Profitability and adoption of limit feeding during the stocker phase

by

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Abstract

This analysis aims to measure and quantify the profitability and adoption of limit feeding stocker cattle to better assist producers with management decisions. One analysis looks at comparing the profitability of limit feeding or ad libitum feeding stocker cattle, and the other looks at factors that influence producer adoption of limit feeding.

When comparing the profitability of limit feeding and ad libitum feeding, values of interest were measured at the stocker phase, feedlot phase, and at harvest. At the stocker phase, cattle performance, feed costs, labor requirements, and machinery usage costs were collected. Cost of gain and performance was measured throughout the feedlot phase, and then quality grades, yield grades, and dressing percentages were recorded at harvest. These values allowed for producer budget sheets to be constructed that compare the profitability of limit feeding or ad libitum feeding stocker cattle or compare the profitability of finishing cattle that had been limit fed or fed ad libitum during the stocker phase. During the research trial a net benefit was observed for limit feeding stocker cattle, but it was more profitable to finish cattle that had been fed ad libitum at the stocker phase. However, much of this profitability relies on input costs and rate of adoption within the industry.

To analyze the factors that influence producer's adoption of limit feeding, willingness to change between practices, and measure producer's views of different management options, a producer survey was conducted. Stocker producers were asked to complete a survey that included questions regarding operator characteristics, operational characteristics, respondents' preferences, and a choice experiment. Results from producers that currently limit feed showed that main socioeconomic variables do not influence a producer's decision to limit feed. Within the choice experiment, producers that currently limit feed are more likely to select limit feeding,

producers that have a bachelor's degree and above are more likely to select ad libitum feeding, and producer's that sell 50% or more of their cattle through a traditional auction market are more likely to select ad libitum feeding. Additionally, if producers see an increase in ADG or a cost benefit the probability of them switching to limit feeding increases. Results from this survey provide a better understanding of potential adoption of limit feeding, measure market impacts that may occur, and target educational programs that are most beneficial to producers.

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Chapter 1 - Overview of the Stocker Industry and Literature Review

1.1 Stocker Industry

Stocker cattle production focuses on growing calves prior to shipping them to be finished in a feedlot. There are various stocker systems to produce feeder cattle that are prepared to go into a finishing system. Factors including, beginning weight, rate of gain, diet fed, ending weight, length of time, and other management choices allow for many different stocker production programs for producers to choose from. However, the profitability of stocker production often depends on which program is chosen at a point in time. One management option is to limit feed the stocker calves. This feeding method restricts feed intake relative to actual or anticipated ad libitum intake to maximize nutrient utilization and to improve feed conversion ratios (Hannon and Murphy, 2019, Hicks et al., 1990; Murphy and Loerch, 1994; Galyean et al., 1999). Previous research has found both positive and negative attributes of limit feeding. The debate of limit feeding focuses around feed efficiency, increased time on feed, animal health, impact on feedlot performance, and carcass characteristics.

Limit feeding cattle and the effect on animal performance has been researched greatly, but economic research pertaining to limit feeding has not been researched extensively. However, some research indicates that it is an economically viable management decision from a feed savings stand point.

1.2 Economics of Stocker Production

Stocker operators make a profit by the margin that they buy calves for and then sell the feeder cattle for. This margin is derived from the relation between feeder cattle price and weight

(Peel, 2006). Like other aspects of the cattle industry, stocker prices are characterized by cycles of prices and production. Seasonal price patterns impact the gross profit margin for stocker enterprises (Peel, 2006). Feed and forage costs drive the cost of production at 8-15% for stocker operations, so when these prices fluctuate in the cycle it greatly impacts the profit margin (Peel, 2006). High corn prices reduce the price that feedlots can pay for feeder cattle and may change the demand for different weights of feeder cattle (Peel, 2006). In the past, research focused on how much grain cattle could consume, but now research is shifting more towards how to produce cattle with as little grain as possible (Ishmael, 2011).

Looking at the value of gain over a specific period of time can show how cycles impact cattle prices and feed costs. Peel found that although values of gain for different stocker programs vary higher and lower together over time, there is an adequate amount of variation across different programs (2006). The goal of stocker operations has become to put as much gain on calves as possible while staying below the cost of gain (Ishmael, 2011). Demonstrating that there are opportunities to improve average returns by selecting different programs under different market conditions (Peel, 2006). Stocker operations evaluate feed costs, cattle prices, and market trends and implement educated management decisions based off the information provided to them.

1.3 Limit Feeding Cattle Performance and Health

1.3.1 Feed Efficiency

Limit feeding cattle to achieve a desired gain is not a novel idea to the beef industry. Previous research has focused on animal performance for limit fed animals in comparison to the traditional ad libitum feeding at different points in the beef supply chain; however, research

focusing on limit feeding at the stocker phase and subsequent impacts has not been researched as heavily.

Feed efficiency has always been a valuable aspect in beef production; although, as the industry is working to produce meat products using fewer resources feed efficiency proves to be an important component to look at. Limit feeding has the potential to increase feed efficiency among growing calves when compared to ad libitum feeding. Ferrell and Jenkins indicated that the relationship between energy intake and energy retention is nonlinear and that maximum feed efficiency does not occur at maximum intake, suggesting that ad libitum feeding is not the most efficient feed management program (1998). This is supported by other studies that found feed efficiency was highest among steers that were limit fed (Knoblich, 1997; Hicks et al., 1990; Schoonmaker et al., 2004: Rossi et al., 2001). However, in Schoonmaker and others' study they found that feed efficiency was similar among cattle that were limit and ad libitum fed (2003). Indicating that a combination of feeding methods may be an option to increase feed efficiency. Knoblich concluded that limit feeding steers and then increasing daily gain through increasing intake can reduce the total feed needed to finish cattle in comparison to ad libitum feeding (1997).

1.3.2 Animal Health

With any management choice, animal health is vital. Cattle need to be feeling their best to stay on feed, achieve desired gains, and maximize performance. Limit feeding calves a high-energy diet and the effect on calf health has been a concern among stocker operations. Spore and others found that limit feeding a high-energy ration does not impact stress or immune function in healthy or sick animals in comparison to lower energy, high forage diets that are fed ad libitum (2017). In fact, stocker calves that are not consuming adequate amounts of energy are prone to

Bovine Respiratory Disease and reduced performance (Spore et al., 2017). Limit feeding has been a management option to increase energy intake upon arrival through the inclusion of cereal grains to create a more energy dense diet (Spore et al., 2017). Cattle can be fed a high-energy diet without negative effects on antibody production towards vaccines, inflammation, overall stress, morbidity, or mortality (Spore et al. 2018 and Spore et al., 2017.)

1.3.3 Feedlot Performance

An aspect to consider when evaluating stocker cattle diets is how the diet impacts cattle performance at the feedlot level as a focus of stocker production is preparing cattle to go into a finishing system. Diet fed during the growing phase did not affect cattle gains during the finishing period according to Schoonmaker and others (2003). This contradicts another trial by Schoonmaker which found that limit fed cattle were the most efficient during the finishing phase (2004). Hicks et al. (1990), Knoblich et al. (1997), and Rossi et al. (2001) also observed that feed efficiency was improved after periods of restriction in limit fed cattle. Steers that were limit fed gained 14.5% faster than steers offered feed ad libitum during the growing phase; however, gains from 119 days of age until slaughter were greatest for steers fed ad libitum (Schoonmaker et al., 2004). One aspect that is accredited for limit fed cattle's ability to gain so well in the feedlot is compensatory gain. Knoblich and others conclude, compensatory gain occurred which allowed steers to overcome slower growth rates that were imposed during the limit fed period (1997).

1.3.4 Time in the Feedlot

When looking at varying management decisions, something to take into consideration is will this prolong the time cattle need to be on feed, and if so, how much longer? Previous research found when slaughtered at a constant fat thickness, cattle fed a high concentrate, ad libitum diet spent the least amount of time in the feedlot and were the youngest at slaughter in

comparison to limit fed calves (Schoonmaker et al., 2004 and Schoonmaker et al., 2003). This contradicts studies by Knoblich et al. (1997), Loerch and Fluharty (1998), and Rossi et al. (2001) which showed steers that were limit fed to achieve stepwise increases in gain no difference was observed for days on feed when steers were slaughtered at a constant body weight. Knoblich's findings support this idea, stating that programmed increases in intake encourage compensatory gain which allows limit fed cattle to reach market weight with the same overall daily gain and in the same number of days as steers that are fed ad libitum (Knoblich, 1997).

1.4 Limit Feeding Impact on Carcass Merit

1.4.1 Fat Thickness and Yield Grade

Cattle managers are careful to not get cattle overly fat which can result in undesirable yield grades and wasting feed resources on fat deposition instead of growing edible product. A study conducted by Schoonmaker and others found that steers offered feed ad libitum had the greatest fat thickness at a constant day of age. However, this fat deposition impact decreases once cattle reach the finishing phase (Schoonmaker et al., 2003). Additionally, the higher concentrate diet fed ad libitum increased energy directed towards producing fat; therefore, accelerating maturity and leading to lower slaughter weights at the same fat thickness. At a constant age, steers fed ad libitum had 48-94% more fat depth over the rib (Schoonmaker et al., 2004). It is possible that ad libitum fed cattle direct more resources towards producing additional fat.

