

An economic analysis of cull cow price trends in Alabama

by

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Abstract

The objective of this study is to analyze the slaughter cow prices in Alabama from 2004 through 2018 to help cow-calf producers capture the most value for their cull cows based on historical price trends. A producer typically sells cull cows shortly after the decision is made to cull the cow from the herd, and in many cases, this is the best option in terms of profitability. Another option is to delay the marketing of cull cows to add value and profitability for the producer. A producer must account for all added input costs to determine if delaying the marketing of cull cows will be more profitable to the operation. When the decision to delay the marketing of cull cows is made, options to add value include increasing weight and body condition, waiting to capture a higher price due to price seasonality, or marketing as a bred replacement female instead of a slaughter cow. The data shows that instead of selling in October and delaying marketing to increase weight and body condition and selling in March of the following year showed an increase in price except for October 2008 – March 2009 and October 2015 -March 2016. In the Lean slaughter cow category by delaying marketing to increase weight and body condition to move up to higher range within the Lean category there is on average \$1.18 - \$12.26 cwt increase in price. In the Boning slaughter cow category by delaying marketing to increase weight and body condition to move up to a higher range within Boning category is on average \$1.15 - \$2.05 cwt increase in price. In the Breaker slaughter cow category by delaying marketing to increase weight and body condition to move up to a higher range within the Breaker category on average \$0.19 - \$1.73 cwt increase in price when going from Breaker Lt to Breaker Md. Yet delaying marketing to increase weight and body condition to move from Breaker Md to Breaker H on average \$0.19 - \$1.28 cwt decrease in price. The data shows there is little to no benefit in delaying the sale to move to a higher range within the

Breaker category as the added input costs will likely outweigh any increase in value. When a producer can increase weight and body condition to enable the cow to move to a higher grade this can add value, moving from Lean to Boning on average sees \$5.93 - \$7.45 cwt increase in price, however moving from Boning to Breaker averages \$1.11 – \$2.93 decrease in price. The price seasonality of the slaughter cow market shows that prices are typically higher in the spring and summer months- May typically being 6-8% higher than average price and then price falls below the average price in the fall- November being 10-12% lower than average price due in part to the supply of slaughter cows. Additionally, when a producer makes the decision to delay the marketing of cull cows to a later date, exposing the cows to bull will allow the producer the potential to market the cows as a bred replacement instead of a slaughter cow. A producer must look at their current resources in terms of pasture space and forage availability to determine if marketing of cull cows is more profitable to sell immediately or to delay to a later date.

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Introduction

Cattle producers know at some point a cow will likely be culled from the herd, sometimes the challenge producers have is knowing when the best time is to cull the cow. Cull cow receipts typically account for about 20% of the farm's income (Tronstad and Teegerstrom 2003); this is sometimes overlooked by producers when they simply take the cow to the sale without giving a thought about "is now the best time to sell this cow?" The cull cow market has very strong seasonal price trends in the U.S., typically prices are lower in the fall months as compared to spring and summer months (Peel et al 2002). This is due in part to the fact that most of the cattle in the northern and western U.S. states calve in the spring as this fits their environment in terms of available forage and weather conditions (Adams et al 1996 and Clark et al 1997). These producers will wean calves and pregnancy check cows in late summer and early fall and is the typical time producers make cull decisions. In Alabama due to the availability of forage almost year-round and milder weather conditions, producers can calve almost year-round. This leads many cattle producers in Alabama to ask "when should I sell my cull cows?"

Producers need to decide whether the cow should be culled immediately or explore the potential that delaying could be more profitable. Before a producer adds more input costs, they should evaluate the body condition score of the cull cows and understand the amount of feed or forage needed to increase the body condition score of the cull cows to be able to move to a more desirable slaughter class with the potential to capture higher prices. This leads to the hard decision a cattle producer must face "do I keep the cull cow and feed/graze her to increase weight and body condition score with the hopes of higher prices in the future that will exceed my input costs?" Observing trends in the data will help Alabama producers make a more informed decision on when to market and how to manage cull cows to increase returns to the farm.

Background

The United States is third in the world in terms of beef cattle inventory with 91,902,000 head, yet the United States is the world's largest producer of beef- producing 12,724,000 metric tons of beef for consumption as of January 2022 (USDA ERS). The industry is roughly divided into two production sectors: cow-calf operations and cattle feeding.

Cow-calf operations are located throughout the United States, these operations depend on range and pasture forage conditions, which in turn depend on variations in the average rainfall and temperature for the area. Typically, cow-calf operations are forage based, meaning cows will graze pastures year-round to maintain themselves and raise a calf until it is weaned. Most calves are born in the spring and are weaned when they are three to seven months old. The average cow-calf operation is approximately 40 head, and operations with 100 or more beef cows compose approximately 10 percent of all cow-calf operations. Operations with 50 or fewer head are largely part of multi-enterprises or are supplemental to off-farm employment (USDA ERS). The majority of beef cows in the United States are located in the southern plains and southeast mainly due to longer grazing seasons which reduce the need for high price supplemental feed (McBride et al 2011).

Once calves are weaned producers must decide if they will retain the calves as replacements in their herd, otherwise the calves will enter the feeding sector. There are multiple ways a weaned feeder calf can begin in the feeding sector- stockers, preconditioning, or backgrounding. Stocker calves are typically grazed for three to six months to add weight before going to the feedlots. This is a common practice in the

southeast due to the ability to produce forage year-round. Preconditioning calves is usually a short time 30 – 60 days after weaning to get the calves vaccinated, dehorned, castrated, and started on feed prior to sending to the feedlots. Backgrounding is when calves are put on feed usually three or four months prior to sending to feedlots.

Regardless of how the calves start the process, they all eventually end up at a feedlot to be fed a grain-based ration to produce a carcass to meet minimum USDA quality grades. Majority of the feedlots are in the great plains- Kansas, Nebraska, Oklahoma panhandle and Texas due to a drier climate. Most of the feedlot operations are 1,000 head or less capacity but they make up a small portion of the fed cattle market (USDA ERS). The industry is shifting towards fewer operations that are larger and more specialized to produce cattle that can meet different requirements for exporting and branded beef programs.

Alabama has 714,000 beef cows and ranks 16th in the U.S. in number of beef cows and just over 22,000 cow/calf operations that ranks 12th in the U.S. The average operation size in Alabama in 2019 is 59 head and ranks 33rd in the U.S. The Southeast region consists of Alabama, Arkansas, Georgia, Florida, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, and Virginia. In comparison to the North, South Central and West Regions the Southeast has the lowest number of cattle/calves but the highest number of beef cows. The low number of cattle/calves is due in large part to the lack of cattle on feed in the Southeast region when compared to the other regions. The Southeast region has the highest number of cattle/calves operations with 85% of the operations in the southeast region being under 100 head. Alabama is a good representation of the Southeast region as it ranks 7th in number of cattle/calves, 6th

in number of beef cows, 5th in number of cattle/calves operations, and tied for 6th for average operation size in Southeast region (USDA NASS 2019).

Changes in herd size can be influenced by several things- age of producer, addition/reduction of land, available capital, labor resources and more importantly due to cattle cycle. The cattle cycle refers to cyclical increases and decreases in the cattle herd over time, that are influenced by environmental conditions, cattle prices, and the production cycle of cattle (Anderson et al 1996). The cattle cycle averages 8-12 years in duration, with the most recent full cycle beginning in 2004 through 2014 when the national cattle herd size was the smallest since 1952. (USDA ERS). The length of cattle cycle can be shortened or extended as a response to an environmental change such as drought, a shift in cattle prices, or unforeseen catastrophic event. Understanding breeding stock productivity and inventory along with market timing can help producers in the decision to expand, reduce, or maintain herd size (Rosen et al 1994, Marsh 1999). Cattle producers will see times of growth and reduction in herd size, the timing in respect to the cattle cycle can have a big impact on an operations profitability. A constant inventory or slow sustained growth is better in the long run rather than trying to maintain a countercyclical inventory (Bently et al 1981, Hamilton et al 2000). Producers know that as cows get older their productivity decreases which decreases profitability (Rucker et al 1984), combined with genetic progress made with each generation of replacement females will factor in a cow's value in the operation (Melton 1980). Understanding the current status of the cattle cycle and current state of cow herd in terms of age or productivity can impact the timing for culling a cow.

The most influential factor in terms of profitability of cull cow management is the market price of cull cows and understanding price seasonality. Cull cows have the largest seasonal price swings of all cattle classes and there can be differences in seasonal price patterns based on geographic location (Peel et al 2002). Price seasonality for cull cows is primarily based on most of the United States cow herds calving in the spring and weaning calves in the fall which is typically when cows are pregnancy checked and evaluated to be retained in the herd or culled. Typically, this leads to an influx of cull cows being marketed in the fall months which the increase in supply drives the price down. Then in the spring months the price typically increases due to supply being slowed as the spring calving cows are raising calves. Fall calving cow-calf operations can naturally take advantage of price seasonality by weaning calves and making decisions on cows during spring months. In most cases a fall calving producer's best interests are to sell a cull cow immediately as waiting will not increase profitability. There still are opportunities for fall calving producers especially in the Southeast to graze cull cows for a short time to increase their weight and potentially move to a higher slaughter grade. Again, the issue becomes on when is the best time to sell to capture higher prices to maximize profits.

Previous Studies

Most cattle enterprises today are facing increased input costs due in part to increased prices for feed, fertilizer, fuel, machinery, seed, etc. Producers must look for ways to reduce input costs or find alternatives that can lessen the increased input costs. Such as when feed prices go up producers should consider looking at cheaper alternative feedstuffs or purchasing in bulk to help mitigate the cost increase. However, there is only so much a producer can do in terms of

reducing input costs which is why in many cases cattle producers look at ways to increase profit from cattle sales. For cow-calf operations, selling weaned calves is the primary source of income for the enterprise, and finding ways to increase pounds sold or marketing strategies to increase prices for calves is necessary for the profitability of the enterprise. In most cases producers do not think of the impact selling cull cows has on the enterprise income and profitability, yet they account for about 20% of the farm's income (Tronstad and Teegerstrom 2003). There are many reasons a cow is culled from the herd such as- age, sick/disease, calving issues, progeny performance, injury, temperament, and open. In many cases the reason the cow is being culled will lead producers to sell immediately. Given the current state of high input prices a cow calf producer must look at cows and evaluate them as an asset, which is to say are they more profitable for the operation by remaining in herd or sold for slaughter (Lovell 1974, Paarsch 1985). In many cases a cattle producer will take all cull cows regardless of reason they are being culled to sell at a local stockyard shortly after they wean calves. However, there is potential to add value to cull cows by holding the cow and selling later with the hope of getting a better price.

When it comes to managing and marketing cull cows there are numerous factors that affect value, yet the focus for a producer is understanding body condition scores, cull cow slaughter grades, and the cull cow market (Gill 1998, Stohbehn et al 2002, Wright 2005, Peel et al 2008, Blevins 2009, Fuez 2010). Feeding or grazing a cull cow to increase body condition, or to delay selling cows due to price seasonality is not a new concept, however producers need to look at the cost versus benefits. Producers must consider the impact of keeping cull cows in addition to the remaining herd in terms of space, additional costs for feed and labor (Yager et al 1980 and Little et al 2002). Most of the previous studies were based on the premise of spring calving herds due

to that is when majority of the U.S. cow-calf operations calve, with the decision to cull the cow immediately in the fall or keep her through the winter to sell in the spring.

Body condition scoring beef cows is a useful management practice that cattle producers can utilize to evaluate the body fat and nutritional status of a cow. Beef cows are scored from 1 (emaciated) to 9 (obese), with 5 being average, neither thin nor fat. Body condition or fat can be visually determined by looking at key areas- back, tailhead, hooks, pins, ribs, and brisket. While body condition scoring is subjective, as one person may score different than another, producers can easily evaluate cattle into following categories- thin (body condition score 1 to 3), borderline (body condition score 4), optimum (body condition score 5 to 7), or too fat (body condition score 8 to 9) (Segers et al 2014). Producers need to have a good understanding of the current body condition score of a cow because to change a single condition score for a medium to large frame cow takes about 75-150 lbs change in body weight (Encinias et al 2000, Eversole et el 2005, Segers et al 2014). The body condition of a cull cow has a big impact in terms of carcass value, the price difference in terms of carcass value between body condition score 2 versus body condition score 6 is significant. Marketing cows at a body condition score 6 could optimize the economic returns for a cow-calf producer. Body condition scores 7 and over typically grade higher due to increased fat, but the carcass value goes down likely due to increased fabrication costs and higher trim losses (Apple 1999). A producer must evaluate their cows and any cow that is body condition score 6 or higher should be sold immediately, as holding these cows will likely not improve the net return (Raper et al 2014). There is opportunity to increase the salvage value of younger cows with a lower body condition score by holding to take advantage of price seasonality (Strohbehn 2002, Sawyer et al 2004 and Raper et al 2014).

