Effects of U.S. inflation rates on Fruitful Rim beef cow-calf production input costs

by

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ABSTRACT

The United States relies on the beef industry for both import and export beef; however, the overall U.S. cattle herd size is the lowest it has been since 1954 due to wide variety of factors discussed in this analysis. The United States is one of the top beef exporters in the world, providing beef to many countries. This is also a crucial area of income for the U.S. Due to the increased cost of production and lower profit margins, there have been many herd liquidations across the country, having a negative impact on the national herd size. There are many factors that have affected beef cattle production's overall profitability within the last several years, including but not limited to weather, lack of succession planning, age of cattle producers, global events, and consumer habits. With an increasing inflation rate, many producers are unable to continue beef cattle production due to their inability to financially afford the resources and supplies needed to produce beef cattle, while also providing for their families and covering the increased cost of living. Aside from these things, many cattle producers, as well as other agricultural producers have always been able to rely on lenders to provide capital, allowing them to cover their operating costs until they receive payment for their product.

It is the goal of this study to provide insight through analysis determining the effects of United States inflation on cow-calf production input costs within the Fruitful Rim region. This study uses data analysis through both correlation and regression methods. This analysis focuses on data pertaining to cow-calf producers within the Fruitful Rim Region, collected annually by the U.S. Department of Agriculture and the National Agriculture Statistics Services. The data included numerous categories of input costs as well as the

Consumer Price Index (CPI) from 1996 to 2022 to analyze the correlation between the input costs and in inflation rates.

Through this analysis it was discovered that certain input costs are more affected by changes in inflation than others. For example, there was little to no correlation between the CPI and vet/medicine costs; however, purchased feed cost was directly correlated with the CPI. Purchased feed costs increased $0.55 per head with one unit of increase in the CPI. Cattle for backgrounding were inversely related to the CPI and showed a $0.46 decrease per head of cattle when there was one unit of increase in the CPI. Producers can focus on more affected areas and be less concerned about costs that may not change much. For example, there is no direct correlation between veterinary and medicine costs and the CPI. Therefore, when inflation is increasing this would not be a cost to be as concerned with; however, the results show that purchased feed costs increase with CPI increases. Producers can focus on alternative means of feed, such as grazed feed, to save input costs when inflation is increasing.

The information discovered and summarized in this study provides guidance to producers interested in making educated decisions in different economic situations. As the data shows, there are some categories of input costs that are highly affected by changes in inflation; however, there are others that are not affected at all.

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CHAPTER I: INTRODUCTION

1.1 Motivation

The average consumer does not understand how their food is produced on a large scale. The average consumer is not fully aware of how food is produced before it reaches the grocery store. This gap in information causes a disconnect between the consumer and the average cattle producer. A recent 2022 study by the National Cattlemen's Beef Association showed that less than 30% of consumers, 27% to be exact had any understanding of how beef is produced ("Consumer Beef Tracker", Jan 2022). Cattle producers do not fully comprehend the impact that their operation, regardless of size, has on overall beef production of the United States. The average age of cattle producers is between 65-68, and the average cow-calf beef herd size is approximately 50 head ("US Cattle Production: Sector at a Glance", 2023). The impact that the beef industry has on the world is monumental, but it is often overlooked. Beef is important to the United States economy as well. The United States cattle herd size is the lowest it has been since 1954 (Nelson, 2024). The United States is one of the top beef exporters in the world, providing beef to many countries, and using beef as a major source of income ("Why Do We Export Beef, 2023"). There are many factors that have affected beef cattle production within the last several years, however, inflation has had a significant negative impact on the beef cattle industry.

Inflation has not only affected the beef cattle industry's current production, but it has caused future beef supply issues. Although there are other factors, such as environmental factors, that have caused decreased herd sized within the United States, if beef cattle producers were not experiencing the effects of recent inflation, the cattle

industry would be able to maintain and increase herd size therefore providing beef to the United States, as well as other export countries. “In the ongoing cattle cycle—years of expansion followed by contraction—2022 proved to be a hard-hitting contraction year, as beef cow inventory reached a 60-year low. The current cycle, which started in 2014, also following a significant drought, provided five years of steady expansion in beef cow numbers. However, only to be hit by another drought in 2020, the descent began. While each cycle has a slightly varied length, it tends to evolve gradually and last between eight to 12 years in length—following the biological nature of beef cattle production and cattle producers’ responses to price changes and weather conditions” (Carlson, 2023, para 2). Not only has the overall cost of production increased, but inflation rates have caused many producers to be unable to continue beef cattle production due to their inability to financially afford the resources and supplies needed to properly produce beef cattle. Through the following analysis, it is to be determined what the effect of United States inflation is on cow-calf production input costs within the Fruitful Rim region.