Cattle producers work to obtain any premium they can when raising and marketing calves, and one opportunity they can capitalize on is a yield grade premium. As mentioned previously, limit feeding is often associated with growing leaner cattle. As feeding restrictions increase, the lean carcass fraction of limit fed animals increases- resulting in a yield premium

(Hannon and Murphy 2019). Schoonmaker and others support this as limit fed cattle had the largest percent of steers at a yield grade 1 while steers fed the high concentrate diet ad libitum had the highest percent of yield grade 3 and 4 cattle (2003). This contradicts Schoonmaker and other's findings which found no difference among yield grade distributions (2004). If limit feeding does aid in producing more yield grade one and two cattle, less resources are directed to putting undesired fat on cattle and a premium could be captured.

1.4.2 Marbling

Diets are an important component in producing beef product. Understanding the type of beef that is produced by utilizing certain diets is needed, so the industry can produce the high-quality beef that consumers are demanding. Management at the stocker phase could increase intramuscular fat deposition while decreasing fat deposition in unwanted areas; ultimately, leading to more efficient beef production and increased carcass quality (Krehbiel et al., 2012). Marbling is an aspect that often drives consumer eating experience, so when looking at alternative feeding programs the effect on marbling is an important component. Higher energy diets have been shown to be one way to increase intramuscular fat deposition. Previous research has found that starting cattle on higher energy diets at earlier ages led to increases in marbling (Wertz et al., 2002 and Meyers et al., 1999a; 1999b). Other research has found that limit feeding in comparison to ad libitum feeding high concentrate diets did not impact average marbling score, but cattle fed the ad libitum diet did have a higher percentage of intramuscular fat at conclusion of the growing phase (Schnoomaker et al., 2003). This contradicts findings by Schoonmaker which found that limit fed steers had a higher level of intramuscular fat than ad libitum fed steers; although, there was no difference for marbling score (2004). Overall, marbling

scores at slaughter were not impacted by the diet fed during the growing phase (Schoonmaker et al. 2003).

1.5 Economics of Limit Feeding

Limit feeding and the impact on animal performance has been researched greatly and appears to be a viable possibility for stocker operations in terms of performance. However, for stocker operators to best understand if limit feeding is appropriate for their operation, economics need to be applied. Some research has shown that limit feeding may provide some economic benefit in terms of feed costs and resource usage.

1.5.1 Feeding Savings

Feed costs for raising cattle and producing meat is the highest percentage of a producers' costs, next to the purchasing of the animal. Any management practices that can help diminish those costs, will improve a stocker operator's profit margin. Knoblich and others found that various treatments of limit feeding created a feed usage savings of 4.10-10.32% of total feed consumed by cattle when compared to cattle offered feed ad libitum (1997). When able to decrease feed volume, a monetary savings is likely to follow. When Knoblich and others evaluated feed costs at $0.21/ kg of DM, the savings in feed costs per steer ranged from $12.28 to $30.35 in comparison to ad libitum feeding (1997). Savings of this magnitude could greatly enhance stocker operations' margins. Additionally, limit feeding provides a benefit by reducing early stage feeding costs and makes ad libitum feeding in the finishing phase more efficient (Hannon and Murphy, 2019). Lower feed costs, less feed required, and more efficient gains assist stocker operations in being more economically viable.

1.5.2 Feed Waste

A potential savings when utilizing limit feeding is reduced feed waste. Knoblich and others found that feed refusals for limit fed steers averaged between 10.3 to 21.4 kg per steer, while the average feed refusal for ad libitum fed steers was 32.8 kg per steer. When dollar values are applied to these volumes the money wasted per steer is substantial. For limit fed steers the feed waste costs were $2.23 to $4.64 per head and the steers fed ad libitum had a feed waste cost of $7.10 per head (Knoblich et al., 1997).

1.5.3 Fat Deposition from an Economic Perspective

Different diets and feed management programs cause fat to deposit differently and to occur at different times. Some fat deposition is valuable for eating experience and protection of key organs, but excessive fat results in wasted resources and additional harvesting costs. Reducing internal fat deposition, which is low value trim fat without reducing quality grades that are driven by high value intramuscular fat is an important part to beef production (Knoblich et al., 1997; Hannon and Murphy, 2019). Limit feeding has shown to alter fat deposition in a manner that can be beneficial to the beef industry and consumers. Limit fed steers showed reductions is 12^{th} rib backfat, kidney, pelvic, and heart fat, and yield grades which provides evidence that manipulating carcass fat deposition through feeding methods may be economically and physiologically feasible (Knoblich et al., 1997). Altering fat deposition in a way to be more desirable provides consumers with a positive eating experience and diminishes resources directed to fat deposition.

1.6 Sustainability

The economic viability of a beef system is vital, and some may argue that the sustainability of a management decisions is equally important. Sustainability is a word that has

been floating around the beef industry for several years and carries various meanings and interpretations. However, sustainability did not become an important policy concept until the 1980s when concerns about excessive resource use drove publication of a report by the United Nations World Commission on Environment and Development. The report indicates that sustainable development must integrate social, economic, and environmental concerns (WCED, 1987). These three pillars have since been applied through research of food systems and quantified to evaluate sustainability. Research by White and Capper worked to quantify metrics of environmental impact, social acceptability, and economic viability for beef production systems that were varying in efficiency. They hypothesized that improving productivity by increasing finishing weight (FW) or average daily gain (ADG) would reduce environmental impact, improve profitability and enhance beef products' social acceptability (2013).

1.6.1 Land Use

The U.S. beef industry is often criticized for the land required to raise cattle and produce meat. Although much of the land used for beef production is only suited for grazing, opportunities to reduce land use when possible can be considered. Findings by White and Capper showed increasing ADG by 15% decreased land use by 3.2% and increasing FW by 15% decreased land use by 9.2% (2013). The cost of land required to raise cattle is an important component producers take into consideration when raising cattle for meat production.

Models of meat demand indicate that price is one of the most significant determinants of beef consumption (Chavas, 1983; Dahlgran, 1987; Schroeder et al., 2000; Tonsor et al., 2010). Showing that sustainability efforts should be made in an economically sustainable manner for producers and consumers. White and Capper conclude, to prevent increased beef prices beyond a

socially acceptable threshold, the quantity of land required to produce beef could be reduced through improved productivity (2013).

1.6.2 Nutrient Excretion

Nutrient excretion is a component that producers can consider within their operations, so they are not providing resources that end up being discharged into the environment. When ADG was increased, nitrogen (N) excretion decreased by over 4% and phosphorous (P) decreased by almost 14%. Similarly, when FW was increased, N excretion decreased by over 10% and P decreased by over 17% (White and Capper, 2013). Previous research by Tozer and Stokes (2001) found that it is difficult to simultaneously minimize N and P excretion through dietary manipulation, so the findings of White and Capper show that improved productivity can reduce excretion of both N and P (2013). This benefits operations from environmental and economical perspectives.

1.6.3 Stocker Profits

When looking at improving environmental impacts, it is important to consider if improvements can be achieved in an economical sense. Increasing ADG and FW sometimes results in increased feed consumption and increased energy requirements which often equates to increased feed costs. However, White and Capper found when ADG increased, income over variable costs (IOVC) for stockers increased to $0.83 per day, and when FW increased, IOVC for stockers increased $0.82 per day (2013). In this scenario, the improved efficiency lead to reduced costs and improved profitability for producers.

1.6.4 Willingness to Pay

Consumer's willingness to pay for more sustainably produced food is an important aspect to consider when looking at the economic viability of a management decision. A study by Marta-

Pedroso and others found that over 81% of respondents would be willing to pay more for beef with a guaranteed sustainability label (Marta-Pedroso et al., 2012). Additionally, Igo and others estimated that consumer's willingness to pay for more efficiently produced beef was at a 9% premium (2013). This contrasts with a study by Tonsor and Shupp that found the typical consumer is not willing to pay a positive premium for beef labeled as sustainably produced (2009). However, there may be value in marketing sustainably labeled food to certain demographics. Sustainably produced beef demand was higher among younger consumers, those with higher incomes, and those who related sustainably produced beef with pasture based production (Tonsor and Shupp, 2009). Consumers value different aspects when it comes to sustainable beef production, so knowing how to market different management practices to various consumers can impact beef demand. Marketing of meat products appears to be a key driver in consumer's willingness to pay and the overall profitability of the production systems.

1.6.5 Fat Deposition from a Sustainability Perspective

Food and resource waste is a large part of the conversation around sustainability. Weech believes food waste is built into the beef production cycle and it needs addressed (2015). Weech is referring to the high percentage of cattle that are fed until a yield grade 4 and 5 in hopes that the cattle will classify for Certified Angus Beef or grade Prime, and a premium can be captured (2015). If more cattle are grading yield grade 1 and 2 that is less fat that needs cut away and discarded. With the use of technology available, educated management decisions, and a reasonable marketing target, having more cattle with a resulting yield grade of 1 and 2 should be easily attainable (Weech, 2015). Like any management program, one way to get producers to adapt to this change is to show a profit. Therefore, Weech pushes the U.S. beef industry to focus on a marketing target that encourages cattle to be finished with minimal days on feed and at a

yield grade of 1 or 2 (2015). Based off previous research, limit feeding may have a role in achieving this marketing target. Hannon and Murphy found that fixed feed restriction percentages of 5% to 15% relative to ad libitum have generally increased feed efficiency and improved carcass yield grade (2019). As the beef industry looks for ways to improve sustainability, food waste from unneeded fat on cattle deserves to be part of the conversation; feeding options that work towards more sustainable beef production are a good starting point.