In the Midwest and Western United States where most feedlots are located there has been a growing trend of putting cull cows on feed to increase profitability by increasing body mass and improved carcass characteristics (Price et al 1981, Pritchard et al 1993, Sawyer et al 2004). It is noted that cows have poorer feed conversions than compared to feeding yearling calves in a feedlot setting, the greatest gains will be in early stage due to compensatory gains then cows will level off to a slower rate of gain (Pritchard et al 1993, Funston et al 2003). In terms of carcass quality feeding cull cows over 100 days showed significant improvement (Wooten et al 1979, Pritchard et al 1993), however more recent studies have shown the greatest improvement of carcass traits in the first 60 days (Schnell et al 1997). The use of implants can improve the feed conversion and increase carcass characteristics of cull cows on feed with little impact in terms of cost (Funston et al 2003 and Wright 2005). A producer must still determine with lower feed efficiency, does the added input cost of feed outweigh any added value through improved carcass grades (Price et al 1981, Stohbehn et al 2002, Funston et al 2003). Since there are very few true feedlots in the Southeast (Asem-Hiable et al 2018) the potential to feed cull cows would require producers to dedicate a pasture or location to feed cows separate from cows remaining in the herd. Feeding a lower level of supplements over a longer period of time will get the most response to the supplement as higher levels of supplement reduce forage intake and digestibility (Kunkle et al 1994). Producers must look at how feeding cull cows fits in their existing operations, and if profitability of feeding cull cows is sufficiently competitive to displace other enterprises (Little et al 2002).

Producers can look at the potential of grazing culls cows as a lower input method to improve body condition when forage resources are available (Peel et al 2008, Amadou et al 2012, Raper et al 2014). For grazing to be a viable option producers must have available forage and

implement basic management practices (Hoveland 1986, Troxel et al 2007). There is potential for producers in the Southeast, no matter the size of the operation, to manage their forage system to extend the grazing season to 300 days (Jennings et al 2020). A benefit of cattle producers in the southeast in terms of carrying capacity in acres/cow is 2 acres/cow which is significant when compared to midwestern producers carrying capacity of 14 acres/cow (Coady et al 1993). This gives producers in the Southeast an advantage from a space standpoint for grazing additional cull cows for a short time frame. Producers could graze thin cows on higher quality pasture or graze thin cows on pasture first, then the cows with higher body condition scores to clean up residual forage (Kunkle et al 1994).

In many cases the reason a cow is culled is due to being open, which reproductive performance is greatly influenced by body condition score (Selk et al 1988, Segers et al 2014). Given the likelihood a cull cow is open, producers that are going to delay sending the cow to market can potentially add value by having a bull with their cull cows (Blevins 2009, Amadou et al 2012). This is a more recent concept, but it gives the producer flexibility as the cow can be sold either as a replacement or for slaughter, depending on what is most profitable at that time she is marketed. Generally, producers are willing to pay more for a pregnant cow that an order buyer will pay to send the cow to slaughter (Troxel et al 2002). It is difficult to predict the selling price of replacement cows sold in weekly livestock auctions as there are many factors that influence price, such as number of replacements being sold, quality of replacements, and more importantly the number of buyers wanting replacement cows.

Methods and Materials

The USDA AMS reports slaughter cow prices in the following categories- Breaking, Boning, and Lean. Breaking cows are higher conditioned slaughter cows that are expected to yield

carcasses with excellent dressing percentages in the range of 75-80% lean. A typical breaking cow is a body condition score 7 and above with more than .35 inch of backfat at the 12th rib. Boning cows are moderate conditioned slaughter cows that are expected to yield carcasses with an average dressing percentage in the range of 80-85% lean. A typical boning cow will have a body condition score of 5-7 and have .15-.35 inches of backfat at the 12th rib. Lean cows are lighter conditioned slaughter cows that are expected to yield carcasses lower in dressing percentage in the range of 85+% lean. A typical lean cow is very thin with a body condition score of 1-4 with less than .15 inch of backfat at the 12th rib. In each category of slaughter cows, it is further broken down by weight of cow, such as Breaking Md 1200-1600 is breaking cows weighing 1200 pounds to 1600 pounds. This allows us to compare cattle weighing the same range in the same category in Alabama to the rest of the U.S. Since the majority of previous research has utilized data from the Mid-West, I compared the monthly price data from Alabama (USDA, AMS 2004-2018) to monthly price data from Oklahoma City (LMIC 2004-2018) on slaughter cows. The Oklahoma City data only had data in the following categories Breaking 1200-1600, Boning 1200-2000, Lean 750-850, and Lean 1200-2000, I compared the same categories from Alabama to see if there was any difference. As you can see in figures 1, 2, and 3 Alabama has followed the same price trend as Oklahoma City from 2004-2018, with the only noticeable difference is Alabama typically has a slightly lower price on slaughter cows.

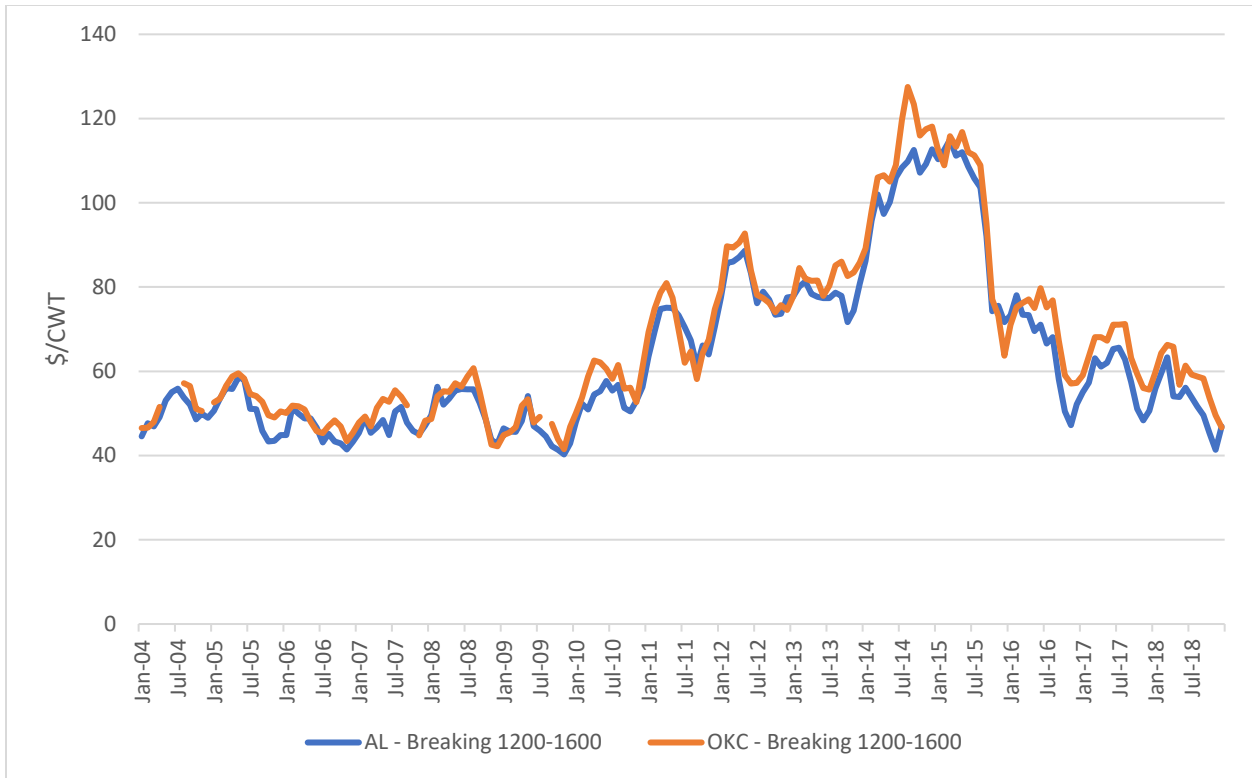


Figure 1. Breaking cows in the 1200-1600lb range for OKC and AL

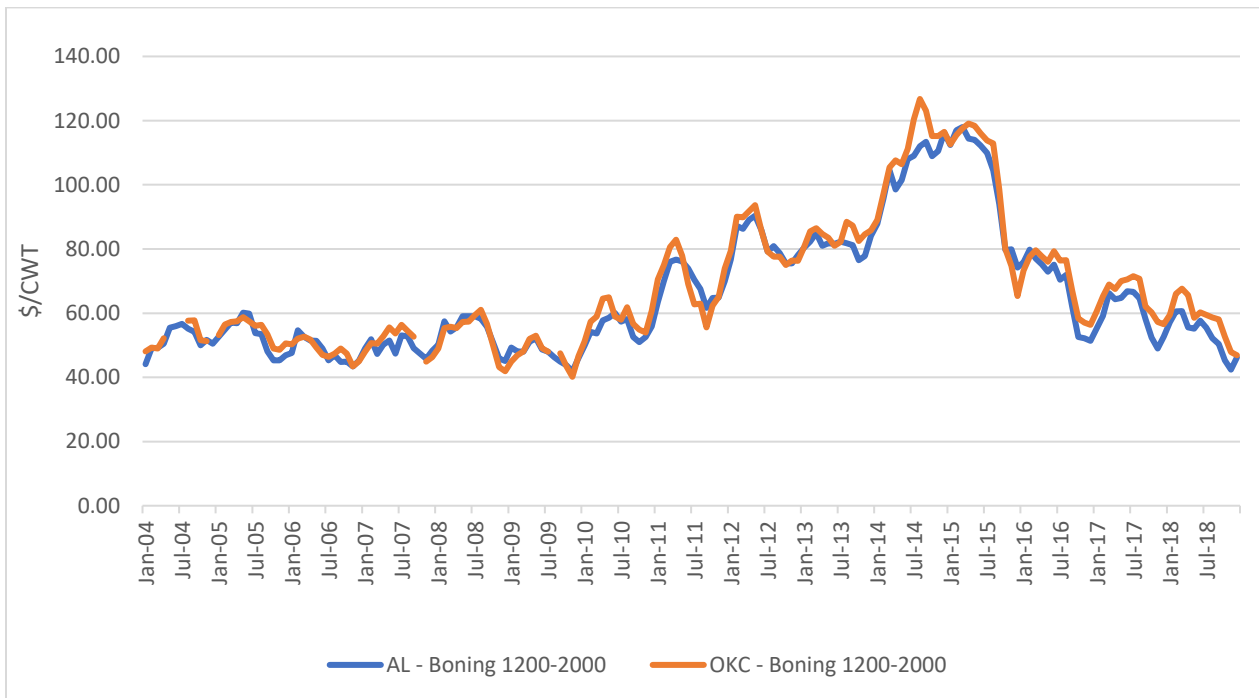


Figure 2. Boning cows in the 1200-2000lb range for OKC and AL

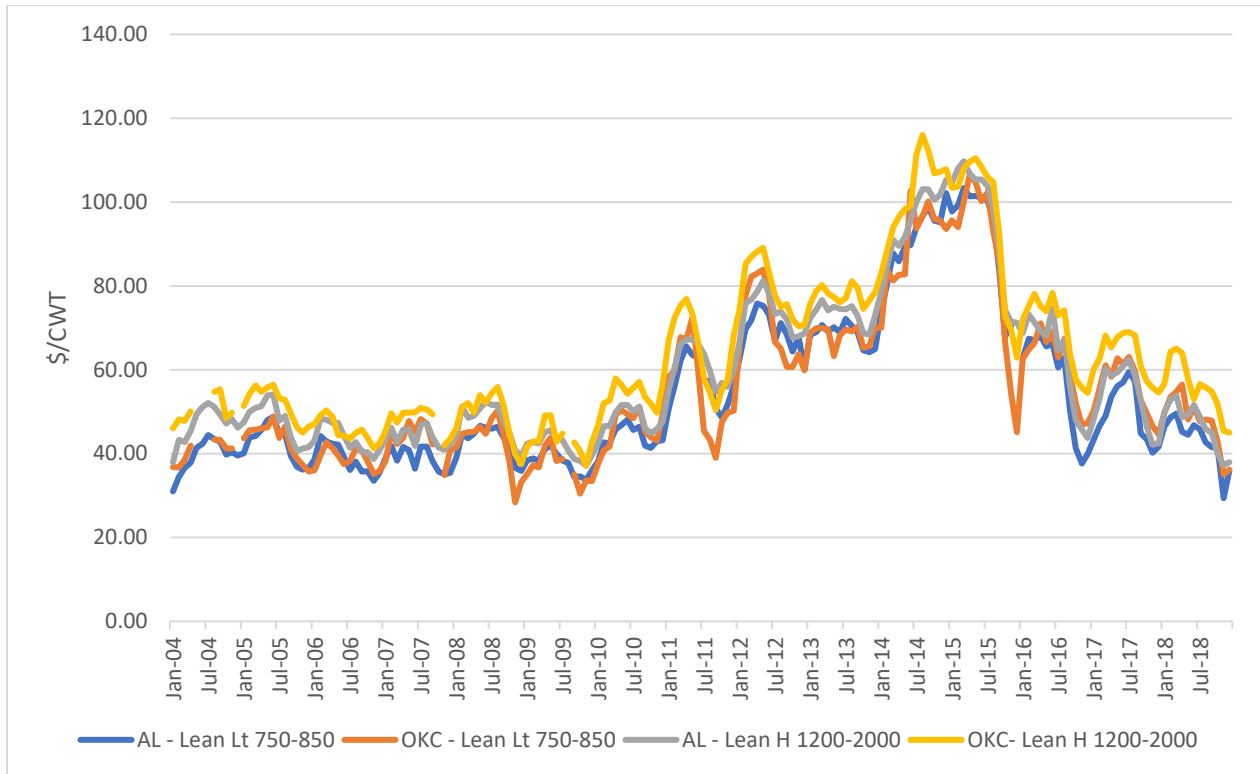


Figure 3. Lean cows in the 750-850 and 1200-2000lb range for OKC and AL

My primary focus is to look at the data on slaughter cow prices in Alabama from 2004-2018 to help cow/calf producers understand market trends on slaughter cow prices to enable them to make decision on when is the best time to cull cows to increase profit margins. I took the average price for each month during 2004-2018 and the overall average price during 2004-2018 for each of the following categories- Breaking Lt 850-1200, Breaking Md 1200-1600, Breaking H 1600-2000, Boning Lt 800-1200, Boning H 1200-2000, Lean VL 0-750, Lean Lt 750-850, Lean Md 850-1200, Lean H 1200-2000.