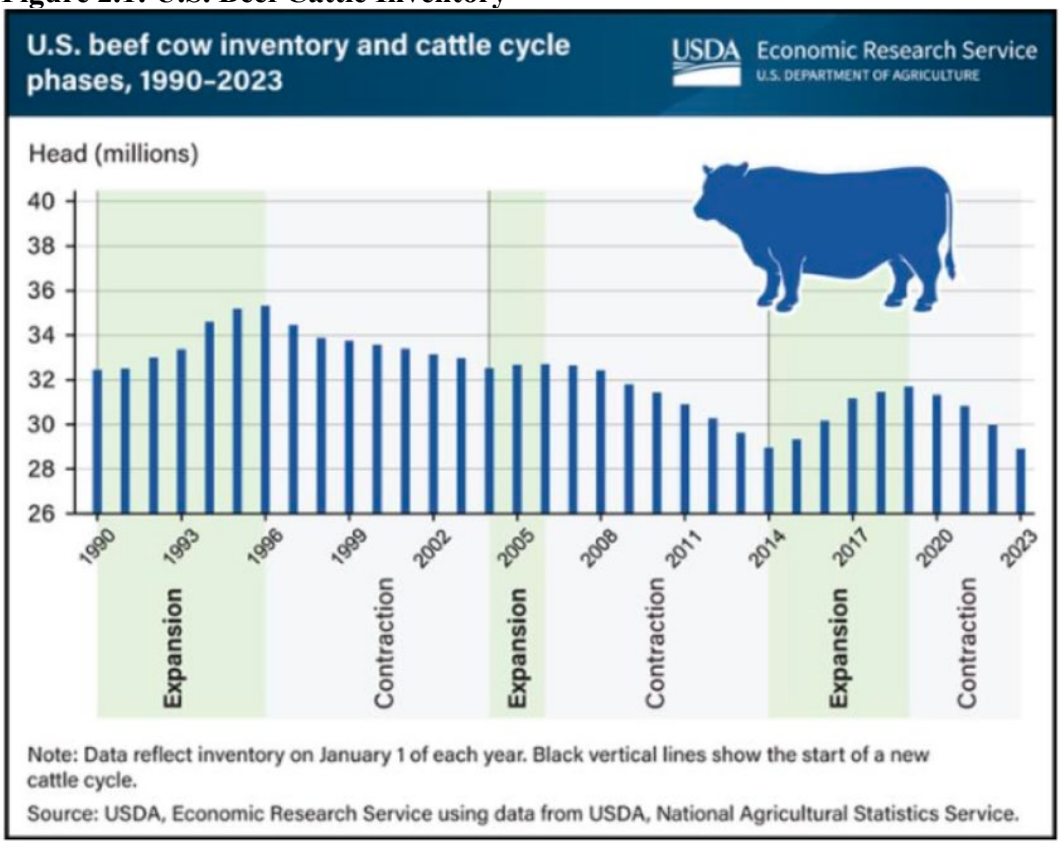
1.2 Objectives

The results of this analysis pertain to cattle producers within part of the United States, focusing on the Fruitful Rim; however, the information gathered from the results is applicable across the United States beef industry in its entirety. It is the goal of this study to determine the magnitude and direction of inflation’s influence on input costs that influence producer profitability.

CHAPTER II: LITERATURE REVIEW

Figure 2.1 below, "Cattle Cycle Uncertainty Looms As Drought Kicks Expansion Down the Road" (Carlson, 2023), shows a continual fluctuation in the herd inventory, but in the recent years, there has been a continual decline in cattle count in comparison to years past. The average cattle herd size in the United States is 50 head of cattle, yet in 2022, the U.S. produced 12.89 million tons of beef. (USDA, 2023)

Figure 2.1: U.S. Beef Cattle Inventory



Source: Carlson, 2023

The U. S. exports beef all over the world. The United States is one of the highest-ranking exporters of beef. Brazil is generally the largest exporter of beef in the world, however, in 2022 the United States was the largest exporter of beef in the global market.

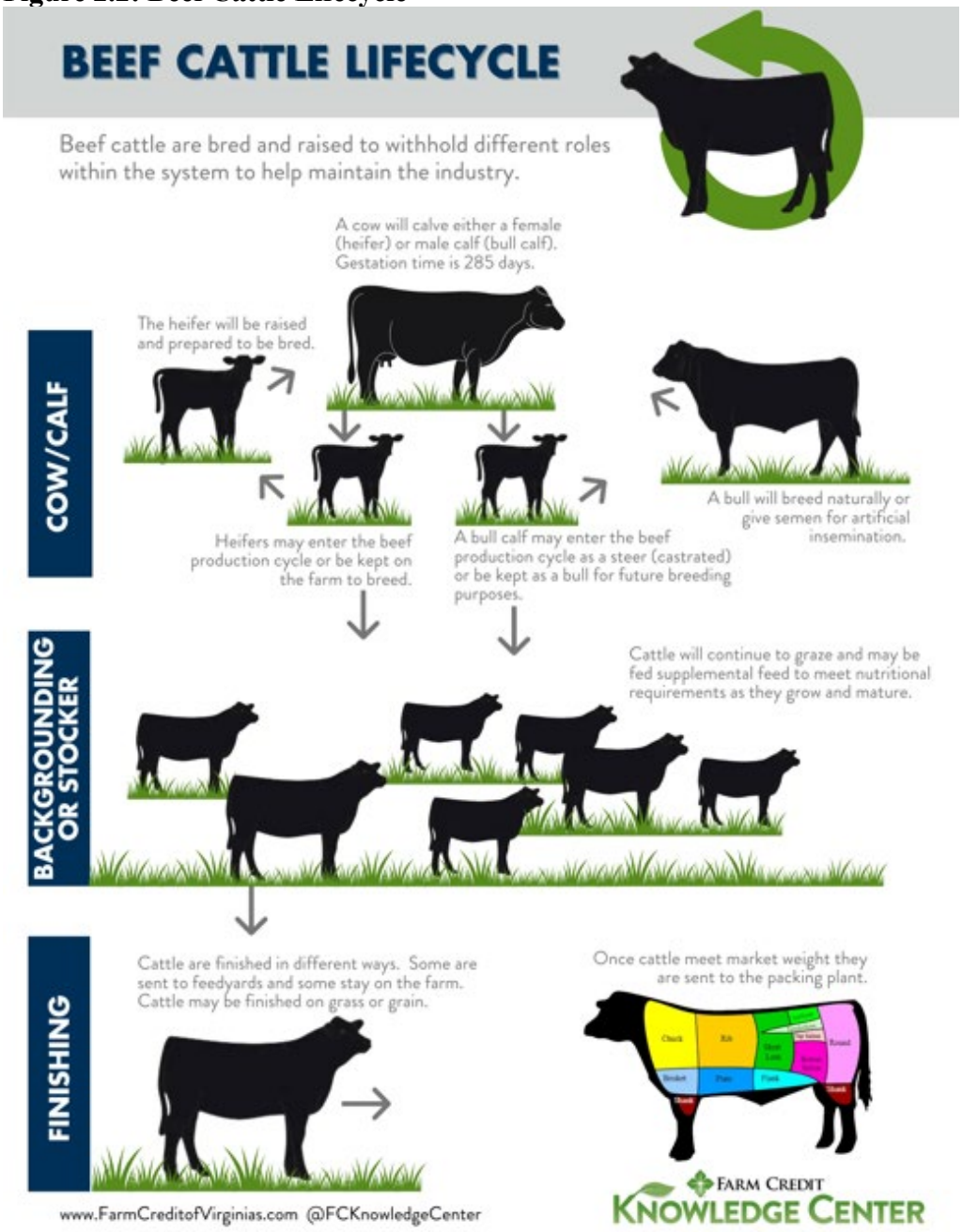
("Why Do We Export Beef?", 2023) The past several years have been full of various hardships that have caused a decline in the overall United States herd inventory ("Market Outlook Beef/Cattle", 2024).

There have been many producers resorting to herd liquidation, allowing them to receive compensation from their cattle as they are sold (Dennis, 2023). This decrease in herd size not only causes issues within the U.S. beef supply, but it also causes a decrease in beef exports and the revenue for the country it generates.