1.7 Producer Adoption

With a variety of production options and information resources available, numerous factors play a role in a producer's decision to adopt specific agricultural practices. Understanding what factors affect producer adoption of given production practices has been a heavily researched topic. One of the first studies around adoption of new technologies found profitability to be the largest determinant (Griliches, 1957). Rogers examined how various characteristics affected adoption; he concluded profitability was one component that positively influenced adoption along with relative advantage, compatibility, complexity, trialability, and observability. Operation characteristics have also been found to influence adoption (1983). Farm size has frequently been found to influence adoption of agricultural practices (Banerjee et al., 2008; Diederen et al., 2003; Gillespie, Basarir, and Schupp, 2004; Just and Zilberman, 1983; Popp, Faminow, and Parsch, 1999; Rahelizatovo and Gillespie, 2004; Ward et al., 2008). Furthermore, operators of large farms that are more dependent on revenue from the operation and are less likely to purse off-farm work were found to be more likely to adoption technologies that required additional managerial time (Caswell et al., 2001). Percentage of household income from the operation has been found to influence adoption of practices as well. Producers that adopted recommended practices tended to be more dependent on income generated from the operation

(Gillespie, Kim, and Paudel, 2007). Best management practices that resulted in immediate economic benefit were found to be most frequently adopted (Gillespie, Kim, and Paudel, 2007).

1.7.1 Operator Characteristics

Operator characteristics has shown to influence adoption of agricultural practices. Age, education, and experience have frequently been identified as factors that influence agricultural technology adoption (Banerjee et al., 2008; Caswell et al., 2001; Daberkow and McBride, 2003; Gillespie, Basarir, and Schupp, 2004; Gillespie, Kim, and Paudel, 2007; Rahelizatovo and Gillespie, 2004). Education was often demonstrated to have a strong positive effect on adoption (Johnson et al., 2010). Age has been found to have a negative effect on adoption of some technological agricultural practices (Daberkow and McBride, 2003). However, other research by Ward et al. (2008) found age, education, and farm objective positively impacted adoption.

1.7.2 Stocker Industry Adoption

Johnson et al. (2010) looked specifically at the stocker industry and what factors influenced adoption of key production management decisions. Operational characteristics had the most impact on adoption (Johnson et al., 2010). Operation size was significant in almost all the management practices, and positively influenced adoption of every practice (Johnson et al., 2010). Dependency on income generated from the operation also significantly impacted adoption of most practices (Johnson et al., 2010). Contrasting previous research, education did not always positively impact adoption (Johnson et al., 2010). In agreement with previous studies, age negatively impacted adoption rate (Johnson et al., 2010). Johnson et al. (2010) concluded that if age continues to have a negative impact on adoption of practices that are beneficial to the general welfare, incentive programs for older producers may be useful.

Adoption of production practices can be influenced positively or negatively by many different aspects. Furthermore, the variables that influence some practices positively may impact others negatively or vice versa. Research by Hill found that when looking at risk management practices, variables that significantly impacts use of some practices did not significantly impact the use of other risk management practices (2015). Identifying factors that influence adoption is useful; therefore, educational programs can be focused on specific demographics to be most successful. When extension groups or producer education groups are working on educational programing, Johnson et al. explains how results can be used to target educational efforts to groups with the higher return on investment (2010).

1.8 Choice Experiments and Stated Preference Data

Choice experiments showcase a respondent's preferences by evaluating the choice that is selected within a survey. Choice is something people do in every aspect of their life and involves the support or rejection of a good, service, or practice. Habit, inertia, experience, advertising, peer pressure, environmental constraints, accumulated opinion, household, family constraints, and many other aspects influence an individual's choice (Louivere et al., 2000). Choice experiments investigate the responsiveness of respondents to particular situations (Louivere et al., 2000). The order of stages in a consumer's decision process are in figure 1.1 (Louivere et al., 2000). First, a consumer must become aware of a need or problem that needs solved. Then the consumer learns about goods, services, or practices that can fulfill the need or solve the problem. While learning, consumers form beliefs about the available solutions. Once informed, consumers form a utility function in which they value and trade off attributes of each decision. Consumers then develop a preference ordering for the attributes and then make a selection.

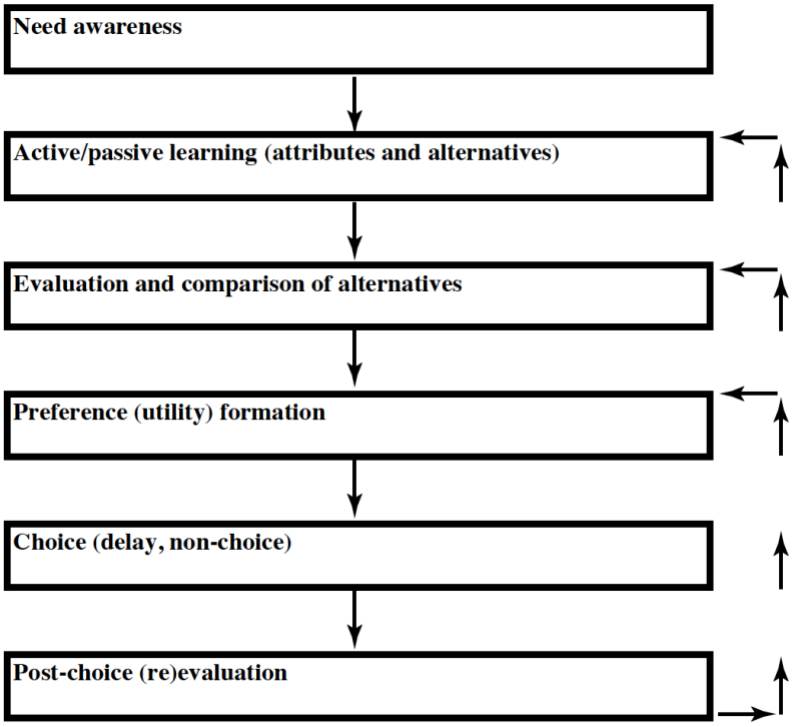

Figure 1.1. Consumer Choice Process (from Louivere et al., 2000)

In choice experiments, respondents are given scenarios characterized by a unique combination of attributes at varying levels (Hill, 2015). Two assumptions of choice analysis about a respondent's choices is they are acting rationally and acting as if they are maximizing utility (Hensher et al., 2005). Choice experiments provide researchers with stated preference data which involve choice responses from the same economic agents that occur in the marketplace, but are evoked in a hypothetical situation (Louivere et al., 2000). Stated preference data are beneficial as it is a way to estimate demand for new products or practices prior to the development of those products or practices (Louivere et al., 2000). Overtime, new variables are introduced that may influence choices; stated preference data allows for those new variables to be evaluated and changes in demand can be quantified (Louivere et al., 2000). Furthermore, stated preference allows for goods that are not traded in actual economic markets to be evaluated. Environmental or public goods are not publicly traded goods, but the value or cost and benefit of

those items can be addressed through a stated preference (Louivere et al., 2000). Stated preference data aids in identifying possible demand, the target audience, and appropriate market and educational strategies (Louivere et al., 2000).

Overall, stated preference data are used by economists for a variety of situations and reasons. Choice experiments are useful is describing hypothetical decisions and allow for the flexibility of a simulated decision (Louivere et al., 2000). With stated preference data, the mapping of different utility functions occurs through the control relationship between attributes (Louivere et al., 2000). A characteristic of stated preference data is the multiple observations per respondent when the respondent is committed to and responds to the tasks (Louivere et al., 2000).

Stated preference data are beneficial for economic research as it provides tradeoff information; therefore, the data are useful in quantifying and forecasting changes in behavior (Louivere et al., 2000). There is additional value in mapping tradeoffs over a wide range of attribute levels and including new choice alternatives as they become available (Louivere et al., 2000).

Chapter 2 - Profitability of Limit Feeding Stocker Cattle

2.1 Introduction

Beef cattle production in the United states contains three main sectors that build upon each other. The different sectors are cow-calf, stocker or backgrounder, and finishing. The focus of this research is the stocker/backgrounder phase which focuses on growing cattle prior to placing them into a finishing program. Some stocker operators utilize a forage based grazing system to grow calves while others utilize a combination of grains and forages while bunk feeding cattle. This research focuses on growing cattle in a dry lot setting while bunk feeding. The stocking or backgrounding segment is an important part of the beef cattle production cycle due to the variety of management options and the emphasis on cattle nutrition and health during this time.

One management option is to limit feed stocker cattle a high-energy diet in comparison to traditional ad libitum, or as much as desired, feeding. While the performance of stocker cattle and varying production systems has been researched heavily, the economics of the stocker phase, specifically limit feeding, has not been researched deeply. The stocking segment is vulnerable to changes in land prices, commodity prices, the feeder calf and fed cattle price spread, and labor requirements. The profitability of the stocker phase often varies from year to year and depends on the production system chosen in a given year. Limit feeding is a novel feeding type that many stocker or backgrounders may not be familiar with. An understanding of limit feeding including animal performance, variable and total costs, and labor requirement is necessary for producers to make educated production decisions.

Therefore, this study looks at animal performance and input costs through a live animal research study. This research seeks to provide an overview of the economics of limit feeding in

terms of key variables that impact profitability. For example, average daily gain (ADG), feed costs, labor costs, equipment requirements, impact on finishing phase performance, and carcass merit were all variables of interest for the live animal study. Each variable impacts profitability, so quantifying it allows producers to best compare limit feed and ad libitum feeding, and then make a decision for their operation.

The economic information gap that stocker producers experience when evaluating the option to limit feed stocker cattle is the key driver behind this research. Improved understanding of the economics, labor requirement, and cattle performance at the stocker phase and on through to slaughter will provide information that is relevant industry wide.