The overall average price of Breaking Lt 850-1200 in Alabama from 2004-2018 was \$62.66 cwt. I divided the monthly averages of Breaking Lt 850-1200 in Alabama from 2004-2018 by the overall average of \$62.66 cwt to develop monthly splits that show the percentage over or under the overall average price of \$62.66 cwt. Such that in Figure 4, the average price of Breaking Lt

850-1200 is \$62.66 cwt in Alabama and in January the price is \$63.91 cwt which is 2% higher than \$62.66 cwt. Figure 4 shows that producers in Alabama with cows that fall in Breaking Lt 850-1200 category should see higher than average price Of \$62.66 during the months of January through August and lower than average price of \$62.66 from September through December.

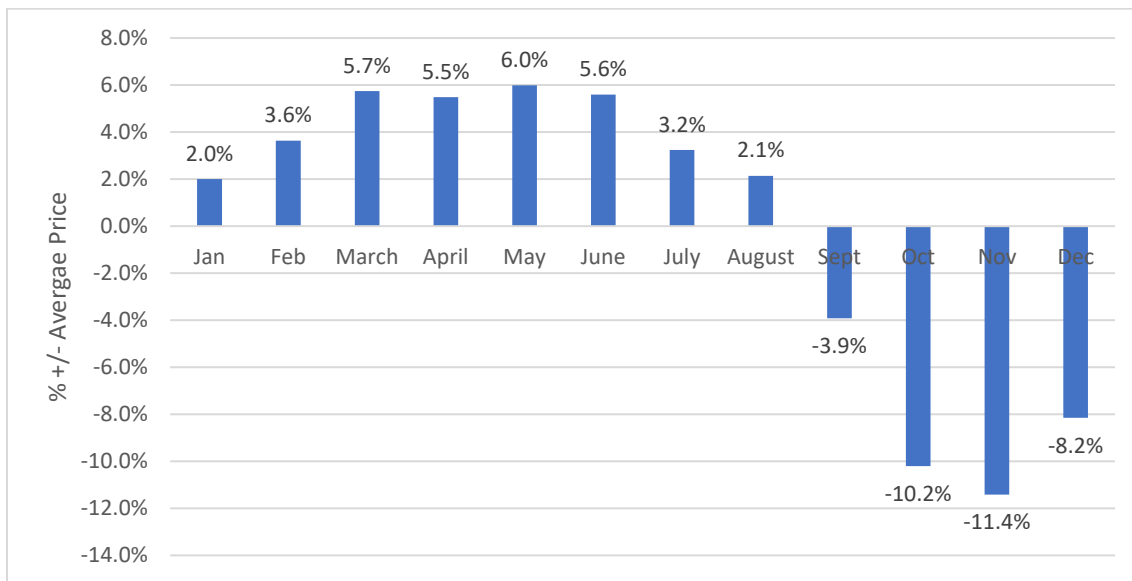


Figure 4. Percentage over/under average price per month for Breaking Lt cows in Alabama

The overall average price of Breaking Md 1200-1600 in Alabama from 2004-2018 was \$63.47 cwt. I divided the monthly averages of Breaking Md 1200-1600 in Alabama from 2004-2018 by the overall average of \$63.47 cwt to develop monthly splits that show the percentage over or under the overall average price of \$63.47 cwt. Such that in Figure 5, the average price of Breaking Md 1200-1600 is \$63.47 cwt in Alabama and in January the price is \$61.93 cwt which is 2.4 % lower than \$63.47 cwt. Figure 5 shows that producers in Alabama with cows that fall in the Breaking Md 1200-1600 category should see higher than average price of \$63.47 during the

months of February through August and lower than average price of \$63.47 from September through January.

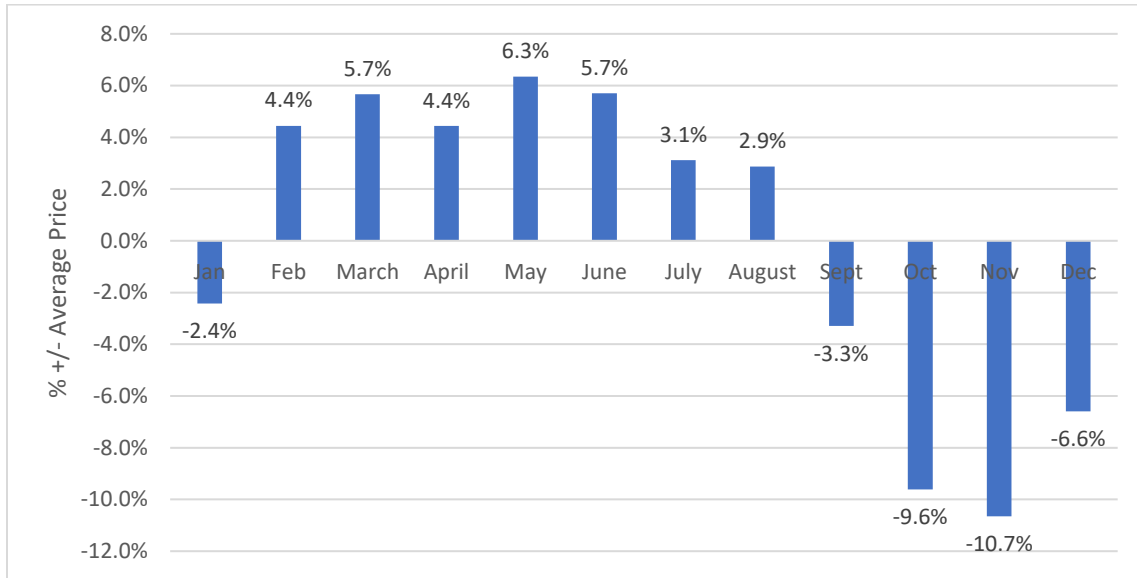


Figure 5. Percentage over/under average price per month for Breaking Md cows in Alabama

The overall average price of Breaking H 1600-2000 in Alabama from 2004-2018 was \$63.12 cwt. I divided the monthly averages of Breaking H 1600-2000 in Alabama from 2004-2018 by the overall average of \$63.12 cwt to develop monthly splits that show the percentage over or under the overall average price of \$63.12 cwt. Such that in Figure 6, the average price of Breaking H 1600-2000 is \$63.12 cwt in Alabama and in January the price is \$62.73 cwt which is 0.6 % lower than \$63.12 cwt. Figure 6 shows that producers in Alabama with cows that fall in the Breaking H 1600-2000 category should see higher than average price of \$63.12 during the months of February through August and lower than average price of \$63.12 from September through January.

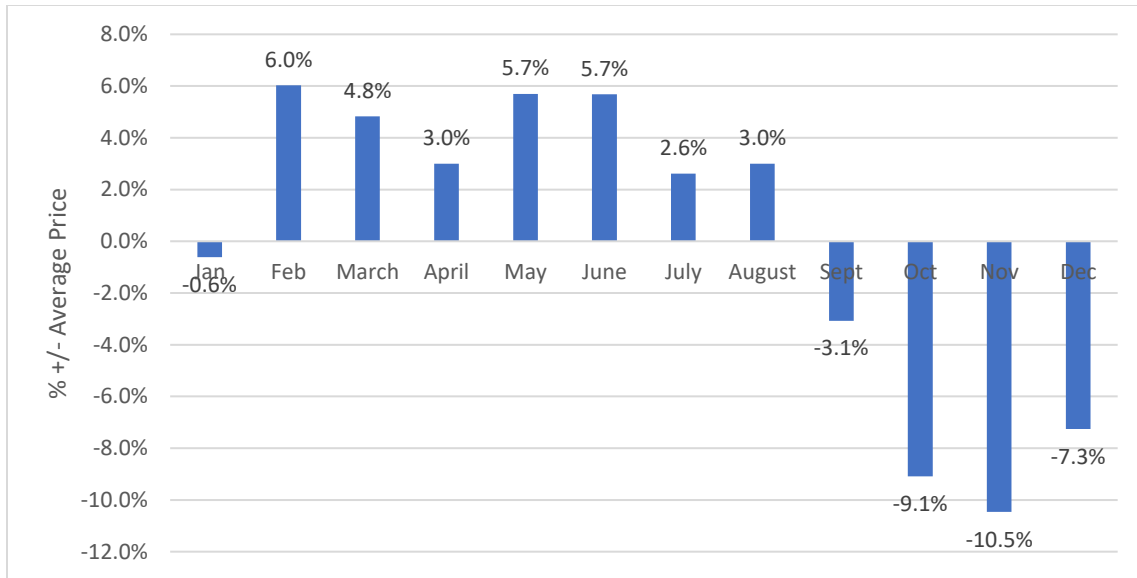


Figure 6. Percentage over/under average price per month for Breaking H cows in Alabama

The overall average price of Boning Lt 800-1200 in Alabama from 2004-2018 was \$63.89 cwt. I divided the monthly averages of Boning Lt 800-1200 in Alabama from 2004-2018 by the overall average of \$63.89 cwt to develop monthly splits that show the percentage over or under the overall average price of \$63.89 cwt. Such that in Figure 7, the average price of Boning Lt 800-1200 is \$63.89 cwt in Alabama and in January the price is \$61.96 cwt which is 3 % lower than \$63.89 cwt. Figure 7 shows that producers in Alabama with cows that fall in the Boning Lt 800-1200 category should see higher than average price of \$63.89 during the months of February through August and lower than average price of \$63.89 from September through January.

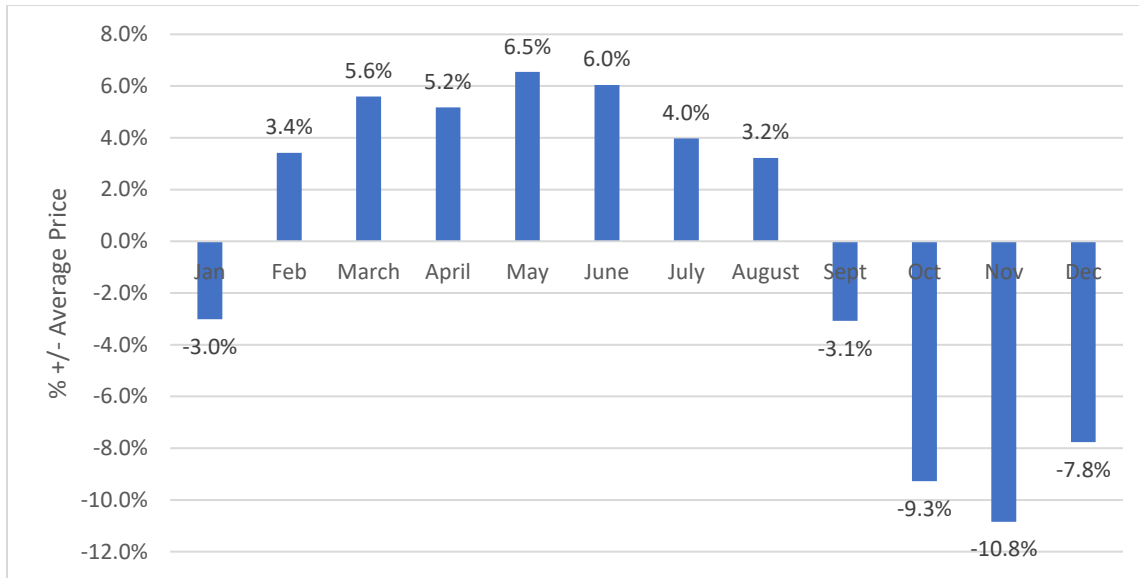


Figure 7. Percentage over/under average price per month for Boning Lt cows in Alabama

The overall average price of Boning H 1200-2000 in Alabama from 2004-2018 was \$65.41 cwt. I divided the monthly averages of Boning H 1200-2000 in Alabama from 2004-2018 by the overall average of \$65.41 cwt to develop monthly splits that show the percentage over or under the overall average price of \$65.41 cwt. Such that in Figure 8, the average price of Boning H 1200-2000 is \$65.41 cwt in Alabama and in January the price is \$63.45 cwt which is 3 % lower than \$65.41 cwt. Figure 8 shows that producers in Alabama with cows that fall in the Boning H 1200-2000 category should see higher than average price of \$65.41 during the months of February through August and lower than average price of \$65.41 from September through January.

