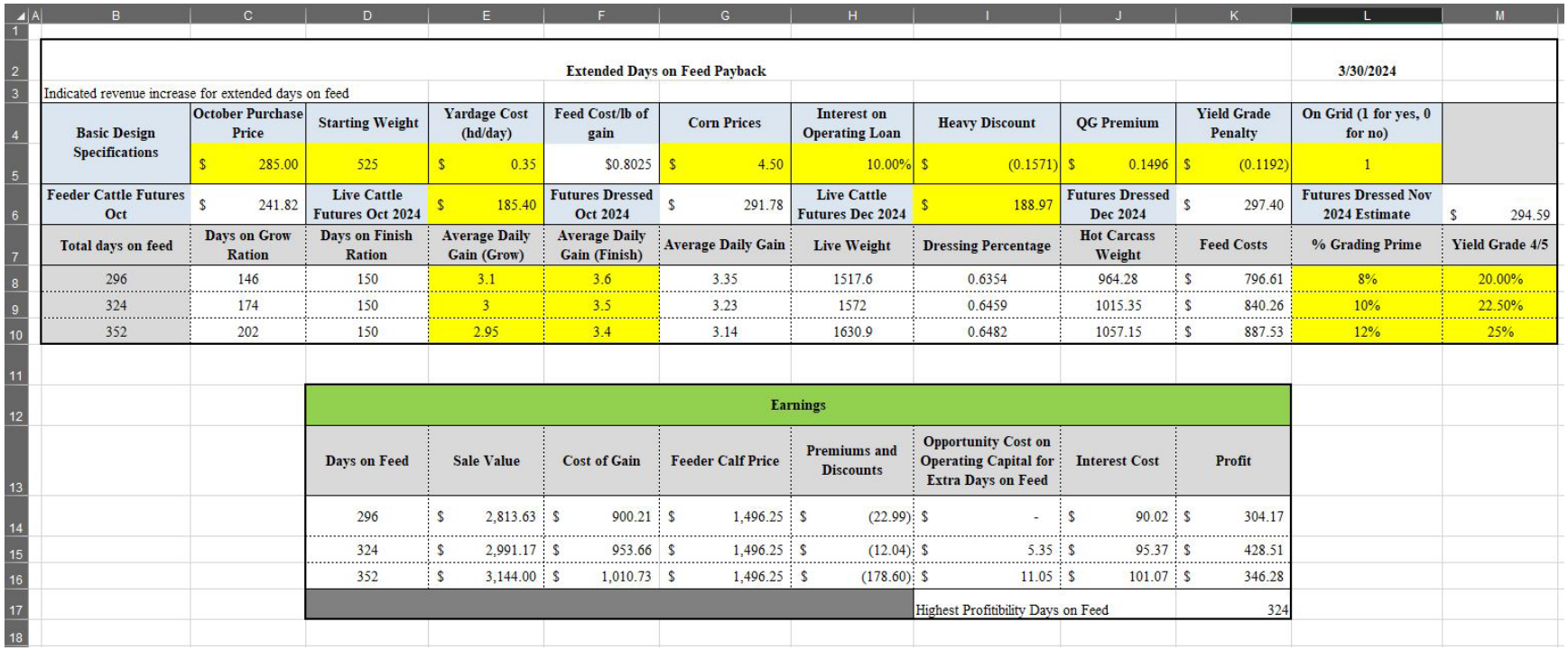
Microsoft Excel was used to design the extended DOF spreadsheet model. The model was designed to allow a producer to input their own parameters quickly and easily such as calf purchase price, yardage costs, starting weight, interest on operating loan, etc. The flow of information for inputs leading to the outputs of the model can be seen in Figure 3.3.

Figure 3.3: Extended Days on Feed Spreadsheet Model Flow Chart



The model itself can be seen in Figure 3.4 as a screen shot from the actual spreadsheet. The spreadsheet model will also be available as an appendix.