2.2 Data Collection

Four hundred eighteen crossbred heifers were placed into a backgrounding program for 90 days at the Kansas State Stocker unit (Scilacci et al., 2020). Heifers were blocked by weight and randomly assigned to a treatment pen with two treatments on May 29, 2019. One treatment was a 45 NEg diet that was fed ad libitum and the second treatment was a 60 NEg diet that was limit fed at 85% of the ad libitum dry matter intake. Throughout the trial, variables of interest were recorded to be utilized to build a producer budget sheet that improves decision-making of those considering a change in feeding program on their operation. Variables include, performance data of cattle, dry matter intake, feed cost, and time to mix and deliver each diet.

On September 26 and 27, 2019 heifers were sent to Pratt Feeders where heavier cattle were fed for 141 days and lighter cattle were fed for 163 days. All cattle were fed the same finishing diet, ad libitum. During the finishing phase, cost of gain and cattle performance was evaluated. Cattle were then harvested on January 14, 2020 or February 4, 2020 and carcass data are collected. Carcass data included quality grades, yield grades, liver abscesses and scaring, hot

carcass weights, dressing percentages, and carcasses that were accepted into branded beef programs.

2.3 Results and Discussion-Stocker Phase

During the stocker backgrounding phase variables that impact the profitability of each feeding type were recorded to provide producers with all necessary information that may play a role in their decision-making process. These variables include, performance data, feed costs, machinery usage costs, and labor requirements.

2.3.1 Performance

In terms of animal performance, variables of interest were total gain, average daily gain (ADG), feed-to-gain (F:G), and gain to feed (G:F). Performance measures are an important aspect to growing cattle, so producers know how much their cattle are expected to gain and about how long it will take to reach that desired gain. Limit fed cattle had a higher overall total gain; with an average gain of 222 pounds in comparison to the ad libitum fed cattle that had an average total gain of 193 pounds throughout the backgrounding phase. Consequently, limit fed cattle achieved a slightly higher ADG. On average, limit fed cattle had an increase in ADG of 0.13 pounds per day. Therefore, cattle that are limit fed would require fewer days on feed to reach a desired weight, or achieve a higher ending weight when fed for the same number of days as ad libitum fed stocker cattle. Feed to gain was also evaluated for each treatment group. Feed to gain is an efficiency measure that explains how well cattle convert feed nutrients into weight gain. Feed to gain is an important variable to measure as it provides insight into the cost to feed an animal. Therefore, lower F:G is desired. The study at the Kansas State Stocker Unit found limit fed cattle had a lower F:G ratio than ad libitum fed cattle. Limit fed cattle were more efficient with a F:G of 6.72 than ad libitum cattle with a F:G of 8.44.

2.3.2 Ration Cost

The two treatments were fed different diets at different rates, resulting in different feed ration costs. The two diets, pounds fed per head per day, and the feed cost per pound can be found in tables 1.1 and 1.2. As shown in table 1.1, the diet that was fed ad libitum was more expensive to feed per head per day. The diet that was limit fed was less expensive during the trial due to feed prices at the time and the rate of inclusion into the diet as shown in table 1.2. The feed ration costs totaled $0.9021 per head per day for the limit fed diet. The diet that was fed ad libitum was more expensive at $1.0306 per head per day to feed. Feed and commodity prices vary over time, so it is possible at a different point in time, the ad libitum diet may be the less expensive option or the two diets may be the same price.

Table 1.2.1. Ad Libitum Fed Diet

Ingredient	Lbs./head/day	Cost/lb.
Dry Rolled Cracked Corn	1.41	0.08
Supplement	1	0.17
SweetBran	9.57	0.03
Alfalfa	3.55	0.09
Prairie Hay	3.53	0.04
Total	19.06	0.41
Total cost/head/day	1.0306	

Table 1.2.2. Limit Fed Diet

Ingredient	Lbs./head/day	Cost/lb.
Dry Rolled Cracked Corn	5.02	0.08
Supplement	1	0.17
SweetBran	7.52	0.03
Alfalfa	0.81	0.09
Prairie Hay	0.8	0.04
Total	15.15	0.41
Total cost/head/day	0.9021	

2.3.3 Labor Requirement

To garner an understanding if there is a difference in labor requirement between the two feeding types, time to mix and deliver the two diets was recorded throughout the trial. The diet that was fed ad libitum was more forage based and was fed at a larger volume, so it took additional time to mix and deliver. Data collection showed that the 45NEg diet took an additional 0.319 hours per head per feeding. Consequently, this will result in a higher labor requirement than the diet that is limit fed.

2.3.4 Machinery Costs

A difference in time to mix and deliver the two diets leads to a difference in tractor and mixer usage costs as well. The additional 0.319 hours per head per feeding for the diet fed ad libitum will increase tractor and mixer costs as more hours are put onto the machinery to feed the 45NEg diet that is fed ad libitum to the same amount of cattle.

Overall, this research trial showed that limit fed cattle outperformed ad libitum cattle from an ADG and F:G aspect. Additionally, the 60NEg diet that is limit fed was less expensive and reduced feeding time in comparison to the 45NEg diet. The reduced feeding time also lowered the tractor and mixer usage costs.

2.4 Results and Discussion-Feedlot Phase

After 90 days at the Kansas State Stocker unit calves were sent to Pratt Feeders to be finished. All cattle were fed the same diet ad libitum. While in the finishing phase, performance data were collected and cost of gain was calculated.

2.4.1 Performance

Cattle were fed to an average weight of 1,282 pounds. The cattle were divided into a heavy group with 100 head that were fed the 60NEg diet at the stocker phase and 101 head that were fed the 45NEg diet at the stocker phase. There was a lighter group with 100 head that were fed the 60NEg diet at the stocker phase and 102 head that were fed the 45NEg diet at the stocker phase. The light group took an additional 23 days to reach finishing weight and condition. The ADG between the heavy and light group for the cattle that were limit fed at the stocker phase was 2.795 pounds per day while the ADG for the cattle that were fed ad libitum at the stocker phase was 3 pounds per day. Once the cattle reached the finishing phase, the cattle fed ad libitum during the stocker phase had a better ADG, so opposite of calf performance during the backgrounding phase. Feed to gain was also observed throughout the finishing phase. As anticipated from the ADG results, cattle fed ad libitum at the stocker phase were more feed efficient. Cattle fed ad libitum had a F:G of 6.995 pounds compared to limit fed cattle which had a F:G of 7.445 pounds. Therefore, cattle limit fed at the stocker phase required an additional 0.45 pound of feed to gain a pound.

2.4.2 Cost of Gain

Additional feed requirements lead to additional costs. Consequently, cattle that were limit fed during the stocker phase had a higher average cost of gain (COG) at $96.12/cwt. Cattle that had been fed ad libitum had an average COG of $90.12/cwt; a difference of $6.02/cwt.

Overall, cattle that were fed ad libitum at the stocker phase achieved a higher ADG, a better F:G, and a lower COG during the finishing phase than cattle that were limit fed at the stocker phase.

2.5 Results and Discussion-Carcass Merit

Cattle were then harvested and carcass data were collected on each. Quality grades were assigned based off cattle maturity and marbling of the meat. In terms of quality grade, cattle that were limit fed during the stocker phase, 5.19%, 89.67%, and 5.16% graded prime, choice, and select, respectively. Cattle fed ad libitum during the stocker phase; 10.35%, 84.28%, and 4.94%. graded prime, choice, and select, respectively. Carcasses that grade prime earn a premium on the grid while select takes a discount, and choice is the base with no premium or discount applied. Therefore, this trial shows cattle fed ad libitum at the stocker phase are more likely to earn a premium and take less discounts in terms of quality grade. Yield grades measure the cutability of an animal, in other words the percent of useable meat product in comparison to waste fat. A lower yield grade is more desirable because that means an animal is mostly muscle that can be turned into meat product with little fat that will need trimmed off. Of the cattle that were limit fed during the stocker phase, 8.55% had a yield grade of 1 and 1.05% had a yield grade of 5. Additionally, 33.36%, 43.29%, and 13.77% had a yield grade of 2, 3, and 4, respectively. Of the cattle that were fed ad libitum during the stocker phase, 9.13% had a yield grade of 1 and 0.56% had a yield grade of 5. Additionally, 37.95%, 45.12%, and 7.25% had a yield grade of 2, 3, and 4, respectively. A yield grade of 1 or 2 earns a premium, 4 and 5 take a discount, and 3 is the base with no premium or discount applied. Therefore, the ad libitum fed cattle were more likely to receive a premium than limit fed cattle, and limit fed cattle are more likely to receive a yield grade discount. Another way carcasses can earn a premium is by being accepted into a branded beef program. Branded beef programs have specific quality standards that carcasses must meet to be accepted. One of the most popular branded beef programs is Certified Angus Beef (CAB). The trial through Kansas State found cattle fed ad libitum during the stocker phase had a 1.41%

higher CAB acceptance rate. When all the premiums and discounts are added up and percentage of cattle calculated together, cattle fed ad libitum at the stocker phase averaged a premium of $3.35/cwt. Cattle that were limit fed at the stocker phase averaged a premium of $1.65/cwt.

Overall, cattle fed ad libitum during the stocker phase captured more premiums for quality grade, yield grade, and acceptance into branded beef programs than cattle that were limit fed during the stocker phase.