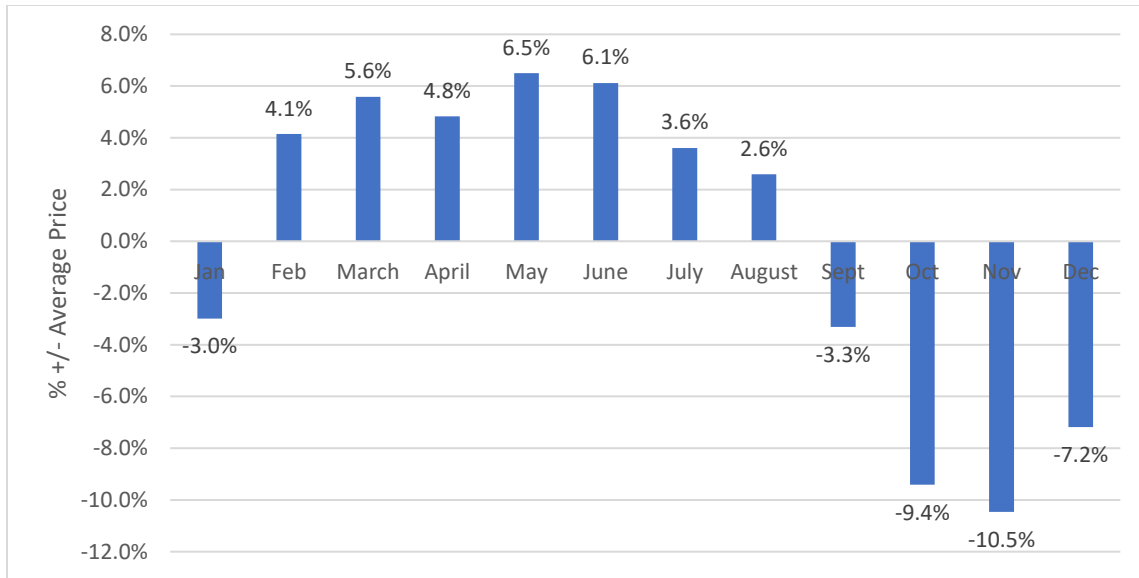


Figure 8. Percentage over/under average price per month for Boning H cows in Alabama

The overall average price of Lean VL 0-750 in Alabama from 2004-2018 was \$47.94 cwt. I divided the monthly averages of Lean VL 0-750 in Alabama from 2004-2018 by the overall average of \$47.94 cwt to develop monthly splits that show the percentage over or under the overall average price of \$47.94 cwt. Such that in Figure 9, the average price of Lean VL 0-750 is \$47.94 cwt in Alabama and in January the price is \$47.14 cwt which is 1.7 % lower than \$47.94 cwt. Figure 9 shows that producers in Alabama with cows that fall in the Lean VL 0-750 category should see higher than average price of \$47.94 during the months of April through August and lower than average price of \$47.94 from September through March.

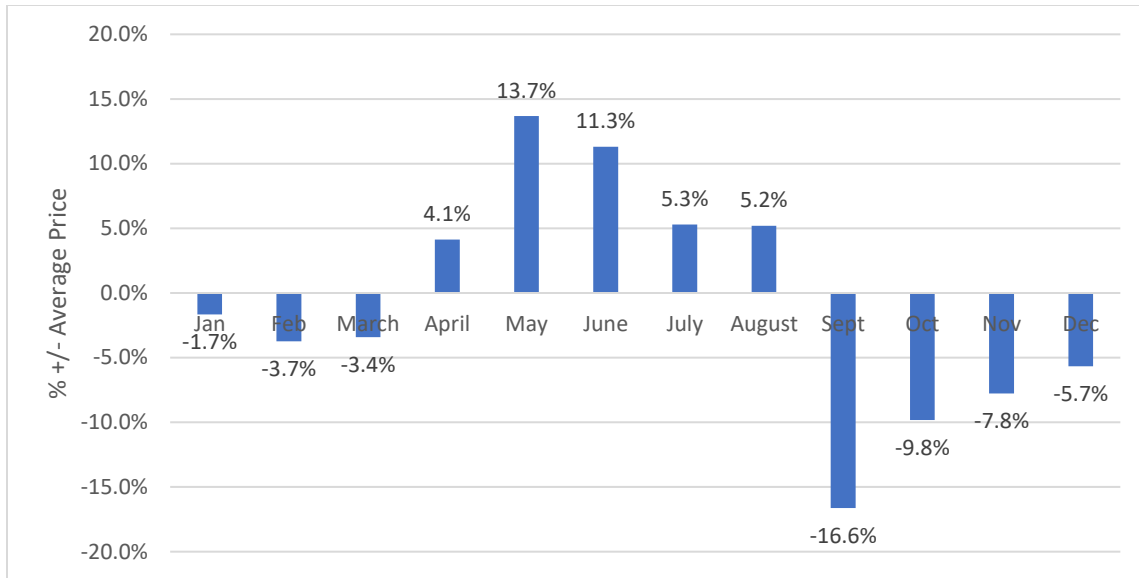


Figure 9. Percentage over/under average price per month for Lean VL cows in Alabama

The overall average price of Lean Lt 750-850 in Alabama from 2004-2018 was \$53.91 cwt. I divided the monthly averages of Lean Lt 750-850 in Alabama from 2004-2018 by the overall average of \$53.91 cwt to develop monthly splits that show the percentage over or under the overall average price of \$53.91 cwt. Such that in Figure 10, the average price of Lean Lt 750-850 is \$53.91 cwt in Alabama and in January the price is \$51.34 cwt which is 4.8 % lower than \$53.91 cwt. Figure 10 shows that producers in Alabama with cows that fall in the Lean Lt 750-850 category should see higher than average price of \$53.91 during the months of February through August and lower than average price of \$53.91 from September through January.

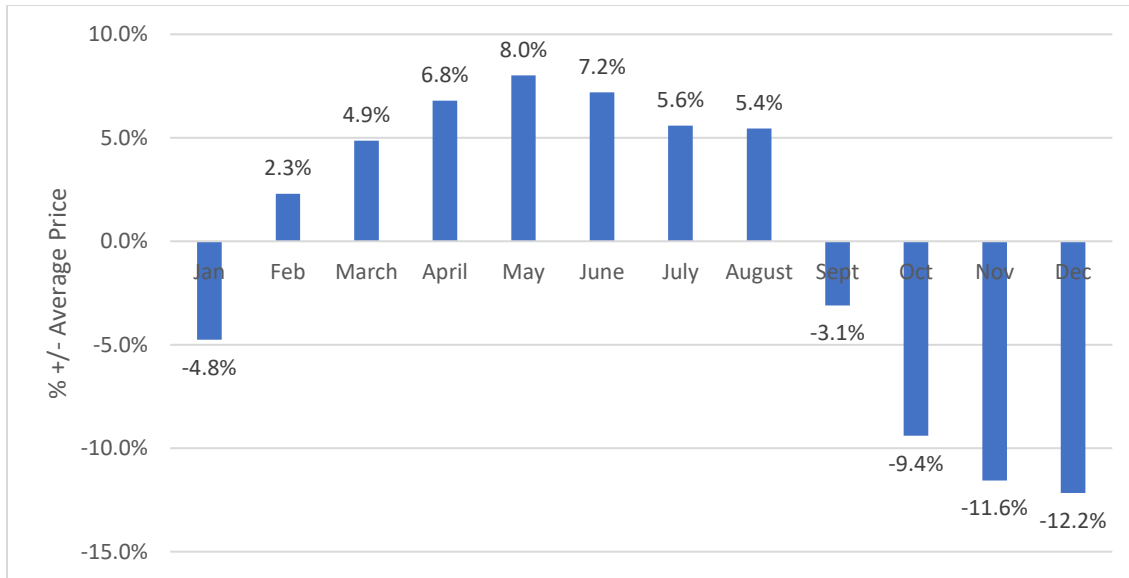


Figure 10. Percentage over/under average price per month for Lean Lt cows in Alabama

The overall average price of Lean Md 850-1200 in Alabama from 2004-2018 was \$57.13 cwt. I divided the monthly averages of Lean Md 850-1200 in Alabama from 2004-2018 by the overall average of \$57.13 cwt to develop monthly splits that show the percentage over or under the overall average price of \$57.13 cwt. Such that in Figure 11, the average price of Lean Md 850-1200 is \$57.13 cwt in Alabama and in January the price is \$54.48 cwt which is 4.6 % lower than \$57.13 cwt. Figure 11 shows that producers in Alabama with cows that fall in the Lean Md 850-1200 category should see higher than average price of \$57.13 during the months of February through August and lower than average price of \$57.13 from September through January.

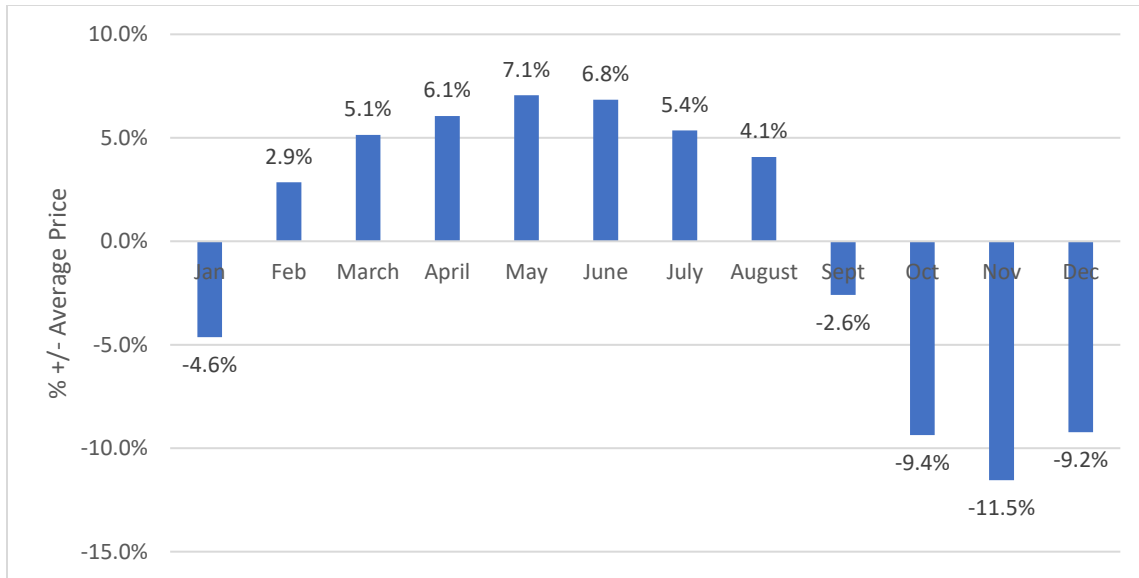


Figure 11. Percentage over/under average price per month for Lean Md cows in Alabama

The overall average price of Lean H 1200-2000 in Alabama from 2004-2018 was \$58.75 cwt. I divided the monthly averages of Lean H 1200-2000 in Alabama from 2004-2018 by the overall average of \$58.75 cwt to develop monthly splits that show the percentage over or under the overall average price of \$58.75 cwt. Such that in Figure 12, the average price of Lean H 1200-2000 is \$58.75 cwt in Alabama and in January the price is \$56.33 cwt which is 4.1 % lower than \$58.75 cwt. Figure 12 shows that producers in Alabama with cows that fall in the Lean H 1200-2000 category should see higher than average price of \$58.75 during the months of February through August and lower than average price of \$58.75 from September through January.