Figure 3.4: Extended Days on Feed Spreadsheet Model



Extended Days on Feed Payback — 3/30/2024

Indicated revenue increase for extended days on feed

Basic Design Specifications	October Purchase Price	Starting Weight	Yardage Cost (hd/day)	Feed Cost/lb of gain	Corn Prices	Interest on Operating Loan	Heavy Discount	QG Premium	Yield Grade Penalty	On Grid (1 for yes, 0 for no)	
	$ 285.00	525	$ 0.35	$0.8025	$ 4.50	10.00%	$ (0.1571)	$ 0.1496	$ (0.1192)	1	
Feeder Cattle Futures Oct	$ 241.82	Live Cattle Futures Oct 2024	$ 185.40	Futures Dressed Oct 2024	$ 291.78	Live Cattle Futures Dec 2024	$ 188.97	Futures Dressed Dec 2024	$ 297.40	Futures Dressed Nov 2024 Estimate	$ 294.59

Total days on feed	Days on Grow Ration	Days on Finish Ration	Average Daily Gain (Grow)	Average Daily Gain (Finish)	Average Daily Gain	Live Weight	Dressing Percentage	Hot Carcass Weight	Feed Costs	% Grading Prime	Yield Grade 4/5
296	146	150	3.1	3.6	3.35	1517.6	0.6354	964.28	$ 796.61	8%	20.00%
324	174	150	3	3.5	3.23	1572	0.6459	1015.35	$ 840.26	10%	22.50%
352	202	150	2.95	3.4	3.14	1630.9	0.6482	1057.15	$ 887.53	12%	25%

Earnings

Days on Feed	Sale Value	Cost of Gain	Feeder Calf Price	Premiums and Discounts	Opportunity Cost on Operating Capital for Extra Days on Feed	Interest Cost	Profit
296	$ 2,813.63	$ 900.21	$ 1,496.25	$ (22.99)	$ -	$ 90.02	$ 304.17
324	$ 2,991.17	$ 953.66	$ 1,496.25	$ (12.04)	$ 5.35	$ 95.37	$ 428.51
352	$ 3,144.00	$ 1,010.73	$ 1,496.25	$ (178.60)	$ 11.05	$ 101.07	$ 346.28
					Highest Profitibility Days on Feed		324

The first step in the use of the model is to input the October purchase price paid, per hundredweight, for the feeder calf into cell C5. The next step is to put in the starting weight (in pounds) of the calf into D5, the feed lot's yardage cost into E5, and corn prices (real or expected), into G5. Cell F5 will then populate with an estimated feed cost per pound of gain, as corn prices account for 46% of the feed cost. The user should then input their operating loan interest rate into H5, and then cells I5, J5, and K5 are for the heavy discount, quality grade premium, and yield grade penalty pricing from the packer grid. Cell L5 allows the producer to use grid pricing in the model's output, or to compute the net returns past the starter ration without the grid pricing in place. These cells can be seen in the red box in Figure 3.4.

The next section of the spreadsheet model focuses on the live cattle future prices. Cell E6 is the live cattle future price for October, and cell G6 calculates the dressed future price by using the formula Futures Dressed = live futures / dressing percentage (G6=E6/I8). Cell I6 is the live cattle future price for December, and cell K6, December dressed futures, uses the same formula as previously discussed for the futures dressed pricing for October. Lastly cell M6 calculates the November dressed futures by average the October and December prices. November live cattle futures are not available on the open market. These cells can be seen in the blue box of Figure 3.4.

In the green section of Figure 3.4, these cells build in the desired total DOF in cells B8, B9, and B10. Days on the grow ration are in cells C8 through C10, and days on the finish ration are in cells D8 through D10. The producer is then able to input their average daily gain estimates for the grow and finish rations in cells E8:F10, and cells G8 through G10 calculate the average daily gain for the total DOF by the equation

G8=(C8*E8+D8*F8)/sum(C8,D8). The equation is followed for cells G9 and G10 as well, replacing the row in the cell with 9 and 10 respectively. The live weight of the steer is calculated in Cells H8 through H10 with the formula Live Weight = Average Daily Gain * Total Days on Feed+Starting Weight (H8=G8*B8+D5). The dressing percentage in cells I8 through I10 is used to calculate the hot carcass weight in cells J8 through J10, and the equation used here is live weight multiplied by the dressing percentage. Feed costs in cells K8 through K10 are calculated by subtracting the starting weight from the live weight, and multiplying by the feed cost per pound of gain (K8=(H8-D5)*F5). The last cells in the section are the percent grading prime and yield grade 4 and 5, which are cells L8:M10. These numbers are input by the producer as an estimate for the percentage of steers that would typically grade prime from these DOF, and the yield grade 4/5 is the percent of steers typically with yield grade 4/5 discounts.