2.6 Outputs

Data collected throughout each phase were then utilized to build enterprise budget sheets. There are budget sheets for the stocker/backgrounding phase and feedlot phase. The feedlot budget sheet was designed with the option to sell live fed cattle or sell cattle on the grid. Marketing live fed cattle focuses strictly on the differences in performance while the grid marketing incorporates premium and discounts from carcass merit. The budget sheets are designed to be utilized by producers to input their own production costs if known and compare the profitability of each feeding type in their stocker operation or the profitability of finishing calves that have been limit fed or fed ad libitum at the stocker phase. The budget sheet can also be used to establish break evens for an operation as well as identify points of sensitivity. For example, evaluating how a 10% increase in the price of corn, a 5 cent/cwt. decrease in purchase price, or a 5 cent/ cwt. increase in sale price, etc. would affect profitability. Each budget sheet has a fact sheet that explains the research conducted, the values provided, values that producers should input to represent their own operation, and how to utilize the document to get the most accurate results. Each of the budget sheets, fact sheets, and a video tutorial can be found at Limit Feeding Stockers as shown in figure 2.1.

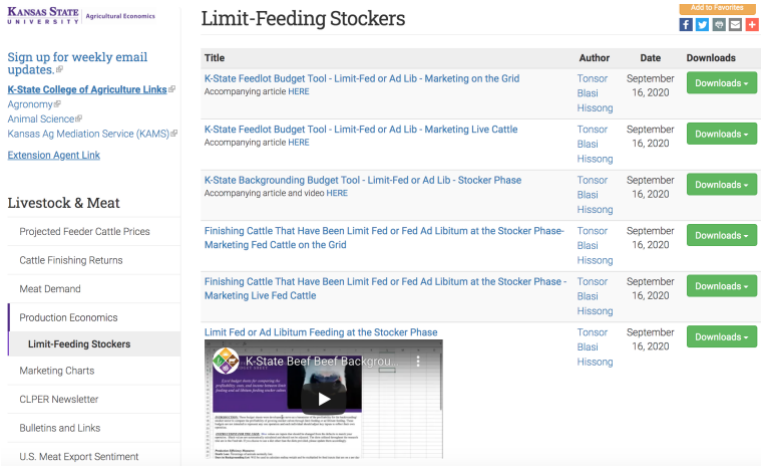

Figure 2.1. Limit Feeding Stockers on AgManager. Info (from Hissong et al., 2020)

2.6.1 Enterprise Budget Sheets

Enterprise budgets are commonly used for livestock enterprises as a barometer for economic performance given anticipated variable and fixed costs. Enterprise budgets are made up of five sections. Those sections include, production efficiency information, gross return, variable costs, fixed costs, and total costs. Production efficiency information includes death loss, days in the enterprise, average daily gain, and hundredweight produced. Gross return utilizes animal purchase price and weight and sale price and weight along with death loss to calculate a total gross return. Variable costs include all costs that are associated with growing cattle within that enterprise. That includes all feeding costs, labor, vet medicine, drugs, marketing costs, utilities, gas, fuel, oil, manure management, machinery and facility repairs, tractor and mixer usage, cash interest paid, and other miscellaneous variable costs. Fixed costs include all costs that exist regardless if growing cattle or not. Costs included are depreciation, taxes, farm/livestock insurance, opportunity cost of investment, and other fixed costs. Variable costs and fixed costs are then subtracted from total gross returns to get the income over variable costs and income over total costs per head.

2.6.2 Stocker Budget Sheet

The stocker budget sheet is for stocker/backgrounder operators to input values relevant to their operation in combination with values found during the trial to evaluate the per head income over total costs for ad libitum and limit feeding (Hissong et al., 2020). Values that are meant to be changed by the producer to represent their own operation is signified with blue text. However, if these values are unknown for an operation, there are values in place that can be used as a default.

To begin a producer will fill out death loss, average daily gain, and days in the backgrounding lot relevant to their operation and management choices. The anticipated increase in average daily gain for the limit fed diet is the value that was found through the research conducted at the Kansas State Beef Stocker Unit. If a producer would choose to not account for the anticipated increase, this value can be set to zero. These values go into calculating the weight of calves when they are ready to be sold. The prices for feeder animal sale price is a default price based upon a March steer price and purchase price is a default price based upon an October steer price. If purchasing heifers or steers at a different time of year these values should be adjusted accordingly. The average weight of calves purchased for a given operation should be inserted into the purchase price quantity. Total gross return, is then calculated by taking the feeder animal sale price and subtracting purchase price and death loss from that value. Differences between the two feeding types are captured here through the anticipated increase in average daily gain of limit fed cattle resulting in a greater hundred weight produced.

The next section looks at the variable costs between the two feeding types. Pasture, crop residue, and harvested forage have been zeroed out as a default, but a producer can input values if they utilize those resources to grow their calves. Grain/protein/mineral supplement price per

head per day values are representative of the diets fed during the research trial. The two diets include different volumes of each ingredient, so the price for each diet is represented within the sheet. The price is then multiplied by the days in the backgrounding lot. If the operation has additional feed costs those can be accounted for in the additional space provided. Labor represents the labor requirement for each animal during the backgrounding phase that has been found through previous research. The wage for employees should be adjusted to represent the producer's operation. Rain events require more labor, so a labor value per head was found. The average precipitation event value can be adjusted to fit the necessary climate to account for the additional labor cost. Mix and delivery times for each diet were recorded throughout the trial. The anticipated increase in time to mix and deliver the diet fed ad libitum is presented in the sheet. However, this value can be set to zero if preferred by the producer. Variable costs for vet medicine/ drugs, marketing costs, utilities, gas, fuel, oil, and machinery, facility/ equip repairs are all Kansas Farm Management Association (KFMA) values for the stocker/ backgrounding phase. These values may be used, or values for a specific operation should be inserted if available. Tractor and mixer time and usage accounts for the per hour lease cost of the equipment multiplied by the per head use. Research shows, the diet fed ad libitum takes additional time to mix and deliver, so the anticipated increase in machinery use is accounted for. Again, this value can be set to zero if one prefers. Cash interest paid and other default variable costs are also KFMA data for stocker and backgrounding operations. Other variable costs are a rough sum of all other KFMA variables costs, including fees/publications/travel, conservation, building rent, and auto expenses. If additional bunks are required to limit feed cattle at an operation, that per head cost should be included here. The sum of these values gives the total variable costs. The

difference in variable costs are driven by the differences in feed cost, mix and delivery time, and tractor and mixer time and usage.

The next section in the budget sheet focuses on fixed costs. Depreciation, taxes, and farm/ livestock insurance values are all from KFMA. The opportunity cost of investment is a KFMA value that represents interest charge, it does not represent cash interest paid, rather a measure to reflect the interest that could have been earned had the investment been made elsewhere. It is important to note that the fixed costs are the same for both feeding methods.

Finally, the income over variable costs and income over total costs is found at the bottom of the spreadsheet. The profitability of each feeding type can be compared utilizing the stocker budget sheet and accompanying fact sheet. Each producer may make adjustments and decisions as they see fit for their operation.

2.6.3 Feedlot Budget Sheet-Live Fed Cattle

The feedlot budget sheet is designed for feedlot operators to input values relevant to their operation in combination with values found during the trial to evaluate the per head income over total costs for finishing calves that were fed ad libitum or limit fed at the stocker phase (Hissong et al., 2020). There is a budget sheet that is designed to be utilized by operators that sell their fed cattle on a live basis. There are values within the sheet that are meant to be changed by the producer to represent their own operation. However, if these values are unknown for an operation, there are values in place that can be used as a default.

It is important to note that the budget sheet is designed as a comparison, assuming the same feeder animal is placed into each scenario. There are numerous factors that impact stocker cattle production with key factors being the diet fed, the rate at which it is fed, and the weight of cattle entering the feedlot. With that, data from previous studies comparing feeder cattle to fed

cattle shows that as bodyweight at feedlot entry increased, finishing average daily gain, dry matter intake, and hot carcass weight increased, whereas gain to feed ratio and days on feed decreased (Rueter and Beck, 2013).

To begin, an operator will fill out death loss, average daily gain, and days on feed relative to their operation. The anticipated increase in average daily gain for the ad libitum fed calves is the value that was found through the research conducted during the Kansas State research trial at Pratt Feeders. If a producer would choose to not account for the anticipated increase, this value can be set to zero. These values go into calculating the weight of calves when they are ready to be sold. The prices for fed animal sale price is a default value based upon a 3-year average steer price, and purchase price is a default value based upon a 3-year average 700-900-pound feeder steer price. The user is encouraged to update both values to obtain a more accurate and timely estimate. Additionally, if purchasing heifers these values should be adjusted accordingly. If purchasing cattle at a specific time of year, an operator can utilize the seasonality tab provided within the document to obtain a more accurate fed steer price. The average weight of calves that the operation typically purchases should be inserted into the purchase price quantity.

Total gross return is then calculated by taking the feeder animal sale price and subtracting purchase price and death loss from that value. Differences between the two feeding types are captured here through the anticipated increase in average daily gain of stocker calves fed ad libitum, resulting in a greater hundred weight produced.

The next section on the budget sheet looks at the variable costs. Prior to beginning this section, the feed tab should be updated by the operator to reflect the ration that is typically fed. Doing so will accurately account for the harvested forage, grain/protein supplement, and mineral cost per head per day. Research at Pratt Feeders found an anticipated increase in feed costs for

limit fed calves, so that value is accounted for in the budget sheet. This value may be zeroed out if preferred. If the operation has other feed costs those can be accounted for in the space provided. Labor represents the labor requirement for each animal during the feedlot phase that was found through prior research. The wage for employees should be adjusted to fit the operation. Variable costs for vet medicine/drugs, marketing costs, utilities, gas, fuel, oil, and machinery, facility/equip repairs are all KFMA values for the feedlot sector. These values may be used, or values for a specific operation should be inserted if available. Cash interest paid and other variable costs are also KFMA data for feedlot operations. Other variable costs are a rough sum of all other KFMA variable costs, including fees/publications/travel, conservation, building rent, and auto expenses. The sum of these values gives the total variable costs. The difference in variable costs between the two feeding types is due to the anticipated increase in feed costs for limit fed stocker calves.