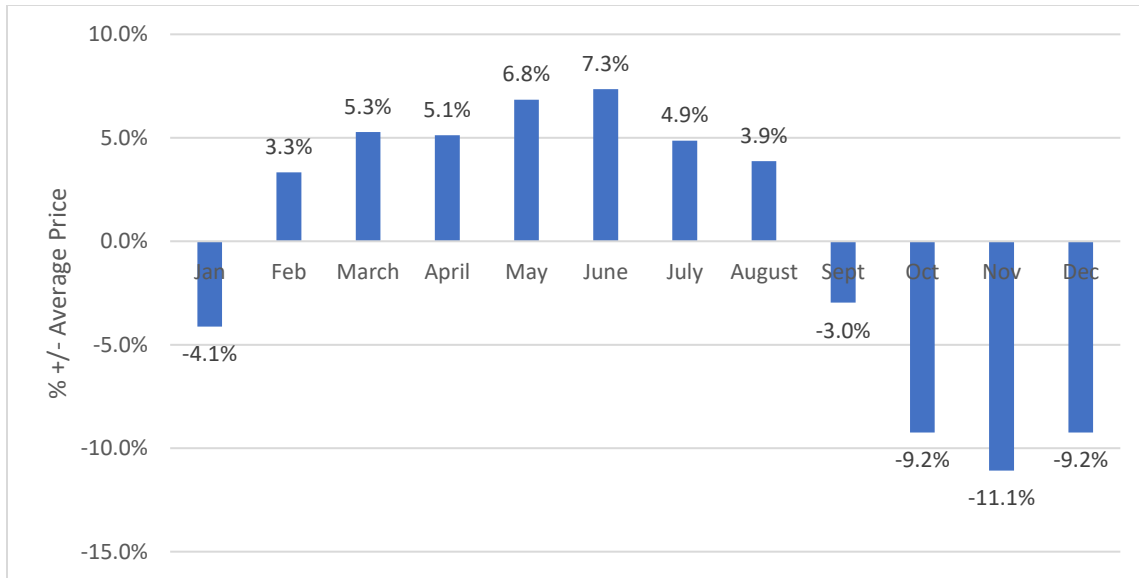


Figure 12. Percentage over/under average price per month for Lean H cows in Alabama

As you can see in Figure 4-12, Alabama cattle producers should see higher than average prices for all slaughter cow categories from February through August except for Lean VL 0-750 which is April through August. In Figures 4-12 it should be noted that in Alabama producers should see lower than average prices for slaughter cows in all categories from September through December. It would be advantageous for producers to sell cull cows prior to September unless there are adequate feed and forage resources to carry the cows to February when prices typically rise above the average price.

When a cow/calf producer chooses to delay marketing of a cull cow there is potential to capture a higher price/cwt when they increase weight and body condition to move into a higher range of a slaughter cow category. Figure 13 shows the difference in the monthly average price of cows in Lean VL 0-750 category when compared to monthly average price of cows in Lean Lt 750-850 category. This figure shows that on average producers in Alabama should see an increase of

\$2.13-\$12.26 in the price/cwt of slaughter cows by increasing weight and body condition to move from Lean VL to Lean Lt.

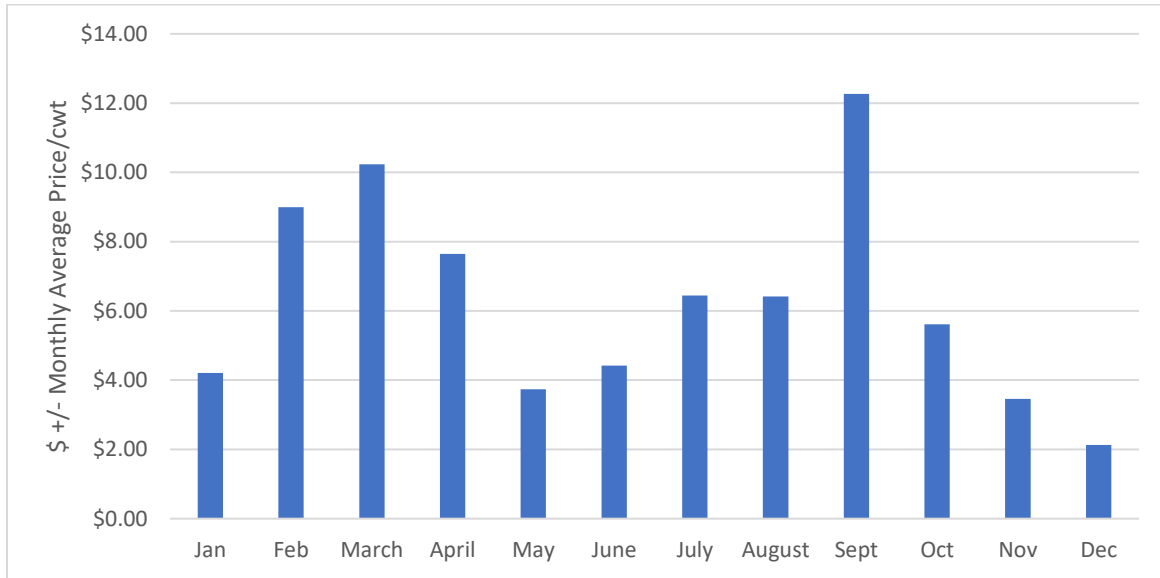


Figure 13. Price over/under monthly average price for Lean VL cows that move to Lean Lt in Alabama

Figure 14 shows the difference in the monthly average price of cows in Lean Lt 750-850 category when compared to monthly average price of cows in Lean Md 850-1200 category. This figure shows that on average producers in Alabama should see an increase of \$2.61-\$4.51 in the price/cwt of slaughter cows by increasing weight and body condition to move from Lean Lt to Lean Md.

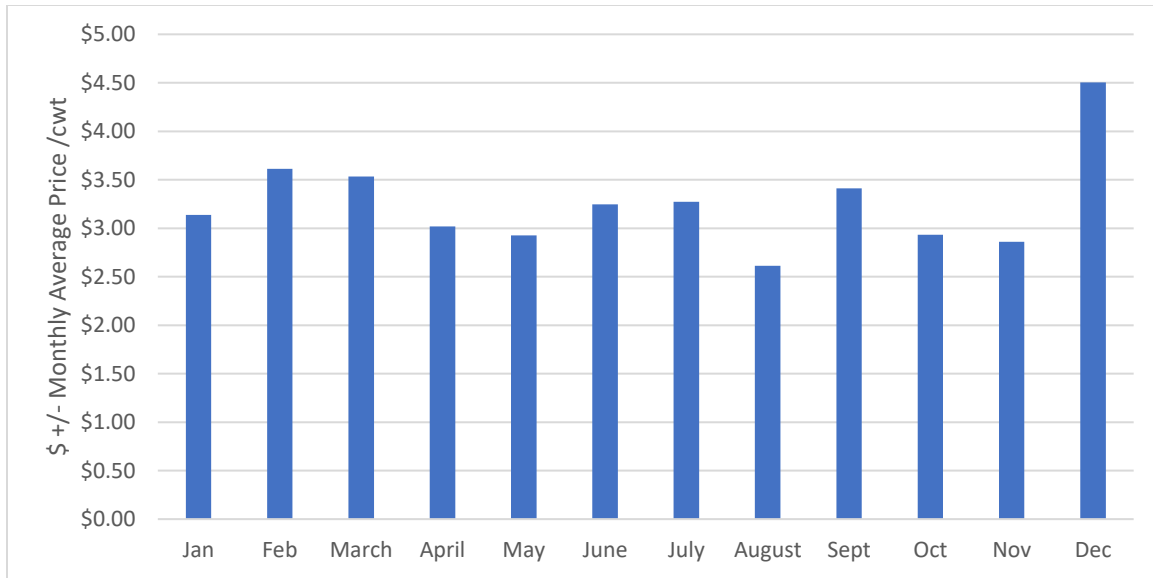


Figure 14. Price over/under monthly average price for Lean Lt cows that move to Lean Md in Alabama

Figure 15 shows the difference in the monthly average price of cows in Lean Md 850-1200 category when compared to monthly average price of cows in Lean H 1200-2000 category. This figure shows that on average producers in Alabama should see an increase of \$1.18-\$2.03 in the price/cwt of slaughter cows by increasing weight and body condition to move from Lean Md to Lean H.

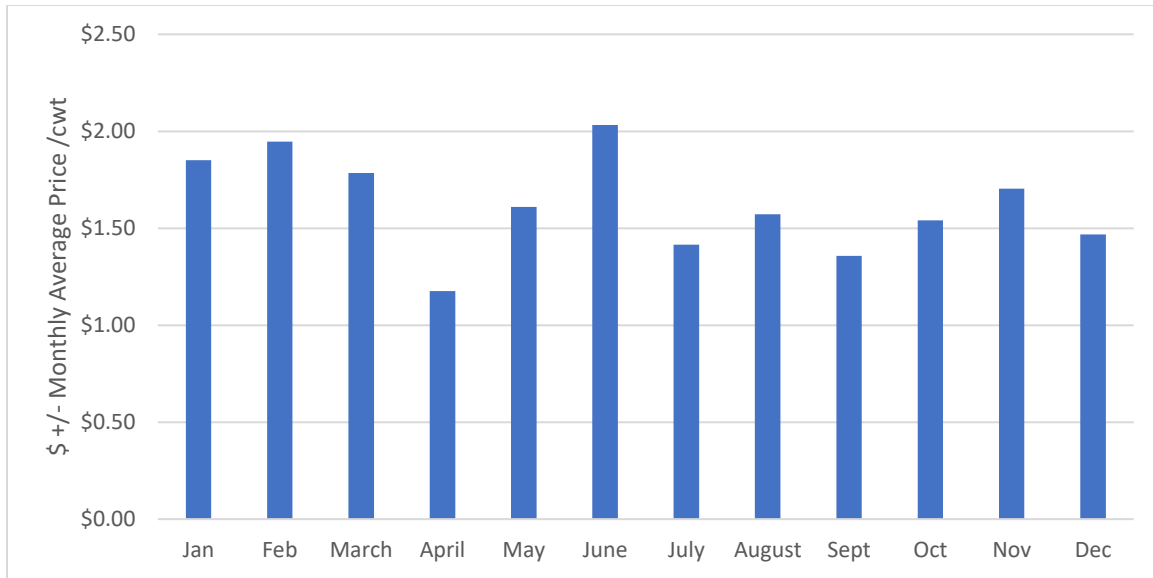


Figure 15. Price over/under monthly average price for Lean Md cows that move to Lean H in Alabama

Figure 16 shows the difference in the monthly average price of cows in Boning Lt 800-1200 category when compared to monthly average price of cows in Boning H 1200-2000 category.

This figure shows that on average producers in Alabama should see an increase of \$1.15-2.05 in the price/cwt of slaughter cows by increasing weight and body condition to move from Boning Lt to Boning H.

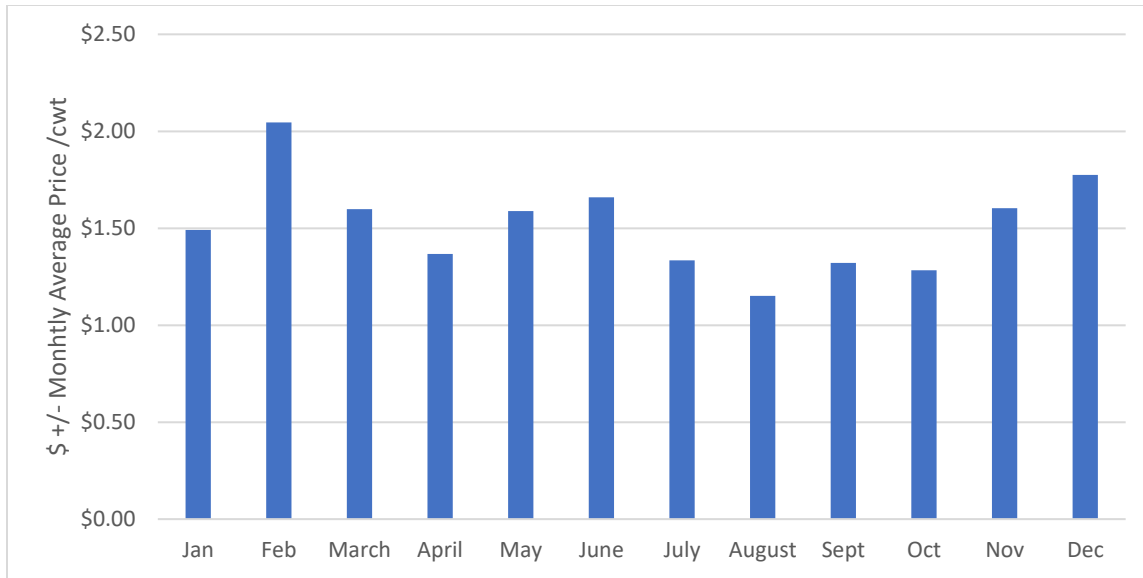


Figure 16. Price over/under monthly average price for Boning Lt cows that move to Boning H in Alabama

Figure 17 shows the difference in the monthly average price of cows in Breaking Lt 850-1200 category when compared to monthly average price of cows in Breaking Md 1200-1600 category. This figure shows that on average producers in Alabama should see a decrease of \$1.98/cwt in January, then an increase of \$0.19-1.73 in the price/cwt of slaughter cows from February through December by increasing weight and body condition to move from Breaking Lt to Breaking Md.