The last section of the model is surrounded in orange in Figure 3.4. This section explains the profitably of each desired DOF, the premiums and discounts and opportunity cost on capital. Cell E14 calculates the sale value of the steer by multiplying the HCW by the October dressed futures price in G6 (divided by 100). Cell E15 uses the November dressed futures prices, and cell E16 uses the December dressed futures price. The cost of gain in cells F14 through F16 is calculating the cost of gain by multiplying the total days on feed by the yardage cost, and then adding the feed costs from cells K8 through K10. The feeder calf price in G14 through G16 is determined by the starting weight of the calf in D5 multiplied by the purchase price in C5. Since there are thresholds set for the grid pricing to take effect on heavy weight carcasses, days on feed, and yield grade premiums, in cells H14 through H16 the premiums and discounts from the grid pricing is factored by the

following formula:

=IF(L5=1,IF(J8>1050,(J8*I5),0)+IF(B8>275,(J8*K5*M8),0)+IF(J8>1000,(J8*J5*L8),0),0). This formula utilizes the IF function for if the grid pricing is turned on, and if the HCW exceeds the 1050lb threshold for heavy discounts, the 1000lb threshold for yield grade discounts, and the over 275 days on feed for the quality grade premiums. Next in cells I14 through I16 the opportunity cost on operating capital for extra days on feed is factored for the 324 DOF and 352 DOF. This cost is computed by multiplying the interest on the operating loan by the additional cost of gain for each target days on feed over the baseline of 296. These opportunity costs represent the money that was spent to keep the steer on feed longer that could have been used elsewhere in the operation such as buying new calves, equipment upgrades, etc. The interest costs are computed in cells J14 through J16 by multiplying the cost of gain in cell F14 by the interest rate in cell H5. The interest cost represents the interest paid on the operating loan for the cost of gain. Interest on the feeder calf price was not included here as it is assumed the calf is purchased with cash and not with operating loan funds. Lastly, the cells giving final profits for each target DOF are cells K14 through K16. These are calculated by starting with the sale value and subtracting the cost of grain, feeder calf price, grid discounts, opportunity costs, and interest costs. The formula for cell K14 is: =E14-F14-G14+H14-I14-J14.

3.3.4 Sensitivity analysis

Performing a sensitivity analysis on the Extended Days on Feed model will enable us to understand the impact changes in certain parameters will have on the overall net returns past the starter ration of a steer placed into a feed lot. As the parameter values

change, the net returns of the steer will change, and this may influence what the optimal DOF is. All analyses will assume selling on the same packer grid. The first parameter that will be examined is corn prices. As previously mentioned, corn accounts for 46% of the cost of the feed cost per pound of gain, so varying for the price of corn and its impact on the total cost of gain will help us understand if feeding for additional days is still profitable even under unfavorable market conditions. We examine a corn price range of +/- $2.00 the baseline corn price. Second, sensitivity analysis will also be performed on Live Cattle December futures to determine if extended DOF resulting in sale in December is still profitable even if prices drop late in the year. We will look at up to a $20.00 cwt reduction and increase in the December Live Cattle Futures, in $5.00 cwt increments.

CHAPTER IV: RESULTS

4.1 Live Fed Cattle Price Monthly Trends

Visually, prices rose until they peaked in the spring, then tapered off until the fall, approximately week 38 to week 40 of the year, where they then began a rally through the end of November, and then finally fell off through the first of the year before again rising for the next cycle, as seen in Figure 3.2. The year 2023 was the obvious outlier, with elevated pricing through the majority of year and 10-year highs occurring almost all year long. The rally through the end of the year as seen in the prior year was not seen in 2023, and prices ended up dropping significantly ahead of the new year. It is worth noting that while prices in 2023 fell through the end of the year, they were still at elevated prices compared to years prior. In our model we are targeting to market cattle in week 40 and in week 48, so it is valuable to understand what these weeks look like annually compared against each other. Descriptive statistics of these weeks from the years 2013 to 2023 can be seen in table 4.1.

Table 4.1: Descriptive Statistics of Average Weekly Direct Slaughter Dressed Cattle in Week 40 and Week 48 between 2013 and 2023.