Depreciation, taxes, and farm/ livestock insurance are all KFMA values. The opportunity cost of investment is a KFMA value that represents interest charge, it does not represent cash interest paid, rather a measure to reflect the interest that could have been earned had the investment been made elsewhere. It is important to note that the fixed costs are the same for both feeding methods.

Finally, the income over variable costs and income over total costs is found at the bottom of the budget sheet. The profitability of each feeding type can be compared by using the budget sheet and accompanying fact sheet. Producer may then make adjustments and decisions as they see fit for their operation.

2.6.4 Feedlot Budget Sheet-Grid Marketing

There is also a feedlot budget sheet that is designed to be utilized by operators that market their fed cattle on a grid basis (Hissong et al., 2020). Again, the budget sheet is for feedlot operators to input values relevant to their operation in combination with values found during the trial to evaluate the per head income over total costs for finishing calves that were fed ad libitum or limit fed at the stocker phase. Some values should be changed by the producer to represent their operation. However, if these values are unknown for the operation, there are values there that can be used as a default.

Once again, this budget sheet is designed as a comparison, assuming the same feeder animal is placed into each scenario. An operator would first fill out death loss, average daily gain, and days on feed for their operation. The anticipated increase in average daily gain for the ad libitum fed calves is the value that was found through the research conducted at Pratt Feeders in conjunction with Kansas State. If a producer would choose to not account for the anticipated increase, this value can be set to zero. These values go into calculating the finished weight. Finished weight is then multiplied by the different dressing percentages that were found when cattle were harvested. The base price is a default value based upon the price received during the research trial, but should be updated by the user to a timelier price to provide a more accurate estimate. As mentioned previously, premiums and discounts on the grid were evaluated for stocker calves fed ad libitum and stocker calves that were limit fed during the trial. Premium and discount prices were calculated on a 3-year annual average, but the seasonality tab allows producers to better account for the time of year when marketing fed cattle. Premiums and discounts are then multiplied by the percentage of cattle that received those premiums and discounts during the trial. The $/cwt in premiums or discounts in then multiplied by the cwt per

head. Purchase price is a default value based on a 3-year average 700-900-pound feeder steer price and should be updated by the user to reflect the current purchase price. This value can fluctuate when purchasing steers or heifers and time of year, so a producer should take those into consideration when selecting prices to utilize. The average weight of cattle that the operation typically purchases should be inserted into the purchase price quantity space.

Total gross return is then calculated by taking the base price received, adding or subtracting any premiums or discounts, subtracting purchase price, and subtracting death loss. Differences between the two backgrounding options is captured through the anticipated increase in average daily gain which leads to a greater cwt produced for stocker calves fed ad libitum and the differences in how the cattle graded.

The next section on the budget sheet looks at variable costs. Prior to beginning this section, the operator should update the feed tab to reflect the ration fed. Doing so will accurately account for the harvested forage, grain/protein supplement, and mineral cost per head per day. Research at Pratt Feeders found an anticipated increase in feed costs for limit fed calves, however this value may be zeroed out if preferred by the producer. If the operation has other feed costs those can be accounted for in a space provided. Labor represents the labor requirement for each animal during the feedlot phase which was found through previous research. The wage for employees should be adjusted to represent the operation. Variable costs for vet medicine/ drugs, marketing costs, utilities, gas, fuel, oil, and machinery, facility/equip repairs are all KFMA values for the feedlot sector. These values may be used, or values for a specific operation should be inserted if available. Cash interest paid and other variable costs are also KFMA data for feedlot operations. Other variable costs are a rough sum of all other KFMA variables costs, including fees/publications/travel, conservation, building rent, and auto expenses. The sum of

these previously mentioned values gives the total variable costs. The difference in variable costs is due to the anticipated increase in feed costs for limit fed stocker calves.

Depreciation, taxes, and farm/livestock insurance are all KFMA values. The opportunity cost of investment is a KFMA value that represents interest charge, it does not represent cash interest paid, rather a measure to reflect the interest that could have been earned had the investment been made elsewhere. It is important to note that the fixed costs are the same for both feeding methods.

Finally, the income over variable costs and income over total costs is found at the bottom of the spreadsheet. The profitability of each feeding type can be compared using the budget sheet and accompanying fact sheet. Then, a producer may make adjustments and decisions as they see fit for their operation.

2.6.5 Key Take Aways

Utilizing the default values in place for the stocker budget sheet and accounting for the anticipated increases in ADG for limit fed cattle and anticipated increase in mix and delivery times of the ad libitum diet; limit feeding cattle shows to be more profitable at the stocker/ backgrounder sector. A difference in profitability of about $35 or as high as $70 may be observed between the two feedings options. When comparing the profitability of finishing cattle and utilizing the default values along with accounting for the differences found throughout the research trial, finishing ad libitum fed stocker cattle shows to be more profitable than finishing cattle that had been limit fed. Finishing cattle that had been fed ad libitum shows to be more profitable regardless if selling live fed cattle or selling cattle on the grid. A difference of $75 may be observed when selling on the grid and a difference of $63 may be observed when marketing

live fed cattle. Additionally, when utilizing variables found through the research trial, marketing cattle on the grid was found to be more profitable than marketing live fed cattle.

Chapter 3 - Adoption of Limit Feeding: Insights from a Producer Survey

3.1 Introduction

Producers have a wealth of resources and practices available to them, so they have the ability to choose which management practices they adopt. Producer adoption is impacted by a variety of aspects, and slightly different for each producer. However, a reasonable assumption to make when looking at a producers' decision making process is the utility of a practice must be greater than the utility a producer would gain from any other alternative for the producer to adopt that practice (Johnson et al., 2010). Factors that influence utility and adoption also vary depending on the practice. For example, operation and operator characteristics that influence adoption of one practice, may not have a significant influence on adoption of a different practice.

Understanding what factors influence producer adoption of limit feeding is an important component to this research, so the potential rate of adoption can be better understood. As an understanding around what producer's value most in their decision-making process is developed, a more accurate idea of stocker producers' perceptions of limit feeding also develops. Additionally, knowing what factors most influence producer adoption aids in creating and implementing educational programs that are most beneficial to producers. Those educational programs can be centered around what factors are most impactful in producers' decision making process.

Therefore, this research looks at addressing the gap in knowledge of how producers view limit feeding at the stocker phase and the lack of understanding around their willingness to adopt limit feeding given animal performance and cost variables. The information gathered through this research will deepen the understanding of stocker producer perceptions of limit feeding.

With this deeper understanding, education can be better targeted to enhance the industry wide decision-making process.

The objectives of this research include understanding 1) how producer adoption preferences vary across owner demographics and operation characteristics 2) the impact of costs and animal performance on feeding decisions and 3) the potential rate of adoption of limit feeding. To achieve these objectives data collected through a producer survey was compiled and analyzed. Once accomplished and disseminated, this research has the ability to improve the decision-making process of producers who market calves to a stocker operation, raise stocker cattle, or purchase stocker cattle to finish.

3.2 Sample and Data Collection

A survey was conducted to gain a deeper understanding of producer adoption, views, and willingness to limit feed stocker calves. Operations included in the survey are purely stocker operations or stocker operations that engage in another sector of the beef industry. Informa Engage, a research and marketing firm that BEEF Magazine works with, formatted and distributed the survey. The survey was sent to producers from a BEEF Magazine subscriber list. To encourage participation, a $1 bill, cover letter and postage-paid return envelope were included with each survey.

Survey procedures were approved by the Kansas State University Committee on Research Involving Human Subjects, approval #10166 as shown in appendix B. On April 8, 2020 3,500 surveys were sent out through BEEF Magazine. Of the 3,500 surveys, half of them included questions about limit feeding and the other half included questions about intensive grazing as an area of focus in another KSU thesis project by Meghan Brence. Each survey had the same questions regarding general stocker operator demographics, operation characteristics,

and risk management views and practices. A summary of those survey responses can be found in appendix C. There was a total of 645 surveys completed for a response rate of 18.43%. Of the 645 returned, 358 were surveys that include questions about limit feeding.

The survey included questions regarding if operations currently limit feed, their availability to bunk feed, operational fixed and variable costs, views on various production aspects, and operator preferences. The survey also included a section for choice experiment questions. These questions were used to determine producers' preferences and estimate producers' willingness to change between practices given varying levels of average daily gain and costs. The survey involved a variety of questions from write in, select one, ranking, and rate your agreement to a statement.

Tables 3.3-3.10 at the conclusion of this section provides summary statistics from the survey responses regarding limit feeding. The number of responses reported in the tables for specific questions does not always equal the total number of survey responses due to some questions being left unanswered by the respondent.

To begin, survey respondents were asked "does your stocker/backgrounding operation currently limit feed cattle." Of the 296 respondents, 168 (56.76%) selected no and 128 (43.24%) selected yes. Respondents were then asked if they have ever considered limit feeding cattle. Figure 3.1 shows that 52.43% (151 respondents) selected no, 42.36% (122 respondents) selected yes and we limit feed now, and 5.21% (15 respondents) selected yes, but we decided not to. When asked "why did you decide not to limit feed?" answers included, initial cost, out on winter grass, labor, most are turned out, and it does not work.

Next, producers were asked if their stocker/backgrounding operation has the availability to bunk feed cattle. Respondents that selected no totaled 70 (23.81%) and respondents that

indicated yes totaled 224 (76.19%). As a follow up, respondents were asked to indicate how many feet of bunk space per animal. The average was 2.97 feet per animal among 131 observations.