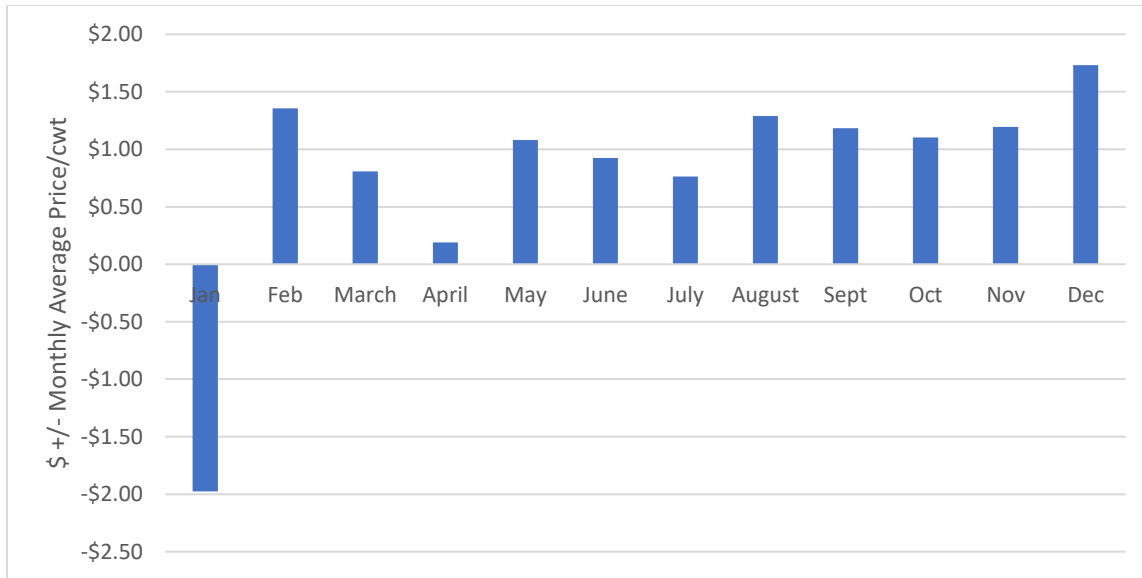


Figure 17. Price over/under monthly average price for Breaking Lt cows that move to Breaking Md in Alabama

Figure 18 shows the difference in the monthly average price of cows in Breaking Md 1200-1600 category when compared to monthly average price of cows in Breaking H 1600-2000 category. This figure shows that producers in Alabama should see an increase of \$0.63-0.80 in the price/cwt of slaughter cows in January and February, then a decrease of \$0.19-1.28 from March through December by increasing weight and body condition to move from Breaking Md to Breaking H.

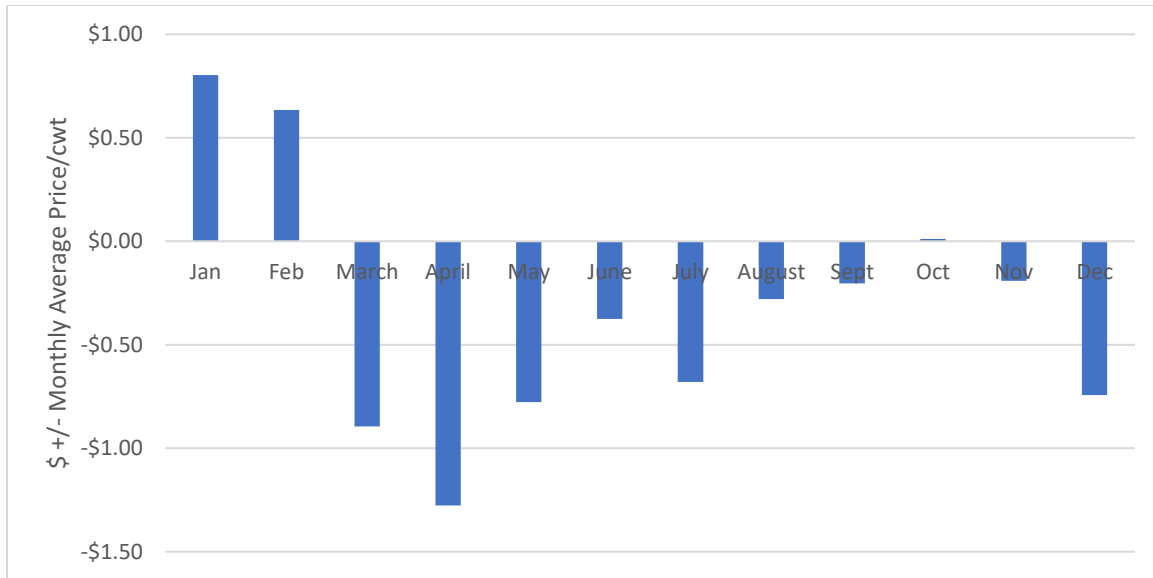


Figure 18. Price over/under monthly average price for Breaking Md cows that move to Breaking H in Alabama

As you can see in Figures 13 through 16 when delaying the marketing of slaughter cows to increase weight and body condition to move to a higher range within the Lean and Boning slaughter categories typically can add value for producers with an increase in price/cwt. Figures 17 and 18 show in the Breaking slaughter category when delaying the marketing to increase weight and body condition to move to a higher range there is potential for producers to add value to move from Breaking Lt to Breaking Md, but when moving from Breaking Md to Breaking H there typically is a negative effect on price. For instance, the average price for Lean Md is \$57.13/cwt and average price for Lean H is \$58.75, take a 1050 lb cull cow that would be in Lean Md would have a value of \$599.86 and by increasing weight the cows to 1250lbs to move the cull cow to Lean H would then have a value of \$734.38. This is a net of \$134.52 to the producer by increasing weight and body condition to move a cull cow to a higher range, however the input cost must be considered to determine if it is more profitable.

When a cow/calf producer chooses to delay marketing of a cull cow to increase weight and body condition to move into a higher slaughter cow category there is potential to capture a higher price/cwt. Figure 19 shows the average monthly price for slaughter cows in Lean Md 850-1200, Boning Lt 800-1200, and Breaking Lt 850-1200. In analyzing the average monthly prices for similar weight ranges over the three slaughter cow categories, cows that moved from Lean Md 850-1200 to Boning Lt 800-1200 should see a \$6.20 - \$7.45 increase in price/cwt. However, cows that move from Boning Lt 800-1200 to Breaking Lt 850-1200 while there is an increase of \$1.94/cwt in January the rest of the year there is a \$1.11-\$1.95 decrease in price/cwt.

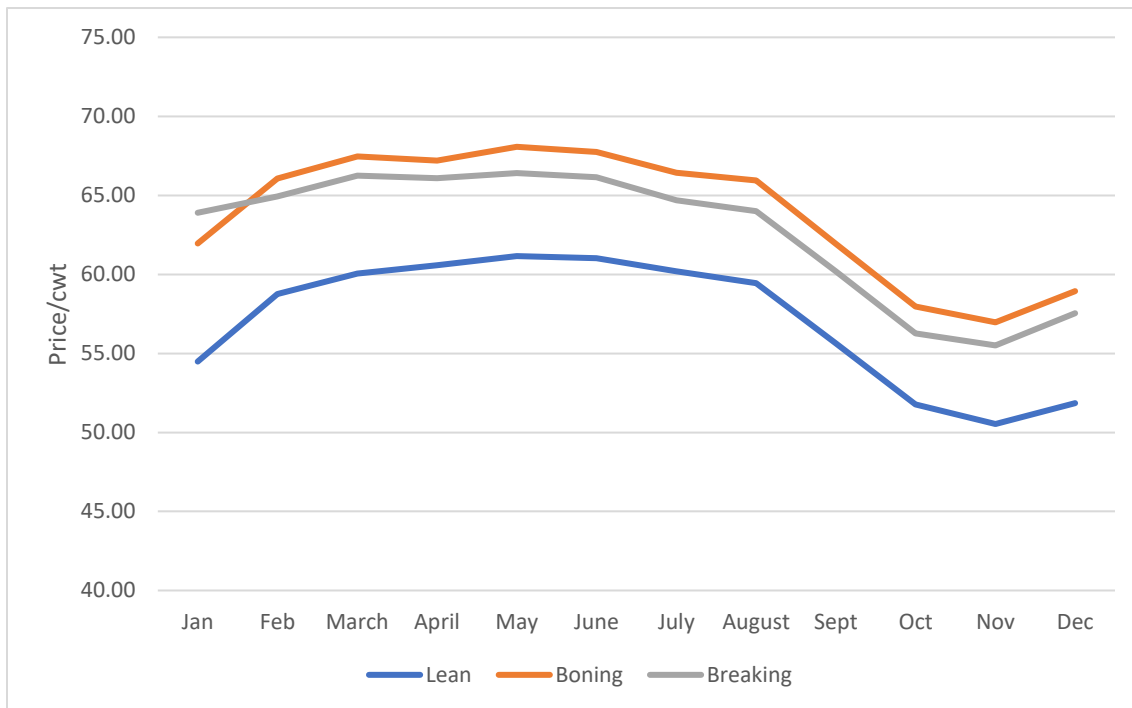


Figure 19. Comparing monthly average price of cows in Lean Md, Boning Lt, Breaking Lt in Alabama

Figure 20 shows the average monthly price for slaughter cows in Lean H 1200-2000, Boning Md 1200-2000, and the average of Breaking Md 1200-1600/Breaking H 1600-2000. In analyzing the average monthly prices for similar weight range over the three slaughter cow categories, cows that move from Lean H 1200-2000 to Boning Md 1200-2000 should see a \$5.93-\$7.41 increase in price/cwt. However, cows that move from Boning Md 1200-2000 to Breaking Md 1200-1600/Breaking H 1600-2000 there is a \$1.12-\$2.93 decrease in price/cwt.

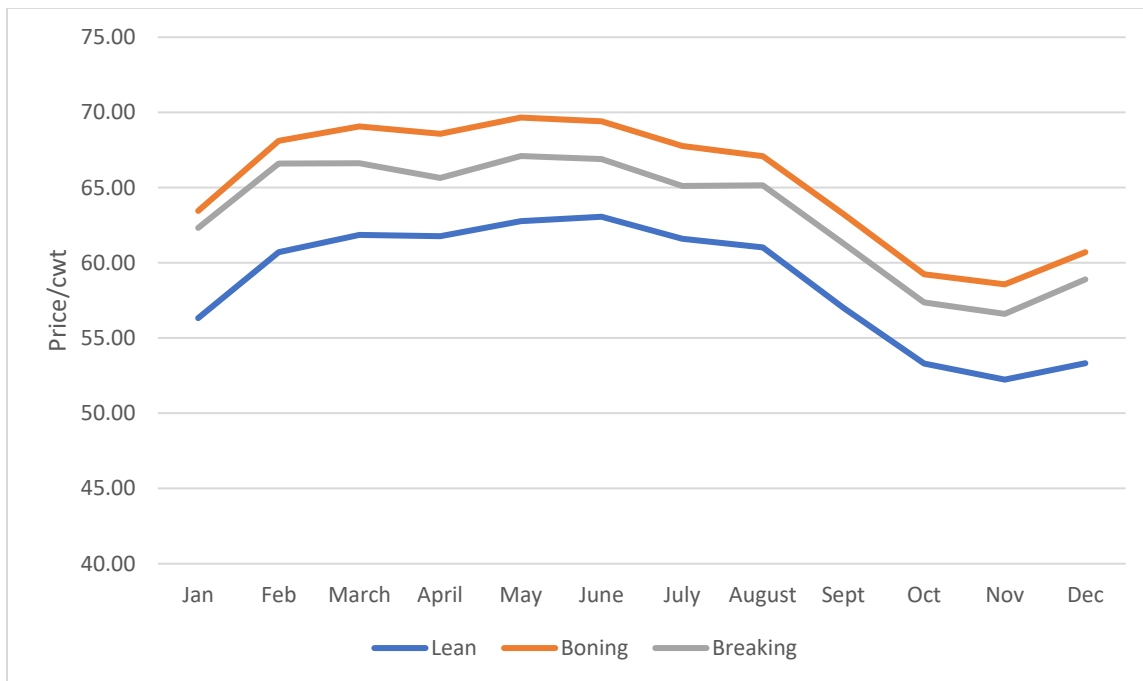


Figure 20. Comparing monthly average price of cows in Lean H, Boning Md, Breaking Md/H in Alabama

Figures 19 and 20 show that producers can gain value with an increase in price by delaying marketing cull cows to increase weight and body condition to move cull cows from the Lean category to the Boning category. These figures also show there is no increase in price when cull cows move from Boning category to the Breaking category after an increase in weight and body condition.