2.1 Beef Cattle Production Overview

The beef cattle industry is made up of multiple segments. The primary categories contain other segment opportunities as well; however, the three primary segments are cow-calf, backgrounding/stocker, and the finishing stage. Cattle go through the stages with the conclusion resulting in the finished product of beef available to consumer, as seen in Figure 2.2.

Figure 2.2: Beef Cattle Lifecycle



Source: Farm Credit, 2021

In this study, the primary focus, and the source of data is the first segment of beef cattle production, the cow-calf segment. “Cow/calf farms or ranches will own a herd of cows that give birth once a year. The calves are kept with their mothers over several months, feeding on milk and grazing on pasture” (Farm Credit, 2021, para 3). Within each

segment, there is a variety of operations, producers, regions, and seasons. Each producer runs their individual operation differently within all of these areas, therefore the costs and profits associated with each segment and each operation is highly variable. The cow-calf segment generally receives payment for their goods, calves produced, once a year depending on their breeding program and efficiency. The payment received also varies based on how they cared for their cattle and calves, the season in which they produced their calves, where they are sold, marketing, how old/ large the calves are upon being sold, the uniformity of the calf group as a whole, and many other factors.

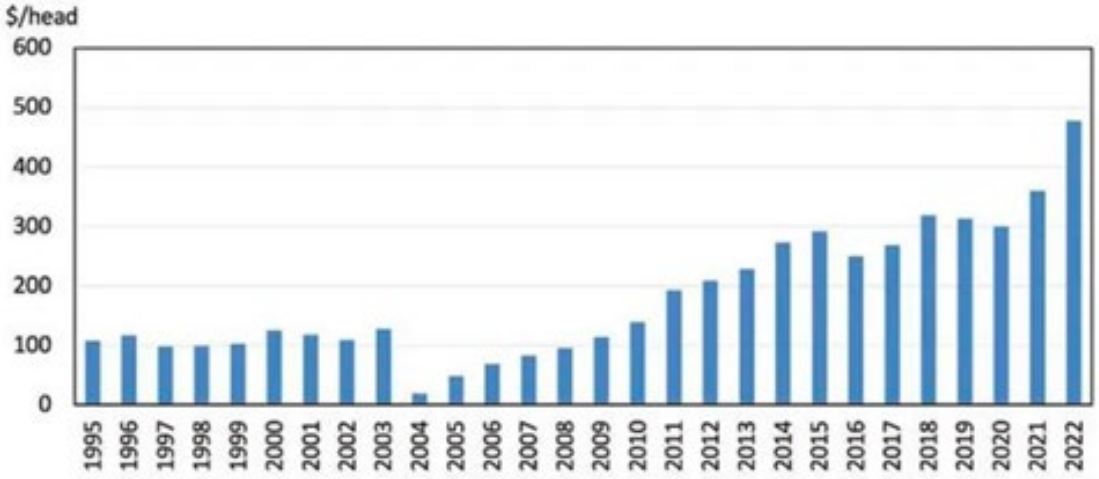
2.2 United States Beef Trade

According to the U.S. Department of Agriculture, "Cattle production is the most important agricultural industry in the United States, consistently accounting for the largest share of total cash receipts for agricultural commodities. In 2023, cattle production is forecast to represent about 17 percent of the $520 billion in total cash receipts for agricultural commodities" ("US Cattle Production: Sector at a Glance", 2023, para 1). In 2023, Brazil was the largest exporter of beef. Demand predictions of the beef export industry show increases within the foreseeable future. Poultry and pork are the most common protein sources consumed within the world. Beef is the third highest traded meat. Consumers and cattle producers are not generally aware of the extreme impact that beef industry has on the U.S. export market, therefore the ongoing decline in the cattle inventory is a serious concern. Cattlemen with operations of all herd sizes have some form of contribution to the herd inventory. It has been a goal of the cattle industry to improve the sustainability and the longevity of the beef cattle industry.

In 2022, *Beef Magazine* released an article explaining how important beef exports are for the cattle industry globally. "Beef wholesalers have access to export markets, so

they can choose whether to grind or export whole muscle cuts. Nothing goes to waste, and more value is created for the entire beef industry. In 2021, beef and veal export value totaled $9.5 billion. This value was created by exporting approximately 11.3% of 2021 U.S. beef production, which totaled 26.973 billion pounds. This year, cumulative year-to-date U.S. beef export value totals $5.6 billion or $477 per head of fed cattle slaughter. This year, cumulative year-to-date U.S. beef export value totals $5.6 billion or $477 per head of fed cattle slaughter. This year, approximately 23% of fed steer value is attributed to beef exports" ("Why do we export beef?", 2023, para 6). The U.S. beef export market is a successful market with continual growth (Figure 2.3).

Figure 2.3: US Beef Industry Export Value



Source: USDA, 2022

Cattle producers are not the only individuals who benefit from beef cattle exports because local consumers are able to receive the cuts that they prefer at an affordable price while undesirable cuts are exported to other countries. For example, according to Beef Magazine, by September of 2022 the US exported 33.7 million beef livers—75% of went to Egypt. This beef liver export to Egypt totaled $67.2 million. To put this into

perspective, this was $67.2 million made off of one product sent to a singular country. Furthermore, in 2021 the U.S. beef export value totaled $9.5 billion and 27 billion pounds. By September of 2022, the US beef exports totaled $5.6 billion ("Why Do We Export Beef?", 2023). Taking all of these things into consideration, it is easy to see why a decline in beef exports will cause a significant decrease in the value generated by that market. Issues that seem like they are only affecting the cattle producers are affecting the beef export market for the United States.

According to Patrick Linnell within a CattleFax report, the overall herd numbers have still not begun to increase as the harsh financial and weather conditions of 2023 has tight production numbers going into 2024. "Cow-calf producers have been reducing inventories for years. Profitability was constrained even pre-pandemic, resulting in producers reducing herd sizes in 2019. The pandemic cattle backlog from plant shutdowns pressured prices and margins further. The severe drought that followed from 2021 to early 2023 raised feed prices and limited forage availability, causing the liquidation to continue. As a result of the prolonged liquidation, 2023 is expected to be the fifth year of consecutively smaller U.S. calf crops. The 33.5 million head projected to be born in 2023 will be 2.8 million head or 8% smaller compared to the cyclical peak in 2018" (Linell, 2024, para 2).