	Week 40	*Week 48*
Mean	199.5913	210.2835
Standard Deviation	41.2842	38.1462
Minimum	161.4030	171.4630
Maximum	291.4970	279.9800

There were multiple years where data was missing for week 40, or for week 48. To account for these missing data points, the average of week 39, 40, and 41 were taken for each year, and the same was done for weeks 47, 48, and 49. The descriptive statistics tell us

that the average price for week 48 is higher than week 40. The standard deviations though for both weeks are high, making it unclear if there is a significant difference statistically.

4.1.1 T-Test Results

Three T-Tests were conducted with the purpose of determining if there is a statistical difference in the pricing of week 40 versus week 48. The first T-Test was on the complete 10-year sample from 2013 to 2023 and can be seen in Table 4.2, the column titled "2013-2023". This T-Test resulted in a P value of greater than .05, telling us that there was not a significant difference between week 48 and week 40 over the time horizon examined.

Table 4.2: T-Test Week 40 to Week 48 from 2013 to 2023

t-Test: Two-Sample Assuming Equal Variances 2013-2023			
	2013-2023	*2013-2018*	*2018-2023*
t Stat	-0.63	-0.56	-0.40
P(T<=t) two-tail	0.54	0.59	0.70

The second T-Test that was performed looked at the difference between week 40 and week 48 for years 2013 to 2018. The purpose of this test was to find out if there was statistical significance in the difference between weeks in a smaller sampler set. This test can be seen in Table 4.2 in the column titled "2013-2018". The test had an associated p-value of .59, indicating no statistically significant difference.

The third T-test that was performed was to evaluate week 40 versus week 48 for the years 2018 to 2023. Again, the purpose of this was to find if there was a statistical difference in live cattle prices between weeks in a different smaller set of data. This test resulted in a p-value of .698, indicating no statistical significance in week 48 and week 40. This could potentially be due to the 10 year high in live cattle prices being experienced in 2023. This T-Test can be seen in Table 4.2 in the column titled 2018-2023.

4.2 Economics of Days on Feed

In section 4.2, we will discuss the overall baseline results of the model, the sensitivity analysis that was performed, and also discussion of the results and what they mean for the operation.

4.2.1 Baseline Results

The model will use a feed cost per pound of gain of $0.8025. The overall ADG for the 296 DOF, 324 DOF, and 352 DOF is 3.35lb, 3.23lb, and 3.14lb. The HCW of the steer at 296 DOF would be 964.28lb, at 324 DOF the steer HCW would be 1015.35lb, and at the longest DOF interval the steer would have an exit weight of 1057.15lb. Feed costs would total $796.61 for 296 DOF, $840.26 for 324 DOF, and $887.53 for 352 DOF. The sale value of the steer would be $2,813.63 at 296 DOF, $2,991.17 at 324 DOF, and $3144.00 at 352 DOF. Total cost of gain is $900.21, $953.66, and $1010.73 respectively. The feeder calf price for each scenario is constant at $1,496.25. The discounts resulting from the grid pricing for each scenario is $22.99, $12.04, and $178.60. There is an opportunity cost on capital for the two scenarios in which the steer is feed longer than the baseline of 296 DOF, and those are $5.35 and $11.05. There is also interest costs, from operating loans, on the cost of gain of $90.02, $95.37, and $101.07 for each scenario. Lastly, the net returns past the starter ration for the scenario in which the steer is on feed for 296 days is $304.17 per head. For 324 days, the net returns for the steer is $428.51 per head, and for 352 days the net returns of the steer is $346.28 per head. In the baseline scenarios, the most ideal situation is 324 DOF. This was expected to be the case because at 324 DOF, the steer avoids the large discounts from being overweight (Greater than 1050lb HCW), has a slightly higher quality grade premium than the baseline DOF, and has a lower yield grade penalty than the longer DOF scenario. If you were able to sell on contract without the