A last possibility of increasing profit on a cull cow is if the producer chooses to delay marketing the cull cow to increase weight and body condition, is by running a bull with the cull cows. By doing this it would allow the producer the possibility to market the cow as a bred replacement cow instead of a slaughter cow. While there is no available data on Alabama replacement cow prices, there is available data from Oklahoma City (LMIC 2004-2018) on bred cows young/middle aged, medium & large framed, muscle score 2 in the following categories 900-1100 lbs, 1100-1200 lbs, and 1200-1300 lbs. Figure 21 shows the monthly average prices for the three categories and shows little change during the year. The overall average from 2004-2018 for 900-1100 lb bred cow young/middle aged, medium & large framed, muscle score 2 is \$924.84, overall average from 2004-2018 for 1100-1200 lb bred cow young/middle aged, medium & large framed, muscle score 2 is \$988.01, and the overall average from 2004-2018 for 1200-1300 lb bred cow young/middle age, medium & large frame, muscle score 2 is \$1032.76. There is potential for a producer to capture more value for a cull cow by delaying marketing her and selling her as a replacement instead of a slaughter cow. For example, a producer has 950 lb cull cow that could sell as a Lean Md slaughter cow in October with the average price \$51.78/cwt with a value of \$491.91, typically in Alabama the warm season grasses are beginning to slow growth in October before going dormant during winter months which a producer would have additional inputs of winter annuals and or supplementation with hay. If the producer delayed marketing the cull cow and carried the cow through winter to add weight and increase body condition to market in March when prices go up due to price seasonality when a 1100 lb Lean Md slaughter cow that on average sells for \$60.06/cwt with a value of \$660.66, which is an increase of value \$168.75. Alternatively, the producer could carry the cow through winter to increase weight and body condition while being exposed to a bull which could allow the cow to

be marketed as replacement cow in March as 1100 lb bred cow young/middle aged, medium & large framed, muscle score 2 on average sells for \$924.84. Selling as a replacement bred cow on average would increase the value of the cull cow by approximately \$432.93. It should be noted that delaying marketing of cull cow and running her with a bull will not guarantee that she will get pregnant and there is no guarantee that even if she is bred that will be sold as a bred replacement cow. Unlike the slaughter cow market where there is a consistent demand on a weekly basis, the replacement cow market at a stockyard is more volatile in terms of demand. This is mainly due to number of producers at a stockyard looking for replacement cows will vary from week to week regardless of the supply or quality of the replacement females. In most cases a stockyard will try to sell a young/middle aged, bred cow as a replacement first and if there is no interest, they will sell her as a slaughter cow.

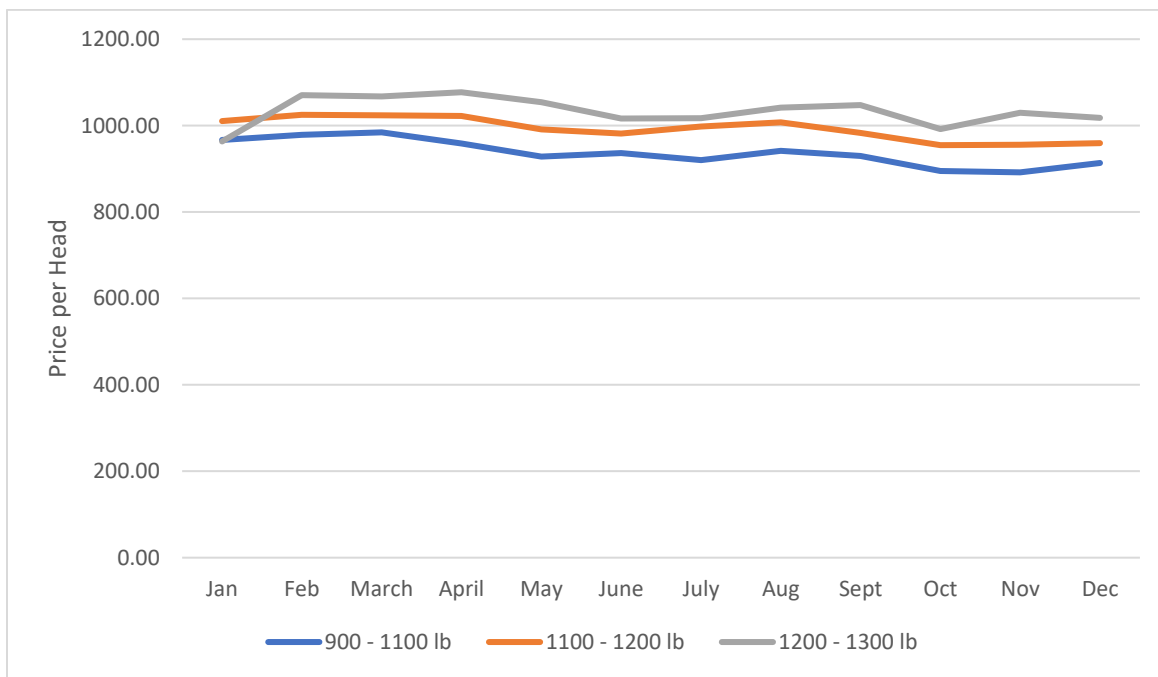


Figure 21. Comparing average monthly price on Young/Middle Aged Medium & Large 2 Bred Cows in OKC

Results

Cattle producers in Alabama will typically see the highest prices for slaughter cows in all categories from February through August, with a slight decrease in price in January and September. Slaughter cow prices in Alabama are typically at the lowest from October through December, and any producer that sells their cull cows during this time could benefit by holding the cows until March when prices rise above average price due to price seasonality. The data shows that instead of selling as slaughter cow in October and by delaying to March of the following year to add weight and body condition within each slaughter category showed an increase in price except for October 2008- March 2009 and October 2015-March 2016. A producer must consider the input costs when carrying a cull cow through winter as most producers will feed hay, plant winter annuals, a source of supplementation, or some combination of these. Typically, the least expensive options for a producer to carry a cow through winter are feeding hay or grazing a winter annual. Using average quality hay as the primary diet a dry cow should consume 2% of her body weight in dry matter, for example a 1000 lb cow would need to consume 20 lbs of hay per day. To calculate the amount of hay needed for a 1000 lb cow during the winter you would multiply 20 lbs by the number of days, which we will use 120 days for total of 2,400 lbs. To calculate potential cost for a producer using the USDA Alabama direct hay report from December 1, 2022, a medium round bale of Bahia grass sold for on average \$120/ton and medium round bale of Bermuda grass sold for on average \$156.21/ton. Using a 1000 lb cow consuming 1.2 tons to carry over through the winter the Bahia grass hay would cost approximately \$144 per cow and the Bermuda grass hay would cost approximately \$188 per

cow. For example, a 950 lb Lean cow in October would on average bring \$51.78 per cwt, \$491.91 value, by feeding hay to delay marketing the cow until March as a 1100 lb Lean cow would on average bring \$60.06 per cwt, \$660.66 value. The added value of \$168.75 by feeding cull cow hay through the winter would be profitable using Bahia grass hay only.

While each cattle operation is different in regards of cow size which can affect the stocking rates, in Alabama the average stocking rate is 1 cow-calf per 2 acres (Mullenix et al 2019). Typically, calves are weaned when it is determined to cull a cow, which could enable a producer to have a stocking rate closer to 1 cow per acre for cull cows. Using enterprise budgets for forages for a typical Alabama operation the cost to no till drill winter annual in pasture will cost approximately \$148.49 per acre (Kelley et al 2019) and the cost for winter annuals in prepared ground will cost approximately \$342.92 per acre (Kelley et al 2022). As in the previous example, a 950 lb Lean cow in October would on average bring \$51.78 per cwt, \$491.91 value, however by grazing winter annuals to delay marketing the cow until March as a 1100 Lean cow would on average bring \$60.06 per cwt, \$660.66 value. The added value of \$168.75 by grazing a cull cow through the winter would be profitable only on the no till drill winter annual in pasture option using a stocking rate of 1 cow per acre.

If the decision is made to delay the marketing of a cull cow, there is potential in running a bull with the cows to give the producer the flexibility of marketing the cows as bred replacements instead of slaughter cows. A producer must keep in mind if they do not have a bull available the cost to purchase the bull and the cost to carry the bull in terms of grazing forages, hay consumption, or supplementation to be factored in the overall value to the producer.

Producers could supplement the cows to increase their weight gains but typically the cost of supplementation will outweigh the increases in the price for slaughter cows in Alabama.

Producers should identify which cows could increase value by grazing to add weight and body condition to potentially move to a more desirable slaughter category. The data clearly shows that any cow that is in the breaking category is better to market immediately as delaying will typically not add any value to the producer. There is potential to add value to a Lean cow by grazing to increase weight and body condition score and move to Boning category. Producers must look at available forages to graze and space to keep cull cows for an additional time period to capture the added value versus marketing immediately.

Discussion

A consideration to delaying the sale of cull cows is the response of the supply with regards to market equilibrium and the price. If enough producers target a specific time to market their cull cows as it is determined to be the best time for them to sell from a price standpoint, the increase of supply above the market equilibrium would likely lower the price. In disequilibrium market where there is a surplus of slaughter cows in the market a producer should look at the input cost of continuing to delay the sale of cull cows to allow the market to stabilize supply and reach equilibrium price. Alternatively, if the cull cow is pregnant the producer could shift selling cull cows in the replacement market instead of selling in the slaughter market with a surplus of cows.

The objective of this paper is to look at slaughter cow prices in Alabama from January 2004 through December 2018, it would be interesting to further evaluate price response after multiple shocks to the slaughter cattle markets the past two years. The first shock was August 9, 2019, when the Tyson beef packing plant caught fire in Holcomb, Kansas, the plant slaughtered on average 6,000 head per day and accounted for approximately 5% of the US beef production. Cattle that were scheduled to be slaughtered at this facility had to be diverted to other plants which caused lag in slaughter production and lowered prices. Just as the market began to

stabilize in early 2020, the coronavirus pandemic hit and turned prices downward again. The slaughter cow markets began to stabilize in 2021 only to see record numbers of cattle sold in 2022. Given the drought conditions in 2022 which impacted the majority of the Western U.S., in particular Texas and Oklahoma that have increased the number of cattle sold. In addition, producers facing higher operating costs which have led many producers to reduce herd size or sell out completely. There are multiple factors that are influencing the current slaughter market in which we are seeing record numbers of culled beef cows, April 2022 had the highest number of beef cows slaughtered for the month since 1996 (Knight and Taylor 2022). In the upcoming year or years there will be less cows in production, this will have a negative impact on the supply to slaughter cow market which should lead to higher prices for producers.

References

- Adams, Don C., Clark, Richard T., Klopfenstein, Terry J., and Volesky, Jerry D. *Matching the Cow with Forage Resources*. Rangelands, Vol. 18, No. 2, pages 57-62, 1996
- Amadou, Zakou, *Value Enhancement Marketing Strategies for Cull Beef Cows*. Doctoral Dissertation, Oklahoma State University, 2012.
- Amadou, Zakou, *Value Enhancement Marketing Strategies for Cull Beef Cows*. Doctoral Dissertation, Oklahoma State University, 2012.
- Amadou, Zakou, Raper, Kellie C., Biermacher, Jon T., Cook, Billy, and Ward, Clement E. *Alternative retention and marketing strategies for cull beef cows*. Journal of the ASFMRA, pages 248-267, 2013.
- Anderson, David P., Robb, James G., and Mintert, James, *The Cattle Cycle*. Managing for today's cattle market and beyond, US Department of Agriculture and Cooperating States Extension Services. 1996.
- Apple, J.K. *Influence of Body Condition Score on Live and Carcass Value of Cull Beef Cows*. Journal of Animal Science, Vol. 77, pages 2610-2620, 1999.
- Asem-Hiablie, Senorpe, Rotz, C. Alan, Stout, Robert, Dillon, Jasmine, and Stackhouse-Lawson, Kim, *Management characteristics of cow-calf, stocker, and finishing operations in Kansas, Oklahoma, and Texas*. The Professional Animal Scientist, Vol. 31, Pages 1-10, 2015.
- Asem-Hiablie, Senorpe, Rotz, C. Alan, Stout, Robert, Dillon, and Stackhouse-Lawson, Kim, *Management characteristics of cow-calf, stocker, and finishing operations in Northern Plains and Midwest Regions of the United States*. The Professional Animal Scientist, Vol. 32, Pages 736-749, 2016.
- Asem-Hiablie, Senorpe, Rotz, C. Alan, Stout, Robert, and Place, Sara. *Management Characteristics of Beef Cattle Production in the Eastern United States*. The Professional Animal Scientist. Vol. 34, pages 311-325, 2018.
- Ball, Donald M. *Summer annual grasses as forage crops in Alabama*. Auburn University, extension publication, ANR-134, 2001.
- Barksdale, Hiram C., Hilliard, Jimmy E., and Ahlund, Mikael C., *A cross-spectral analysis of beef prices*. American Journal of Agricultural Economics, Vol. 57, pages 309-315, 1975.
- Bentley, Ernest, and Shumway, Richard C., *Adaptive planning over the cattle price cycle*. Southern Journal of Agricultural Economics, Vol. 13, pages 139-148, 1981.
- Blevins, Phil. *Marketing Cull Cows in Virginia*. Virginia Tech, Extension Publication, 400-761. 2009.
- Boyles, Stephen, *Feeding cull cows*. Ohio State University, Extension Service, undated.

Clark, Richard T., Adams, Don C., Lardy, Gregory P., and Klopfenstein, Terry J. *Matching Calving Date with Forage Nutrients: Production and Economic Impacts*. The Range Beef Cow Symposium XV December 9-11, 1997.