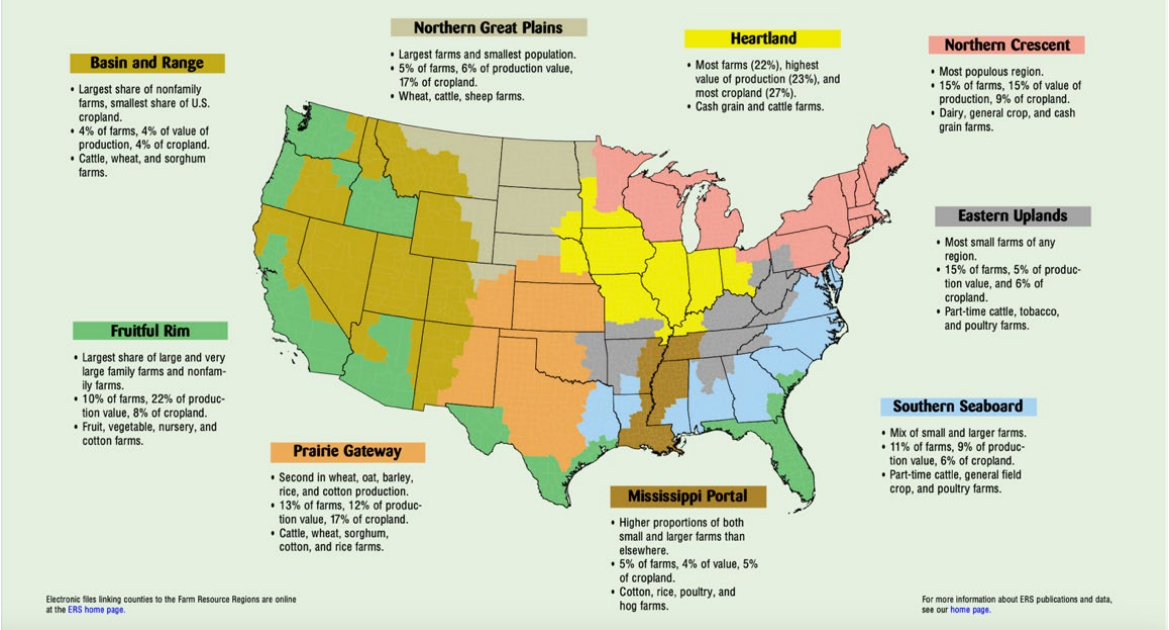
As the demand for beef continues to grow, the United States beef industry must continue to expand to meet this demand. Maintaining and increasing production is critical in both domestic and global beef business for the U.S.

2.3 Fruitful Rim Cattle Production

For this study, the Fruitful Rim was selected due to its beef production primarily being in the cow-calf segment. "The Fruitful Rim includes western Oregon, western

Washington, south-central Idaho, western California, most of Arizona, the southern rim of Texas, Florida, southern Alabama and southern Georgia" (Goldstein, 2023, para 25). The Fruitful Rim is denoted in the green shade (USDA, 2000).

Figure 2.4: USDA Farm Resource Regions



This region also contains some of the highest-ranking states in United States cow-calf production. Texas, California, Florida, Alabama, Georgia, and Oregon all are within the 2024 top 20 beef producing states. The states within the fruitful rim, in their entirety, make up approximately 30% of the United States total beef herd (Beef Production by State 2024, 2024). States such as Florida and California are not commonly known among consumers for their beef population, however, according to the USDA, "Florida ranked 12th in beef cows on January 1, 2022, with an inventory of 895,000, 3.0 percent of the U.S. total. The 2021 calf crop totaled 800,000, which was 15th in the nation and 2.2 percent of the U.S. total. Florida ranked 13th in cow inventory on January 1, 2022 with 1 million head, which was 2.5 percent of the U.S. total" ("Florida Cattle Facts - National Agricultural

Statistics Service", 2022). California beef exports are within their top 10 exported goods, totaling $210 million in profit for the state in 2020 ("California Beef Council Commodity Fact Sheet", 2022).

2.4 Inflation

Pertaining to inflation, one of the ways inflation is measured by the CPI, or Consumer Price Index. This index measures the cost for a certain basket of goods and tracks it in real-time, which allows for historical comparisons in the form of percentage changes. To ensure accurate reporting, the CPI produces two measurements: the seasonally adjusted index and the non-seasonally adjusted index. The non-seasonally adjusted index is most beneficial for comparing year over year changes in prices, while the seasonally adjusted index, accounts for typical seasonal fluctuations, and is used for month over month price changes. One of the areas measured by the CPI index is food and consumable food products. These products have seen significant effects from inflation. In addition to this, in the area of food products, meat is the lowest increase in percentage than other food categories including cereal, dairy, fruits and vegetables, and other foods at home (Consumer Price Index (CPI) Databases, n.d.). Within the meat category, beef was the lowest percentage increase in the category of protein. "Among the five categories that comprise the bulk of the meats category, beef experienced the lowest percent increase from August 2021 – August 2022, currently sitting at 2.5 percent. This constitutes a 37.8 percentage point differential from the egg category, which rose by 39.8 percent from August 2021 – August 2022" ("It's What's for Dinner - Beef Industry Inflationary Trends."). There are many issues that the current family experiences with increased inflation rates, but the decrease in their available spending causes many families to choose to eat at home rather than dine out.

According to Will Snell, “From 2000 to 2020, the average annual rate of inflation (seasonally adjusted) was 2.1% which is generally considered by economists and monetary policymakers as a “desirable” level of inflation to help drive consumption and overall economic growth” (Snell, 2022, para 3). The article goes on to compare the inflation rates between 2022 and 2023. In 2022 the inflation rate remained just below 5%; however, the inflation rate for 2023 increased to beyond 7%. With the increasing inflation rate there is an increase in the overall cost of production. An increase in the cost of commodities, fertilizer, livestock, equipment, etc. all causes an increased cost of production and overall cost of living. Aside from these things, the rates on borrowing money for production costs, land, etc. have also increased, which makes it nearly impossible to gain enough money from production to pay for the cost and the interest.

As inflation causes input costs increases, there is a decline in the ability of the average cattle producer to successfully produce cattle while also providing enough profit to cover the cost of living. In many instances the value of production overcompensates for the other hardships associated with cattle production. When the value of production is no longer greater than the input costs, producers seek to liquidate their herds and relinquish their roles in the cattle industry. This ongoing occurrence is one of the causes of decrease in the U.S. herd size.