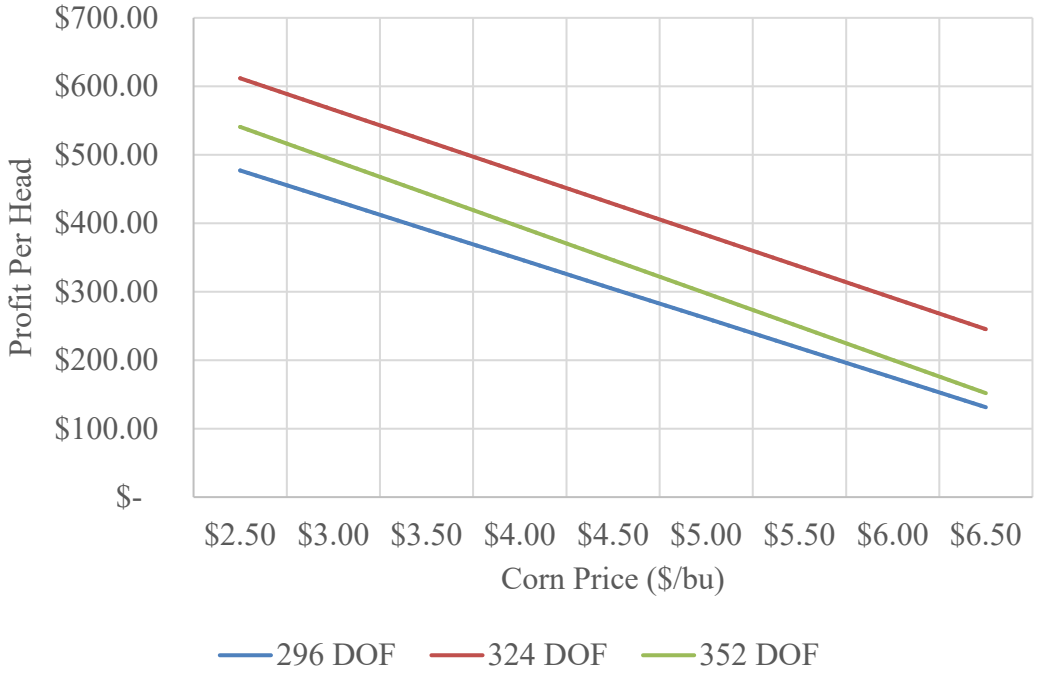
discounts and premiums of grid pricing, extending to the longest DOF would make the most net returns since there would be no overweight penalty. These results should be interpreted in light of the assumptions made.

The overweight penalty that is applied to the 352 DOF target is applied at a 100% rate, meaning that all cattle fed for 352 days will receive the discount for having a HCW over 1050 lb. In actuality, there is a distribution of the cattle weights in lots being sold. Some cattle would surpass the 1050lb mark at each feeding interval and thus receive the overweight penalty, while others may not. Taking this into account was beyond the scope of this study but would likely alter the findings. The results here may be a conservative estimate based on this.

4.2.2 Sensitivity Analysis

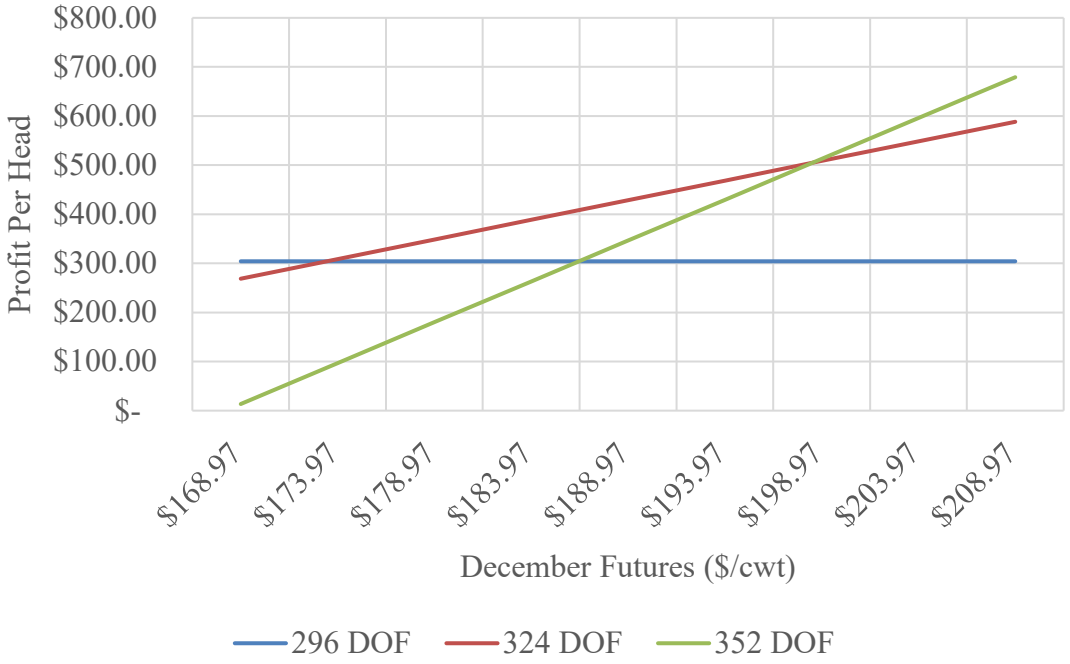
The first sensitivity analysis that was completed was regarding the change in corn prices and their effect on overall net returns past the starter ration of a steer at each DOF interval. The scenario manager in Microsoft Excel was used to look at corn price changes in $0.50 per bushel intervals up to $6.50 per bushel and down to $2.50 per bushel. As would be expected, as corn prices increased, net return per head drops. At 296 days on feed, the marginal change of the line is -$43.23 per head, which was the flattest of the three intervals. 324 DOF had a marginal change of -$45.86 per head, and 352 DOF had a marginal change of -$48.61 per head. The decrease in returns is illustrated in Figure 4.1.