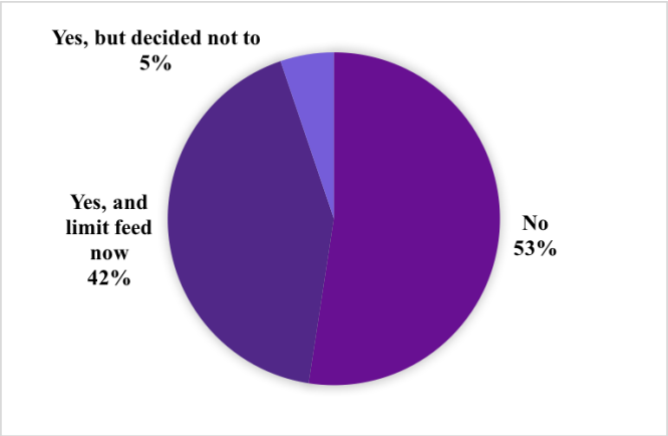

Figure 3.1. Respondents that considered limit feeding

When producers indicated their average variable cost per head, referring to 2019, the most selected answer was $76-$125 per head with 52 respondents (25.12%) selecting that answer as shown in figure 3.2. This was followed by 44 respondents (21.26%), 36 respondents (17.39%), and 28 respondents (13.53%) selecting $26-$75, $126-175, and $176-$225 per head, respectively. This was followed by two groups of 14 respondents (6.76%) that selected less than $26 and more than $325. Finally, 10 respondents (4.83%) indicated $226-$275 and 9 respondents (4.35%) indicated $276-$35.

Additionally, producers were asked to select their average fixed costs per head in reference to 2019. As figure 3.3 shows, 45 respondents (21.95%) selected $26-$35 and this was followed by 39 respondents (19.02%) that selected more than $55. Average fixed costs of $16-$25, $6-$15, and $45-$55 were selected by 34 respondents (16.59%), 32 respondents (15.61%), and 28 respondents (13.66%), respectively. This was followed by 20 respondents (9.76%) who

indicated their average fixed costs are $35-$45 per head. The least number of respondents selected less than $6 which totaled 7 (3.41%).

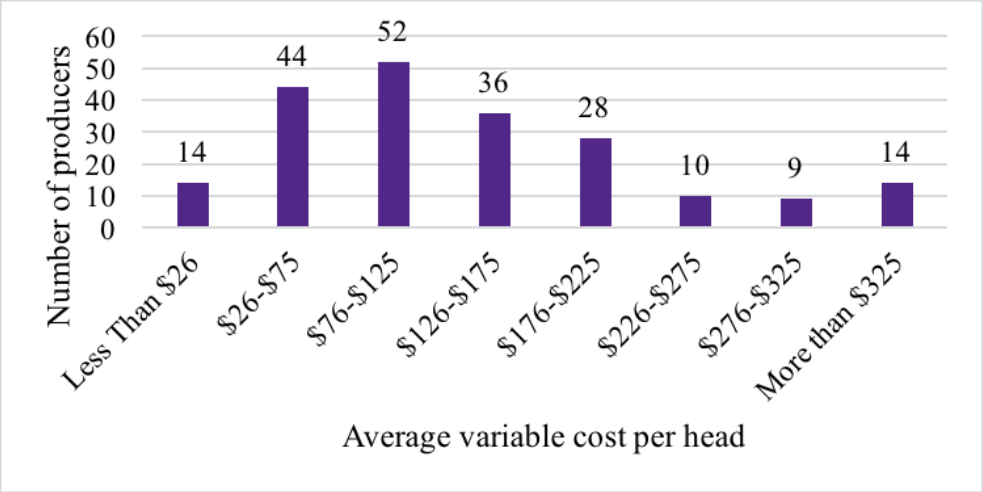

Figure 3.2. Average variable cost per head

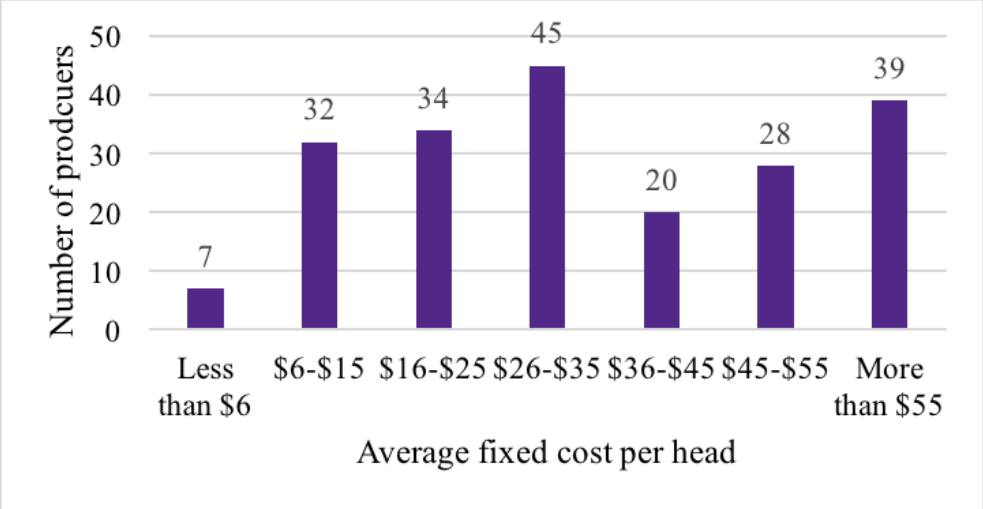

Figure 3.3. Average fixed cost per head

Respondents were then given a set of seven aspects related to their decision-making process and were asked to rank them 1-7 with 1 being most important and 7 being least important. The first aspect was income over total costs. A majority of producers (91 respondents) ranked this as number 1 as figure 3.4 shows. The least number of respondents (2) ranked income over total costs as number 7. Additionally, 19 respondents ranked it number 2, 8 respondents

ranked it number 3, 9 respondents ranked it number 4, 12 respondents ranked it number 5, and 6 respondents ranked it number 6.

The next aspect was labor requirement. The most common ranking was number 7 as figure 3.5 shows, which 38 respondents selected. The least common ranking was number 1 with only 3 respondents selecting that option. The rest of the respondents ranked it someone where in the middle with 24 respondents ranking it number 2, 23 respondents ranking it number 3, 22 respondents ranking it number 4, 15 respondents ranking it number 5, and 22 respondents ranking it number 6.

Feed cost was the next aspect. As shown in figure 3.6 the most selected ranking was number 2 with 45 producers selecting that ranking. The least selected ranking was number 7 with 2 producers selecting that ranking. Producers ranking feed cost as number 1 totaled 15, ranking it number 3 totaled 39, ranking it number 4 totaled 20, and ranking it number 6 totaled 21.

Figure 3.7 shows respondents ranking how average daily gain impacts their decision-making process. The most common ranking was right in the middle at number 4; 34 producers selected this ranking. The least common ranking was number 1; 5 producers selected this ranking. The remaining survey respondents' rankings were scattered with 16 respondents ranking it number 2, 29 respondents ranking it number 3, 28 respondents ranking it number 5, and 14 respondents ranking it number 7.

The next aspect was carcass merit. The most commonly selected ranking for carcass merit was number 7 as figure 3.8 shows. A total of 39 producers selected ranking number 7. Additionally, the least selected ranking was number 1; 5 producers selected that ranking. Carcass merit was ranked lower for a majority of respondents. Eight producers ranked it number 2, 11 ranked it number 3, 14 ranked it number 4, 33 ranked it number 5, and 37 ranked it number 6.

Ranking of feedlot performance was scattered with a majority ranking it within the middle to lower. The most selected ranking was 3 and 6 with 28 producers selecting those as figure 3.9 indicates. The least selected ranking was number 1 with 9 producers selecting that. Respondents ranking feedlot performance number 2 totaled 15, ranking it number 4 totaled 25, ranking it number 5 also totaled 25, and ranking it 7 totaled 17.

The final aspect is sustainability. As figure 3.10 shows, each ranking had at least 18 producers select it, expect for number 3; only 8 producers ranked sustainability number 3. The most selected ranking was number 7. A total of 34 producers selected that option. Number 1 was selected by 18 producers, number 2 was selected by 21 producers, number 4 was selected by 22 producers, number 5 was selected by 19 producers, and number 6 was selected by 25 producers. The mean ranking for each aspect in the decision-making process can be found in table 3.1