The Farm Service Agency (FSA) loans are a crucial part of agriculture production. FSA lending programs are not only necessary for the beginning investments required by producers, but even for well-established producers who are in need of additional assistance during times of hardship. Most of the available loans have interest rates under 10%” (“USDA 2023 Lending Rates”). The FSA provides programs for assisting agriculture

producers. There are still many individuals who require these loans, but have been unable to repay them due to the extenuating circumstances. “In October 2022, USDA provided approximately $800 million in initial IRA assistance to more than 11,000 delinquent direct and guaranteed borrowers and approximately 2,100 borrowers who had their farms liquidated and still had remaining debt” (“USDA 2023 Lending Rates,”2023, para 4). Unfortunately, many producers cannot afford to operate without borrowing finances, but there are also still producers that cannot afford to pay the money back either.

Some of the costs for cattle production are feed products such as hay, protein supplements, minerals, by products, pasture. Other examples are medicine, veterinary expenses, feed mixing, livestock hauling, machinery, fuel, and repairs. Very rarely are the costs associated with beef cow-calf production due to a surplus of product use or irrational expenditures. On top of these production costs, cattle production has a variety of allocated overhead. These total costs must all be considered and removed from the total gross value of production to evaluate the profitability of an operation.

Although the main topic of evaluation for this research is how inflation rate effect beef cattle production, it is important to take into consideration that there are many factors affecting the cattle industry production costs as well as the value of production. In addition to increased inflation rates, there are also numerous environmental factors affecting the cost of beef cattle production. One of these factor environmental factors is drought. “Drought and heat events accounted for 12% of all billion-dollar US disasters from 1980 to 2011, but almost 25% of total monetary damages. Many people do not realize the significant effect that environmental factors have on production in agriculture. Almost 40% (about $30 billion adjusted for inflation) of the cost of the 1988 drought is

estimated to have come from direct losses to agricultural production. Preliminary estimates for the cost of the 2012 US drought based on direct crop losses alone are almost $30 billion and direct losses to livestock and dairy likely added another $5 billion" (Elliott, 2018, para 2). Ultimately, drought affects the United States agriculture production that affects supply and demand along with other factors related to inflation. The current drought has not reached the severity of the 2012 drought. However, the high cost of production and inflation rates along with the drought conditions is causing the current drought to have a severe effect on the U.S. herd size. Inclement weather conditions have long-term effects on agriculture production of all types. For example, drought not only causes a decline in the available resources for cattle during the immediate conditions, but the lack of forage production results in a lack of hay available for use later in the year. Cattle rely on hay in many areas during the winter months when there is little to no available forage. In an instance when there is low hay production, cattlemen must purchase hay from other resources, increasing their input costs to higher levels than when they are producing their own hay. In instances of severe weather conditions, large quantities of producers are seeking the same resources causes a lower available supply. According to University of Missouri Extension specialist Wesley Tucker, "During most droughts, the price of feed goes up, but prices go back to normal when conditions improve. However, input costs – equipment, diesel, fertilizer and labor – likely won't go down anytime soon simply because the drought goes away. If your operation is highly dependent on these inputs, profit margins may evaporate quickly despite higher receipts" (Geist, 2023, para 8).

There have been droughts, increases in interest rates, decreases in available funds for production costs, and overall inflation in general. Figure 2.1 shows that the extreme drought contributed to a decrease in herds that slowly began to increase again across the following five years. However, the recent droughts have caused that increase to begin a decline in herd numbers. Another factor of this drought that many people are unaware of is the decline in condition of the existing cattle. This decrease in body condition is caused from numerous factors such as a decline in forage quality (as well as quantity), a decrease in hay production (as well as availability), an increase in cost of protein supplements/feed, and the environmental hardships from the drought (Peel, 2023). Although these are just some of the factors causing a decrease in cattle body condition, they all have an effect on the overall production of the cattle. Low body condition cattle have a lower chance of getting pregnant, and a higher risk of losing the pregnancy if they do get pregnant. Additionally, if the calf does survive until full term, a cow with a lower body condition score is more likely to have a calf with a lower birth weight and lower weaning weight. All of these factors are also important in beef production (Elliott, 2018).

2.5 Liquidation

According to the USDA, the average age of a cattle producer is 58 years old (USDA, 2023). This is an example of an additional issue that the cattle industry and agriculture industry is facing as a whole that also affects cattle production. There are few succession plans because of this greater age, there are also issues with succession, which has caused an increase in herd liquidation. Along with the severe conditions, increased costs, and inflation-- a lack of succession planning has been another factor in the declining beef cattle numbers. “According to the 2015 Iowa Farm and Rural Life Poll,

among farmers who plan to retire in the next 5 years, only 55% have identified a potential successor" (Arbuckle & Baker, 2015, para 1).

Cattle producers typically receive their farm related income from the sale of the cattle, whether that be their calf crop, cattle they are culling, seedstock sales, etc. Unfortunately, in most cases, this is not a common occurrence throughout the year. Instead, these payments are usually received only a few times throughout the year, and this income is used to pay for any remaining costs of production from that year, as well as, saved for use to cover production costs for the upcoming year. There are many instances when the profit is used up quickly on covering the costs on overdue balances, not leaving enough to cover future production costs. With the increase in input costs, there are many instances when cattle producers rely on other sources of income to fund their operations (Schulz, Arts and Gunn, 2017). As the prices of cattle continue to climb, it is becoming increasingly appealing to producers to liquidate their herds to rid their debts and discontinue the long, labor filled days of producing cattle. It is also important to note that these difficult decisions, extreme conditions, financial hardships and long hours full of hard labor cause a toll on all farmers and ranchers. In a recent study done by the National Rural Health Association, it was shown that farmers and ranchers are 3.5 times more likely to die by suicide than the general population. In this article, the number one major contributing factor for this increased risk was the financial pressures associated with their way of life (Eisnreich, 2023).

The decrease in cattle numbers ultimately has a significant effect on beef exports. Depending on the severity of the issue, there may also be an increase in imports along with the decrease in exports. There is a continual decrease in feeder cattle, and the overall cattle

inventory continues to decrease. It is projected that the beef export ranking for the US would remain, but there is not a likelihood of increase in numbers in the future to improve the ranking.

CHAPTER III: DATA COLLECTION AND ANALYSIS

3.1 Data Collection

The United States Department of Agriculture (USDA) and the National Agriculture Statistics Services (NASS) collect data through multiple surveys related to the costs of production and value of production of the cattle industry across the nation. In this analysis, this information was compiled and evaluated through correlations as well as regressions to examine the effect of inflation rates on the input costs associated with cattle production. These costs included the total operating costs, primarily focusing on the Fruitful Rim Region. Of the overall input cost categories that data was collected for by the USDA and NASS, for this analysis 10 categories were evaluated. These 10 categories include: purchased feed, homegrown harvested feed, grazed feed, cattle for backgrounding, vet and med, marketing, custom services, fuel/lube and electricity, and repairs.