Figure 4.1: Corn Price Effect on Profitability



The next scenario that was looked at was the change in December live futures. For this analysis, futures prices were varied by a range of up to $208.97/cwt, and down to $168.97/cwt in increments of $5.00/cwt. 296 DOF remained flat as we varied the December futures, because these cattle would all be sold on October Futures, however as December futures increased the net returns of 324 DOF and 352 DOF increased, with 352 DOF having a steeper increasing slope, actually overtaking the 324 DOF even with grid discounts. The intersection for 352 DOF and 324 DOF happens at a return of $505.47 per head. This intersection indicates that there is a point at which when the December futures price gets high enough, that returns of the 352 DOF scenario will offset the overweight discount making this the most profitable scenario. The results of this analysis can be seen in Figure 4.2.

Figure 4.2: December Futures Effect on Profitability



4.2.3 Discussion

The sensitivity analysis helps us to decide, based on commodity markets, how to approach the decision of how many days cattle should be on feed. When looking at corn prices, the effect they have on the net returns across the three feeding options is similar until you reach much higher corn prices. Thus, corn prices by themselves may not influence the decision directly.

The December futures sensitivity is interesting because it shows that if the December price reaches the $200/cwt range, even with grid pricing in effect, the higher price will offset heavy weight discount and yield grade discounts and potentially provide higher returns than the shorter 324 DOF. This indicates that HB farms should watch live cattle futures when they are making the decision to extend DOF or not. Again, results should be interpreted in light of the assumptions made.

CHAPTER V: CONCLUSIONS

5.1 Summary

Margins in the cattle industry are getting tighter at all levels, from the cow calf operations to feedlots, and even for packers. To remain profitable, producers must make decisions that place them in the best position to keep their operation profitable, and thinking outside of the box can help to enable this. One option may be extending days on feed for cattle at medium size feedlots. When selling on the grid, results suggest that HB Farms should feed for 324 days to generate the highest profits. 324 DOF puts the most weight on the steer while still avoiding the overweight discount for a heavy carcass that would be incurred by feeding for 352 days. Historical live cattle prices also indicate that there is a seasonal high in week 48, which enables a grower to sell more pounds for more money, but this may not always occur as, on average, there was not a statistically significant difference between week 40 and week 48 live cattle prices. Extending the days on feed requires the team at HB Farms to be in tune with the live cattle markets and the factors that influence them. If cattle can be sold on negotiated flat contracts, absent the grid pricing, it may make extending DOF out to 352 more attractive.

A producer must consider all variables when making their decision on how long to feed. Starting weight, purchase price, interest rates, corn and other feed stuff pricing, and yardage costs will all impact their bottom line. There is also an opportunity cost associated with holding the cattle longer, as the producer not only has the capital that was used to purchase the calf tied up, but is also using the pen space for those cattle instead of potentially bringing a new group of calves in that could potentially have a better return due to market conditions or other similar factors. This aspect was not directly assessed here. This model will help provide an indicator, based on current conditions, what the best DOF

is. The sensitivity analyses indicate to HB Farms that corn prices for the most part should not affect their decision since 324 DOF remains them most profitable, however it also shows that there is a point in the live cattle December futures where it becomes clear that extending DOF all the way out to 352, even if on the grid, is the most profitable option for the farm.