Coady, Sean A., and Clark, Richard T., *Ranch Management Practices in the Sandhills of Nebraska. Managing Production*. University of Nebraska-Lincoln, 1993.

Coleman, S.W., Gunter, S.A, Sprinkle, J.E., and Neel, J.P.S. *Difficulties associated with predicting forage intake by grazing beef cows*. American Society of Animal Science, vol 92, pages 2775-2784, 2014.

Encinias, A.Manuel, Lardy, Greg. *Body condition scoring I: Managing you cow herd through body condition scoring*. North Dakota State University, extension publication, AS-1026, 2000.

Engelken, Terry J., *Marketing and Management of cull cows*. Western Veterinarian Conference, 2008.

Eversole, Dan E., Browne, Milyssa F., Hall, John B., Dietz, Richard E. *Body condition scoring beef cows*. Virginia Tech University, extension publication, 400-791, 2005.

Feuz, Dillion M., *Marketing and feeding cull cows*. Utah State University, Extension Publication, AG/Beef/2010-04pr, 2010.

Foster, Kenneth A., and Burt, Oscar R., *A dynamic model of investment in the u.s. beef cattle industry*. Journal of Business & Economic Statistics, Vol. 10, No. 4, pages 419-426, 1992.

Franzmann, John R. and Wlaker, Rodney L., *Trend models of feeder, slaughter, and wholesale beef cattle prices*. American Journal of Agricultural Economics, Vol. 54, pages 507-512, 1972.

Funston, R.N., Paterson, J.A., Williams, K.E., and Roberts, A.J., *Effects of body condition, initial weight, and implant on feedlot and carcass characteristics of cull cows*. The Professional Animal Scientist, Vol. 19, Pages 233-238, 2003.

Gill, Ron, *Marketing Cull Cows: Understanding what determines value*. Texas A&M University, Extension Publication, AS Web-005, 1998.

Gunter, S.A., Beck. P.A., Weyers,J.S., and Cassida, K.A., *Programmed feeding for maintaining gestating beef cows in the southeastern united states*. Professional Animal Scientist, Vol. 16, pages 220-225, 2000.

Hamilton, Stephen F., and Kastens, Terry L. *Does market timing contribute to the cattle cycle?* American Journal of Agricultural Economics, Vol. 82, pages 82-96, 2000.

Hersom, Matt, Thrift, Todd, and Yelich, Joel. *Culling and replacement rate in the beef cow herd*. University of Florida, Extension Publication, AN323, 2015.

Hoveland, Carl S. *Beef-Forage Systems for the Southeastern United States*. University of Georgia, Journal of Animal Science, pages 978-985. 1986.

- Hoveland, Carl S. *Grazing Systems for Humid Regions*. University of Georgia, Journal of Production Agriculture, Vol. 5, No. 1, pages 23-27, 1992.
- Hutson, J.E., Thompson, P.V., and Taylor Jr, C.A *Combined effects of stocking rate and supplemental feeding level on adult beef cows grazing native rangeland in Texas*. Journal of Animal Science, Vol 71, pages 3458-3465, 1993.
- Jennings, John, Gadberry, Shane, and Simon, Kenny. *Akransas 300 Days Grazing System-Getting Started*. University of Arkansas, Extension Publication, FSA 3139, 2020.
- Kenny, D.A., Fitzsimons, C., Waters, S.M., and McGee, M. *Invited review: Improving feed efficiency of beef cattle- the current state of the art and future challenges*. The Animal Consortium, Vol 12, issue 9, pages 1815-1826, 2018.
- Kelley, Ken, Runge, Max, Mullinex, Kim, Dillard, Leanne, and Russell, David. *Alabama 2019-2020, Overseeding Permanent Summer Pasture with Winter Annuals*. Auburn University, extension publication, 2019.
- Kelley, Ken, Runge, Max, Sawadago, Wendiam, Mullinex, Kim, Dillard, Leanne, Russell, David, and Dunn, Abby. *Alabama 2022-2023, Winter Annuals for Grazing*. Auburn University, extension publication, ANR-2928, 2022.
- Kerley, M. *Potential for nutritional imbalance in high-quality forages*. Proceedings, Grazing Livestock Nutrition Conference July 9 and 10, 2010.
- Knight, Russell and Taylor, Hannah, *Livestock, Dairy, and Poultry Outlook: May 2022*. USDA, Economic Research Service, LDP-M-335, May 18, 2022.
- Kunkle, William E., Sand, Robert S., and Rae, D. Owen, *Effects of Body Condition on Productivity in Beef Cattle*. University of Florida, Extension Publication, SP-144, 1994.
- Lalman, David, *Limit feeding concentrate diets to beef cows as an alternative to feeding hay*. Oklahoma State University, Extension publication, ANSI-3028, 2014.
- Little, Randall D., Williams, Allen R., Lacy, R. Curt, and Forrest, Charlie S., *Cull cow management and its implications for cow-calf profitability*. Journal of Range Management, Vol. 55, pages 112-116, 2002.
- Little, Randall D., Forrest, Charlie S., and Lacy, R. Curt, *Cattle Producer Attitudes towards alternative production and marketing practices*. 2000. Peel, Darrell S., and Doye, Damona, *Cull Cow Grazing and Marketing Opportunities*. Oklahoma State University, Extension Publication, AGEC-613, 2008.
- Loerch, S.C., *Limit-Feeding corn as an alternative to hay for gestating beef cows*. Journal of Animal Science, Vol. 74, pages 1211-1216, 1996.
- Lovell, Jarvis S., *Cattle as capital goods and ranchers as portfolio managers: an application to the Argentine cattle sector*. Journal of Political Economy, Vol. 82, pages 489-520, 1974.

- Marsh, John M., *The effects of breeding stock productivity on the u.s. beef cattle cycle*. American Journal of Agricultural Economics, Vol. 81, Pages 335-346, 1999.
- Mathis, Clay P. and Sawyer, Jason E. *Nutritional Management of Grazing Beef Cows*. Veterinary Clinics: Food Animal Practice. Vol. 23, Issue 1, pages 1-19, 2007.
- Matulis, R.J., McKeith, F.K., Faulkner, D.B., Berger, L.L., and George, P., *Growth and carcass characteristics of cull cows after different times on feed*. Journal of Animal Science, Vol. 65, Pages 669-674, 1987.
- McBride, William D., and Matthews, Jr., Kenneth, *The Diverse Structure and Organization of U.S. Beef Cow-Calf Farms*. EIB-73. U.S. Dept. of Agriculture, Econ. Res. Serv. March 2011.
- Melton, Bryan E., *Economics of Beef Cow Culling and Replacement Decisions Under Genetic Progress*. Western Journal of Agricultural Economics, pages 137-147, 1980.
- Mullinex, Kim, Rodning, Soren, Kriese-Anderson, Lisa, Elmore, Michelle, Goodrich, Brittney, Dillard, Leanne, Kelley, Ken, Runge, Max, Tigue, Alex, Prasad, Rishi, and Stanford, Kent, *Alabama Beef Handbook* Auburn University, extension publication, ANR-1323, revised August 2018.
- Mullinex, Kim, Dillard, Leanne, and Thompson, Gerald. *Stocking Rates for Cow-Calf Operations in Alabama*. Auburn University, extension publication, ANR-2554, 2019.
- Paarsch, Harry J., *Micro-economic models of beef supply*. The Canadian Journal of Economics, Vol 18, No. 3, pages 636-651, 1985. Price, M.A., and Berg, R.T., *On the consequences and economics of feeding grain ad libitum to culled beef cows*. Canadian Journal of Animal Science, Vol. 61, pages 105-111, 1981.
- Parsons, Cory T., Dafoe, Julia M., Wyffels, Samuel A., DelCurto, Timothy, and Boss, Darrin L. *The influence of residual feed intake and cow age on beef cattle performance, supplement intake, resource use, and grazing behavior on winter mixed-grass rangelands*. Animals, vol 11, issue 6, 1518, pages 1-15, 2021.
- Peel, Derrell, and Meyer, Steve, *Cattle Price Seasonality*. Managing for today's cattle market and beyond, US Department of Agriculture and Cooperating States Extension Services. 2002.
- Pritchard, R.H., and Burg, P.T., *Feedlot performance and carcass traits of cull cows fed for slaughter*. South Dakota Beef Report, paper 21, 1993.
- Raper, Kellie Curry, Biermacher, Jon T., Amadou, Zakou. *Marketing cull beef cows: does body condition matter?* Oklahoma State University, extension publication, AGE 627, 2014.
- Rosen, Sherwin, *Dynamic animal economics*. American Journal of Agricultural Economics, Vol. 69, pages 547-557, 1987.
- Rosen, Sherwin, Murphy, Kevin M., and Scheinkman, Jose A., *Cattle Cycles*. Journal of Political Economy, Vol. 102, pages 468-492, 1994.

- Rucker, Randal R., Burt, Oscar R., and LeFrance, Jeffrey T., *An Econometric Model of Cattle Inventories*. American Journal Agricultural Economics, pages 131-144, 1984.
- Sawyer, Jason E., Mathis, Clay P., and Davis, B. *Effects of feeding strategy and age on live animal performance, carcass characteristics, and economics of short-term feeding programs for culled beef cows*. Journal of Animal Science. Vol 82, pages 3646-3653, 2004.
- Sawyer, J.E., Mathis, C.P., Kirksey, R.E., and Lauriault, L.A., *Production alternatives for market beef cow value enhancement*. The Professional Animal Scientist, Vol. 22, pages 132-138, 2006.
- Schmitz, John D., *Dynamics of beef cow herd size: an inventory approach*. American Journal of Agricultural Economics, Vol. 79, pages 532-542, 1997.
- Schnell, T.D., Belk, K.E., Tatum, J.D., Miller, R. K., and Smith, G.C., *Performance, carcass, and palatability traits for cull cows fed high energy concentrate diets for 0, 14, 28, 42, or 56 days*. Journal of Animal Science, Vol. 75, pages 1195-1202, 1997.
- Segers, Jacob, Rossi, Johnny, and Wilson, Timothy W., *Body Condition Scoring Beef Cows*. University of Georgia, Extension Publication, Bulletin 1308, 2014.
- Selk, G.E., Wettemann, R.P., Lusby, K. S., Oltjen, J.W., Mobley, S.L., Rasby, R.J., and Garmendia, J.C. *Relationships among weight change, body condition and reproductive performance of range cows*. Journal of Animal Science, Vol. 66, pages 3153-3159, 1988.
- Strohbehn, Daryl R. and Sellers, Joe. *Economics of adding value to cull cows*. Iowa Cattlemen's Convention, Pfizer cattlemen's college. 2002.
- Swingle, R.S., Roubicek, C.B., Wooten, R.A., Marchello, J.A., and Dryden, F.D., *Realimentation of cull range cows. I Effect of final body condition and dietary energy level on rate, efficiency and composition of gains*. Journal of Animal Science, Vol. 48, pages 913-918, 1979.
- Torell, L. Allen and Rimbey, Neil R. *Economically efficient supplemental feeding and the impact of nutritional decisions on net ranch returns*. Proceedings, Grazing Livestock Nutrition Conference July 9 and 10, 2010.
- Trapp, James N., *Investment and disinvestment principles with nonconstant prices and varying firm size applied to beef breeding herds*. American Journal of Agricultural Economics, Vol. 68, pages 691-703, 1986.
- Tronstad, Russell and Teegerstrom, Trent, *Economics of sale weight, herd size, supplementation, and seasonal factors*. Journal of Range Management, 56, Sept 2003, pages 425-431.
- Troxel, T.R., Gadberry, M.S., Cline, S., Foley, J., Ford, G., Urell, D., and Wiedower, R., *Factors affecting the selling price of replacement and market cows sold at Arkansas livestock auctions*. The Professional Animal Scientist, Vol. 18, pages 380-386, 2002.
- Troxel, Tom R. and Simon, Kenny. *Best Management Practices for Small Beef Cow-Calf Herds*. University of Arkansas, extension publication FSA 3117. 2007.

USDA Alabama Direct Hay Report, December 1, 2022,
https://mymarketnews.ams.usda.gov/filerepo/sites/default/files/3050/2022-11-28/655222/ams_3050_00135.pdf

Wikse, Steven E., Field, Robert W., and Holland, Patricia S. *Use of performance ratios to calculate the economic impact of thin cows in beef cattle herds*. American Association of Bovine Practitioners Proceedings of the Annual Conference. 1994.

Wooten, R.A., Roubicek, C.B., Marchello, J.A., Dryden, F.D. and Swingle, R.S., *Realimentation of cull range cows. 2 Changes in carcass traits*. Journal of Animal Science, Vol. 48, pages 823-830, 1979.

Wright, Cody L., *Managing and Marketing cull cows*. The Range Beef Cow Symposium XIX, Rapid City, SD, Pages 153-160, 2005.

Yager, William A., Greer, R. Clyde, and Burt, Oscar R., *Optimal Policies for Marketing Cull Beef Cows*. Journal of American Agricultural Economics, Vol. 62, pages 456-467, 1980.