All cattle production costs and income data utilized is per head of cattle. For this particular study, data pertaining to production costs and inflation rates over the years of 1996-2022 was collected for only the cow-calf segment of the cattle industry within the Fruitful Rim region.

Input costs and gross value of production does vary across the United States. For this study the area of focus, according to the USDA, is defined as the “Fruitful Rim” region. The data evaluated in this study directly relates to this area within the United States, and the cow-calf segment, therefore the data may vary in other regions of the U.S or other segments of the cattle industry. The data collected is based on multiple surveys conducted by the USDA on numerous occasions and quantified into an annual average for each

category. Additionally, within this data, the input costs selected and reviewed were purchased feed, homegrown harvested feed, grazed feed, cattle for backgrounding, veterinary and med, marketing, custom services, fuel/lube and electricity, and repairs.

Feed input costs include purchased feed, homegrown harvested feed, and grazed feed. All three of these feed categories have factors affecting it such as weather. For information purposes and clarity pertaining to the data, purchased feed is grain or other types of feed stuff that provides nutrients to the cattle that is not grown on the farm. This may be purchased from a local feed store, cooperative, or another producer. This may be hay, liquid feed, mineral, or commodities. There are always purchased feed costs at some point in the year, the required feed increases or decreases based on seasonality of the region as well as the animal's needs. This "purchased feed' data is an annual summary. The homegrown harvested feed may be any type of the feed stuff, but this feed category is available on the farm and is not purchased from another location. However, the costs associated with this category are input costs required to produce and harvest homegrown feed. For example, if the feed is a commodity, it must be planted, fertilized, harvested, stored, and distributed. Although this is not a "purchased feed", there are still costs associated with the feed category even though it is already "owned" by the producer. Finally, grazed feed is related to forages. Forage quality and availability varies from location to location based on the producer's available resources, management, and input into the forage production. For example, an area with poor soil quality or inadequate weather conditions will require more input costs to produce quality forage than an area with good soil condition and appropriate weather. Some areas may require more fertilizer, more water sources, more seed, or a different planting technique. All of these things require more

costs for more product and additional labor ("Soil Nutrient Management for Forages: Nitrogen").

CPI is most commonly used in evaluations pertaining to consumer products; according to the U.S. Bureau of Labor Statistics, it is the "measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services" (Consumer Price Index (CPI) Databases, n.d.). The formula for CPI is simply the cost of products or services in a current period divided by the cost of products or services in a previous time period, multiplied by 100. The CPI data is collected by the BLS, or Bureau of Labor Statistics. In this study, the annual CPI data was collected from the Bureau of Labor Statistics and used in the correlations of input costs. This data is also used to calculate the rate of inflation.

3.2 Summary Statistics

In this analysis, this data was compiled and evaluated through correlations as well as numerous regressions to examine the effect of inflation rates on the overall profitability and longevity of cattle production. Table 3.1 below shows the average, maximum, minimum, and standard deviation of the variables. All input costs were in units of cost per head of cattle.

Table 3.1: Summary Statistics for Study Variables, 1996-2022

Variable	Average	Maximum	Minimum	Standard Deviation
CPI	213.96	292.7	156.9	36.855
Purchased Feed	$ 53.75	$ 95.87	$ 23.02	$ 26.62
Homegrown Harvested Feed	$ 87.81	$ 146.85	$ 54.88	$ 20.45
Grazed Feed	$ 123.16	$ 194.53	$ 85.87	$ 37.12
Cattle for Backgrounding	$ 35.70	$ 68.09	$ 1.01	$ 22.60
Vet/Med	$ 25.50	$ 42.30	$ 14.00	$ 11.04
Bedding	$ 0.62	$ 1.71	$ 0.28	$ 0.45
Marketing	$ 8.62	$ 14.79	$ 4.54	$ 3.85
Custom	$ 30.02	$ 65.39	$ 6.50	$ 25.88
Fuel,Lube,Electricity	$ 29.01	$ 55.03	$ 18.86	$ 9.65
Repairs	$ 24.50	$ 34.20	$ 18.61	$ 5.59

3.3 Correlation Analysis

Correlation analysis was performed with each of these individual category's annual amounts for every year between 1996 and 2022 along with the annual CPI index for that year. The results of these analyses can be found in Table 3.2. There is a high positive correlation between variables of CPI and Purchased Feed. This shows a direct correlation between these two variables. CPI and grazed feed data provide correlation results showing an inverse relationship through high negative correlation between variables. There is an inverse relationship between the CPI index and Cattle for Backgrounding, which is notated through high negative correlation between variables. This indicates that as the CPI index increases, the cost of cattle for backgrounding decreases. Similarly, if the CPI index decreases, the cost of cattle for backgrounding would show an increase. This cost category scenario not only relates to cow-calf production segment, but also to the backgrounding segment as well. After calves are weaning from the cows, they can be sold or transitioned into a backgrounding program. "An optimal backgrounding plan will induce up to 800

pounds of weight gain in your beef calves. The weight gain from backgrounding comes primarily in the form of muscle and frame development, with little from fattening. These gains are accomplished as economically as possible by making maximum use of forages such as hay and silage in addition to pasture feeding" (Harper, 2005, para 1). Relating to another segment of cattle production for reference: this would show that cattle producers in the backgrounding segment of the cattle industry—who receives income from the sale of their backgrounded cattle—would receive less income as the CPI increases and more income as the CPI decreases.

Similar to the previous two input costs, the cost of veterinarian and medicine has a strong, negative correlation with the CPI index. This inverse relationship shows that an increase in CPI index results in a decrease in the input cost of vet and medicine.

In Table 3.2, bedding and litter have a direct relationship with the CPI index; however, it is only moderately correlated. There is a moderately high positive correlation between the costs associated with marketing in the cow-calf segment of cattle production in relation to the CPI index. This is a direct relationship between the two variables. As the CPI index increases the input costs related to marketing also show an increase. These variables are not as highly correlated as other input costs.

Although the input cost categorized as "custom services" is not directly defined by the USDA, there is a high indirect relationship shown by the correlation for CPI index and custom services. Custom services refer to services which require someone of a particular education or skillset to perform a service. The costs associated with this service decreases as the CPI index increases. It is often assumed that the cost of fuel, lube, electricity is directly associated with inflation, however the correlation between the CPI index showed

little correlation between variables. Although there are likely instances of increase in fuel, lube, and electricity at similar times as increases in CPI index, there is no direct correlation between these two variables in this instance. In Table 3.2 the correlation between input cost of repairs and CPI index has a moderate, positive correlation. Although this is a direct relationship, it is not highly correlated showing that there is some correlation, but it is not a category of input costs that is as related to the CPI index shifts as other areas.