5.2 Limitations

There are several limitations of the model that was built for this thesis. The first limitation is that this model is not meant to be a complete enterprise budget, so it cannot be used to model a full budget for a feed lot. There are parts missing such as transport costs, death loss, variability in feed prices for non-corn feed stuffs, and seasonal effects of weather changes and their effects on average daily gain. Some of this could be assessed with additional sensitivity analyses or increasing complexity of the model developed. The other limitation of this model is changes in futures markets that may not be reflected at the time of the decision-making process. To protect yourself against swings in the market, a grower would need to evaluate their risks and work to mitigate them by hedging future contracts or other methods. Another limitation in this model is that grid discounts and premiums are estimates, and there is no futures pricing available for the grid. If something unexpected happens in the market, and the heavy discounts increase in cwt, or if the threshold for what is considered a heavy carcass were to decrease it would cause the grower to incur further penalties even when only feeding for the 324-day period.
Also, not considered in this model is the effect that place of origin, or the breed of the feeder calf may have on the ADG numbers, or on mortality, which may impact net returns. Certain breeds do not have the ability to grow to heavier weights that come with extending

the DOF and result in live weights of over 1600 pounds. These elevated weights could increase mortality rates in those breeds.

The exact distribution of cattle that would surpass the 1050 lb HCW and would actually incur an overweight penalty is unknown, and this presents a limitation in the model which could be affecting the final result of the most profitable targeted DOF.

5.3 Future Research

There are many areas that future research could be focused on to improve the quality of the model for extended days on feed profitability. The first area that could be looked at is the relationship between quality grades, yield grades, and total days on feed. Most research that is available today does not include cattle that are feed for this many days in a feed lot or to this high of an average weight. Most research focuses on cattle finishing with exit weight in the range of 1,450 pounds, e.g. (Bondurant, et al. 2016).

Another area of research that would be beneficial is to deep dive dressing percentages and average daily gain for heavy cattle. As previously mentioned, most research today doesn't look at fat cattle over 1,450 pounds.

WORKS CITED

Bondurant, Robert G, Jim C MacDonald, Galen E Erickson, Kate Brooks, and Rick N Funston. 2016. "Nebraska Beef Cattle Reports." *Univeristy of Nebraksa - Lincoln.* Accessed 09 30, 2023. https://digitalcommons.unl.edu/animalscinbcr.

Felix, Tara L., and Nathan G. Briggs. 2021. *Ration Formulation for Growing Cattle.* October 19. Accessed February 20, 2024. https://extension.psu.edu/ration-formulation-for-growing-cattle.

FINBIN. 2024. *FIN BIN.* 02 10. Accessed February 10, 2024. https://finbin.umn.edu/FinB.dll/generate?RecId=853730.

Melroe, Tyler. 2023. *Adding Value With More Days on Feed.* February 1. Accessed September 10, 2023. https://www.hubbardfeeds.com/blog/adding-value-more-days-feed-does-it-pay.

Moore, Sean, interview by Steve Hunt. 2024. (January 5).

Shulz, Dr. Lee. 2023. "Ag Decision Maker." *Iowa State University Extension and Outreach Historical Cattle Prices.* February. Accessed February 4, 2024. https://www.extension.iastate.edu/agdm/livestock/pdf/b2-12.pdf.

Shulz, Lee. 2023. *Estimated Livestock Returns.* December 31. Accessed February 10, 2024. https://estimatedreturns.econ.iastate.edu/.

2023. *United States Department of Agriculture Agricultural Marketing Services.* 12 31. Accessed January 10, 2024. https://mpr.datamart.ams.usda.gov/results.do.

2023. *United States Department of Agriculture Market News Service.* November 27. Accessed January 10, 2024. www.ams.usda.gov/mnreports/lm_ct155.txt.

Walker, Julie. 2020. *What Goes Into Calculating Yardage.* July 7. Accessed September 10, 2023. https://extension.sdstate.edu/what-goes-calculating-yardage.

Ward, Clement E., Ted C. Schroeder, and Dillon M. Feuz. 2017. "Grid Pricing of Fed Cattle: Base Prices and Premiums-Discounts." *Oklahoma State University Extension.* March 1. Accessed September 9, 2023. https://extension.okstate.edu/fact-sheets/grid-pricing-of-fed-cattle-base-prices-and-premiums-discounts.html.