Table 3.2: Correlations Between CPI and 10 Annual Cow-Calf Fruitful Rim Input Costs

	Correlation Coefficient with CPI
Purchased Feed	0.756
Homegrown Harvested Feed	0.198
Grazed Feed	-0.887
Cattle for Backgrounding	-0.748
Vet and Med	-0.804
Bedding and Litter	0.614
Marketing	0.616
Custom Services	-0.828
Fuel, Lube, and Electricity	0.110
Repairs	0.533

There is a direct correlation between the CPI purchased feed, bedding/litter, marketing, and repairs. There is an indirect relationship between the CPI and vet/medicine, custom services, cattle for backgrounding, and grazed feed. These input costs should also have an inverse relationship in the regression analysis. Other costs such as homegrown harvested feed, and the fuel, lube, and electricity category have little to no correlation with the CPI. The input costs with no correlation will also likely not have statistical significance in the regressions.

CHAPTER IV: RESULTS AND CONCLUSION

4.1 Regression Results

For the regression analysis for CPI and purchased feed variables, Table 4.1, you can see that for every 1 unit of increase in the CPI, the purchased feed cost would increase by $0.55 per head. In perspective of an average cattle herd, 50 head of cattle would have an increased purchased feed cost of $28 due to the single unit of increase in CPI. The CPI and Homegrown Harvested Feed shows little to no correlation between variables, and the regression analysis, Table 4.2, shows no statistical significance based on the p-value of 0.3228 and a R-squared value of 4%. The regression analysis for these CPI and grazed feed, Table 4.3, shows an inverse relationship where for a 1 unit increase in CPI, there is a $0.89 decrease per head in grazed feed. This could be due to the decreased amount of input producers are able to put into the forage program they have, or it could reflect the efficiency of utilizing forages available during times of increased inflation vs investing in purchased feed. Table 4.4, CPI and cost of cattle for backgrounding, for a single unit increase in CPI there is a $0.46 decrease in the cost of cattle for backgrounding. Seen also in the correlation above, there is an inverse relationship between these two factors. Based on this information, the backgrounding segment input costs may have unique results in comparison to the cow-calf segment.

In the regression for the CPI and vet and medicine, Table 4.5, it reflects a decrease in cost of vet/med of $0.24 per head of cattle when the CPI index increases by one unit. This may seem counterintuitive, but as other input costs increase, producers are more lenient with their calls for veterinarian services. Producers tend to handle more situations themselves, on their operations to avoid calls to the vet. Additionally, as the input costs increase, and the amount paid for cattle also increases, herd sizes are decreasing due to the

sale of cattle, therefore there are less cattle to tend to which may also be reflective in this indirect relationship.

The CPI and marketing regression shown in Table 4.7 shows that for a single unit increase in the CPI index, the marketing cost increases by $0.06 per head of cattle. The p-value for the CPI is less than 0.001, showing very strong evidence against the null hypothesis. In Table 4.8, with a single increase in CPI there is a decrease of $0.60 in the cost of custom services. CPI and fuel, lube, electricity, in Table 4.9, p-value shows insignificant, which also relates to the correlation results stating the no correlation between the two values. Finally, CPI and repairs regression, Table 4.10, has less than 30% R-squared but shows that for 1 unit increase of CPI there is a $0.08 increase in cost of repairs.

Table 4.1: CPI and Purchased Feed Regression

Regression Statistics	
Multiple R	0.75560328
R Square	0.570936317
Adjusted R Square	0.553773769
Standard Error	17.78298696
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	10519.99035	10519.99035	33.26640888	<0.0001
Residual	25	7905.865635	316.2346254		
Total	26	18425.85599			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	(63.0265)	20.5337	(3.0694)	0.0051
CPI	0.5458	0.0946	5.7677	<0.0001

Table 4.2: Homegrown Harvested Feed

Regression Statistics	
Multiple R	0.1977
R Square	0.0391
Adjusted R Square	0.0007
Standard Error	20.4474
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	425.3667	425.3667	1.0174	0.3228
Residual	25	10452.3958	418.0958		
Total	26	10877.7625			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	64.3288	23.6102	2.7246	0.0116
CPI	0.1097	0.1088	1.0087	0.3228

Table 4.3: CPI and Grazed Feed Regression

Regression Statistics	
Multiple R	0.8868
R Square	0.7864
Adjusted R Square	0.7778
Standard Error	17.4961
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	28167.4844	28167.4844	92.0163	<0.0001
Residual	25	7652.8543	306.1142		
Total	26	35820.3386			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	314.2435	20.2025	15.5547	<0.0001
CPI	(0.8931)	0.0931	(9.5925)	<0.0001

Table 4.4: CPI and Cattle for Backgrounding Regression

Regression Statistics	
Multiple R	0.7482
R Square	0.5598
Adjusted R Square	0.5421
Standard Error	15.2933
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7434.3548	7434.3548	31.7865	<0.0001
Residual	25	5847.1030	233.8841		
Total	26	13281.4578			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	133.8654	17.6589	7.5806	<0.0001
CPI	(0.4588)	0.0814	(5.6380)	<0.0001

Table 4.5: CPI and Vet/Med Regression

Regression Statistics	
Multiple R	0.8042
R Square	0.6467
Adjusted R Square	0.6326
Standard Error	6.6902
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2048.4521	2048.4521	45.7665	<0.0001
Residual	25	1118.9688	44.7588		
Total	26	3167.4209			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	77.0320	7.7251	9.9717	<0.0001
CPI	(0.2408)	0.0356	(6.7651)	<0.0001

Table 4.6: CPI and Cattle for Bedding/Litter Regression

Regression Statistics	
Multiple R	0.6144
R Square	0.3775
Adjusted R Square	0.3526
Standard Error	0.3628
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.9957	1.9957	15.1601	0.0007
Residual	25	3.2910	0.1316		
Total	26	5.2867			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	(0.9928)	0.4189	(2.3698)	0.0258
CPI	0.0075	0.0019	3.8936	0.0007

Table 4.7: CPI and Marketing Regression

Regression Statistics	
Multiple R	0.6159
R Square	0.3794
Adjusted R Square	0.3545
Standard Error	3.0948
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	146.3599	146.3599	15.2812	0.0006
Residual	25	239.4451	9.5778		
Total	26	385.8050			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	(5.1546)	3.5735	(1.4425)	0.1616
CPI	0.0644	0.0165	3.9091	0.0006

Table 4.8: CPI and Custom Services Regression

Regression Statistics	
Multiple R	0.8283
R Square	0.6861
Adjusted R Square	0.6735
Standard Error	14.7873
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	11946.9232	11946.9232	54.6356	<0.0001
Residual	25	5466.6358	218.6654		
Total	26	17413.5590			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	154.4619	17.0747	9.0463	<0.0001
CPI	(0.5816)	0.0787	(7.3916)	<0.0001

Table 4.9: CPI and Fuel, Lube, and Electricity Regression

Regression Statistics	
Multiple R	0.1099
R Square	0.0121
Adjusted R Square	(0.0274)
Standard Error	9.7843
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	29.2605	29.2605	0.3057	0.5853
Residual	25	2393.2961	95.7318		
Total	26	2422.5567			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	22.8536	11.2977	2.0228	0.0539
CPI	0.0288	0.0521	0.5529	0.5853

Table 4.10: CPI and Repairs Regression

Regression Statistics	
Multiple R	0.53275935
R Square	0.28383252
Adjusted R Square	0.25518582
Standard Error	4.82613737
Observations	27

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	230.774026	230.774026	9.90803584	0.00422278
Residual	25	582.290048	23.2916019		
Total	26	813.064074			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	7.20910094	5.5726547	1.29365649	0.20760933
CPI	0.08083788	0.02568154	3.14770326	0.00422278

Elasticities are calculated from the coefficient of CPI in the regressions and the averages of the CPI and operating costs, in order to get the relative economic effect with a change in the CPI. A 1% increase in the CPI will result in a 0.26% increase in homegrown harvested feed, a 1.55% decrease in grazed feed, a 2.75% decrease in cattle for backgrounding, a 2.02% decreased in veterinarian and medicine, a 2.61% increase in bedding, a 1.60% increase in marketing, a 4.15% decrease in custom services, a 0.21% increase in fuel, lube, and electricity, and a 0.71% increase in repairs, respectively for the.

4.2 Implications

The results of this study have helped provide cattle producers with insight to the variation in affect that inflation, though the CPI index, is shown to have on different input costs. The data show that the CPI index has little to no correlation to the cost of fuel, lube,

and electricity or the cost of harvest feed on a cow-calf operation, but the category of purchased feed had a strong, direct relationship with the CPI index. As the CPI index increases, the cost of purchased feed increases by $0.55. There is data above that show categories of input costs that are inversely related to the CPI index, such as grazed feed, cattle for backgrounding, vet/med, and custom services. The cost of production and overall profitability of the cattle industry varies from year to year; however, these trends remain the same over this analyzed 26-year period. The data collected reflects that different input costs have a different relationship with the rate of inflation. Although it is often stated that the overall cost of production increases as inflation increases, this data shows that there are some areas of input costs that cow-calf cattle producers could focus on in effort to be more efficient in their spending during times of increase inflation. The feed costs can be controlled and focused on by decision making, planning, and proper preparation. In times of increasing CPI, it would be advisable that producers spend less on purchased feed as this cost will also increase. During declining CPI, producers could purchase feed for future instances of increased CPI. Additionally, the purchase or sell of backgrounding cattle could be limited to certain times based on the CPI fluctuation. Although this study has focused on the Fruitful Rim cow-calf beef cattle producers, it could be taken into consideration that there are additionally similar trends in the data throughout the entire U.S. beef industry.

4.3 Limitations

It is critical to consider that as technology has advanced, it has been easier to gather and store more accurate information from cattle producers. There may be variations in the survey group size, as well as the efficiency of the data due to these things.

CPI is a national measurement of inflation, whereas the other data analyzed was specifically relative to the Fruitful Rim. If specific CPI data was available for the region of the Fruitful Rim, it would provide more accurate information.

This similarly relates to the limitations in data due to the segmentation of the cattle industry. Generally speaking there are numerous segments within the cattle industry. The data, situations, and challenges vary from segment to segment across the cattle industry. Similar to segmentation variation, the cattle industry also experiences severe variation based on seasonality. The cattle industry has a wide variation in income based on the season, and based on the individual operations chosen program. Depending on which segment of the industry the producer is in, there are different fluctuations in income. For example, cow-calf producers may have a higher income when they sell their calves and a lower income during other portions of the year. Input costs are going to be higher in some timeframes than others throughout the year depending on segment and season.

The USDA data used within this study is collected through surveys taken by producers across the United States. There may be variation in the individual methods of data input, influencing the results of the end survey figures. The USDA does specify and define numerous categories within the survey to help eliminate discrepancies when producers input their data, but this potential for variation is a limitation that must be taken into consideration.

4.4 Conclusions

Cow-calf producers within the Fruitful Rim region can review their input costs and use the data to make educated decisions in areas of costs affected more strongly by inflation. This also allows them to make futuristic decisions in effort to alleviate unnecessary costs. For example, if the CPI is predicted to remain high, or increase, it would

be best to purchased feed stuff or plan alternative options of feed seeing as though the cost of feed was impacted by CPI. During times of low or declining CPI, cattle producers in the backgrounding segment would receive more income. This would be an opportune time for backgrounders to sell their cattle rather than selling during an increasing CPI in which they would be losing value.

Additionally, information gathered is also beneficial to educate people outside of the agriculture industry on the high costs and sacrifices involved in producing beef for consumers, which is highly comparable to the costs and sacrifices associated with most forms of agriculture production. These results can educate cattle producers on the impact that they have on the United States beef industry, while also educating them for the purpose of efficiency and sustainability within their operations.

The results of this analysis pertain to cattle producers within the region of the United States known as the Fruitful Rim; however, the information gathered from the results maybe applicable across the United States beef industry. The information gathered is beneficial to educate people outside of the agriculture industry on the high costs and sacrifices involved in producing beef for consumers, which is highly comparable to the costs and sacrifices associated with most forms of agriculture production. Cow-calf producers within the Fruitful Rim can utilize this information to make educated financial decisions with the understanding of which input costs are more effected by inflation.

To further the progression of this analysis, research with data specifically related to each individual segment of the cattle industry, categorized by each state, would greatly increase the accuracy of future data analysis. Surveys could be conducted to discover additional costs producers are required to invest in due to inflation related increases in

products. These surveys could also gather information in each region pertaining to weather conditions and the financial repercussions of these conditions.

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