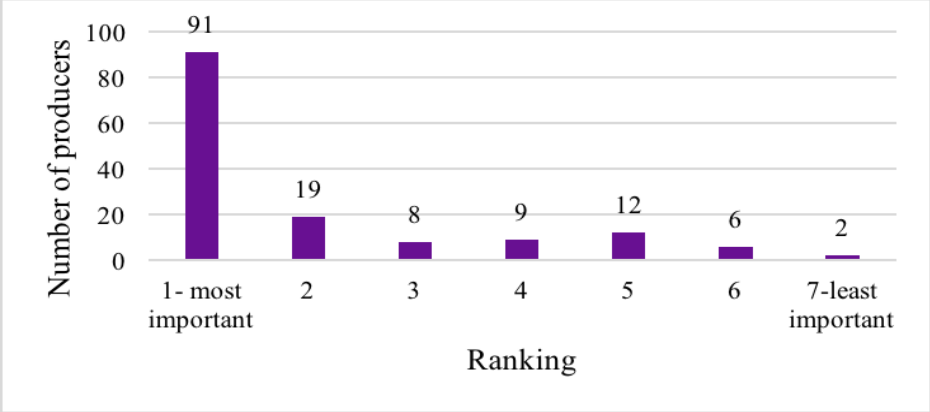

Figure 3.4. Income over total cost rankings

Figure 3.5. Labor requirement rankings

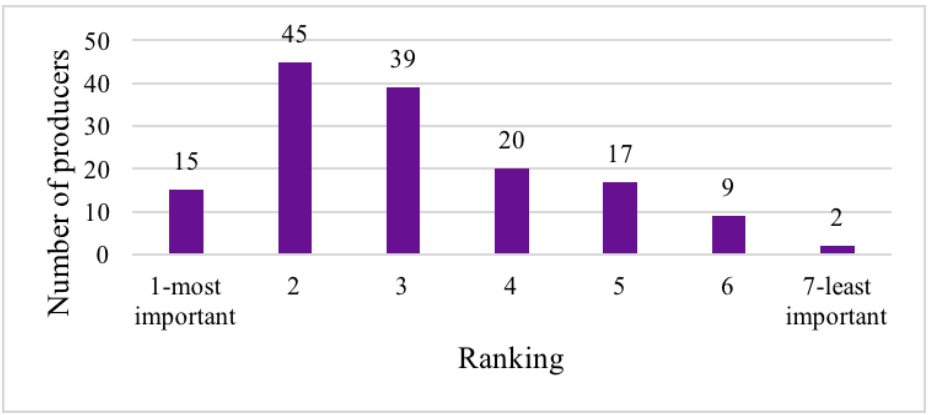

Figure 3.6. Feed cost rankings

Figure 3.7. Average daily gain rankings

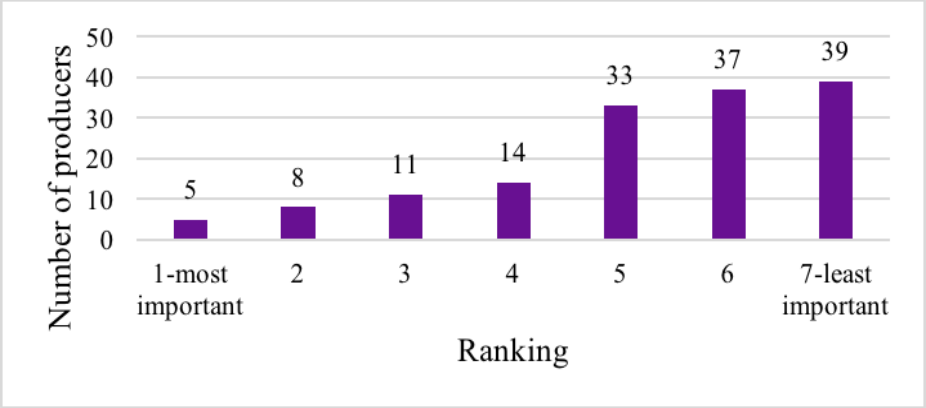

Figure 3.8. Carcass merit rankings

Figure 3.9. Feedlot performance rankings

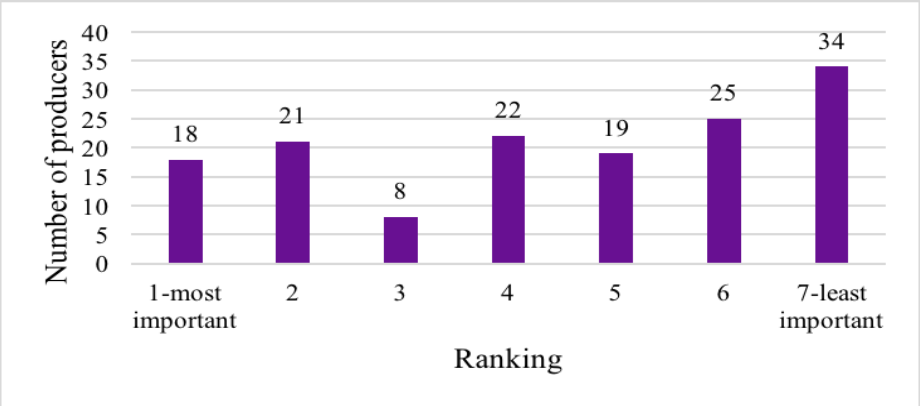

Figure 3.10. Sustainability rankings

Table 3.1. Mean ranking for each decision-making aspect

Aspect	Mean
Income over total cost	2.03
Labor requirement	4.63
Feed cost	3.10
ADG	4.24
Carcass merit	5.24
Feedlot performance	4.32
Sustainability	4.46

Respondents were then asked to please rate their agreement with the following statements. Of the 292 producers that answered, "I'm willing to install more bunk space if it means better feed efficiency," 52 producers (17.81%) selected they strongly agree, 16 producers (5.48%) selected they strongly disagree, with 204 producers (69.86%) selecting a value in the middle of strongly agree or strongly disagree, and 20 producers (6.85%) selected don't know as shown in figure 3.11. Of the 293 producers that responded to "I am willing to devote more labor to feeding the same number of cattle," 15 (5.12%) selected strongly agree, 51 (17.41%) selected strongly disagree, 216 (73.72%) selected a value in the middle, and 11 (3.75%) selected don't know as shown in figure 3.12. The next statement was "I am willing to adopt a new feeding type if carcass value is improved." As figure 3.13 shows, of the 291 producers that answered, 37 (12.71%) selected strongly agree, 6 (2.06%) selected strongly disagree, 236 (81.1%) selected in the middle, and 12 (4.12%) selected don't know. Of the 285 producers that answered, "I make decisions while considering the impact on feedlot performance," 40 (14.04%) indicated they strongly agree, 8 (2.81%) indicated they strongly disagree, 229 (80.35%) indicated somewhere in the middle, and 8 (2.81%) indicated they don't know as shown in figure 3.14. As shown in figure 3.15, of the 289 respondents that answered, "my decisions are impacted by the sustainability of a practice," 46 producers (15.92%) selected strongly agree, 8 producers (2.77%) selected strongly

disagree, 225 producers (77.85%) selected a value in the middle, and 10 producers (3.46%) selected don't know. Of the 288 producers that answered, "I prefer to background my cattle on grass instead of in a lot" 54 (18.75%) selected strongly agree, 71 (24.65%) selected strongly disagree, 149 (51.74%) selected somewhere in the middle of strongly agree and strongly disagree and 14 (4.86%) selected don't know as indicated in figure 3.16. The next statement was "Economics is the number 1 factor that impacts my decision-making process." As figure 3.17 shows, 290 produces responded to the question with 75 (25.86%) selected strongly agree, 9 (3.1%) selected strongly disagree, 202 (69.66%) selected a value in the middle, and 4 (1.38%) selected don't know. Of the 289 producers that answered, "I am open to trying new management techniques," 45 (15.57%) selected strongly agree, 5 (1.73%) selected strongly disagree, 235 (81.31%) selected within the middle of those, and 4 (1.38%) selected don't know as shown in figure 3.18. The final statement was "manure output has a big impact on me adopting a new feeding type." Figure 3.19 shows 15 (5.24%) producers selected strongly agree, 52 (18.18%) selected strongly disagree, 208 (72.73%) selected in the middle of strongly agree and strongly disagree, and 11 (3.85%) selected don't know. The mean for each ranking can be found in table 3.2.

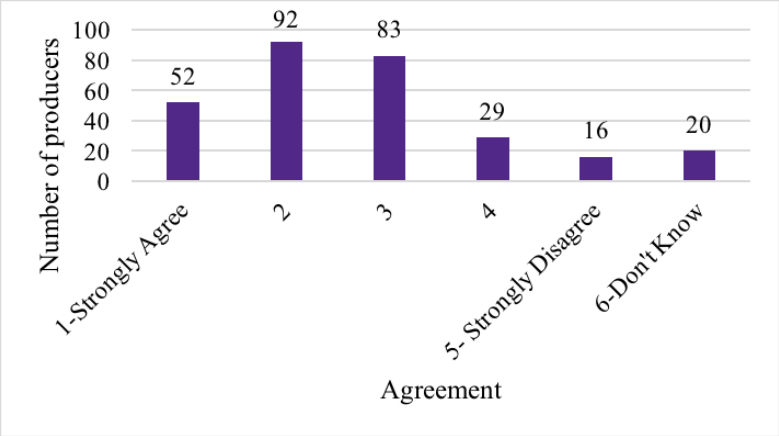

Figure 3.11. I am willing to install more bunk space if it means better feed efficiency

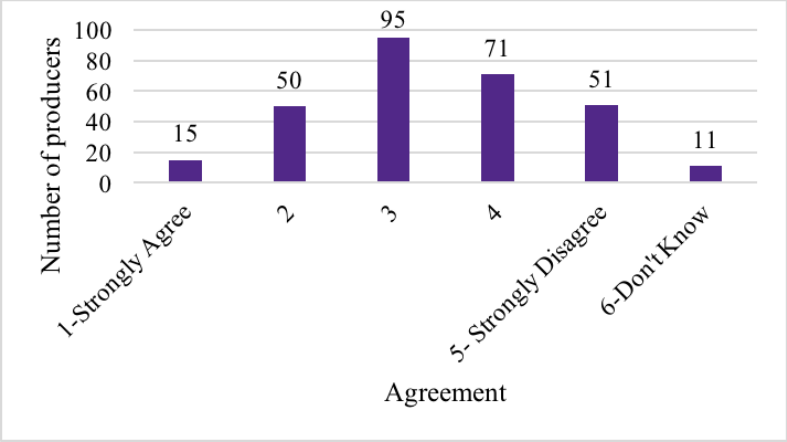

Figure 3.12. I am willing to devote more labor to feeding the same number of cattle

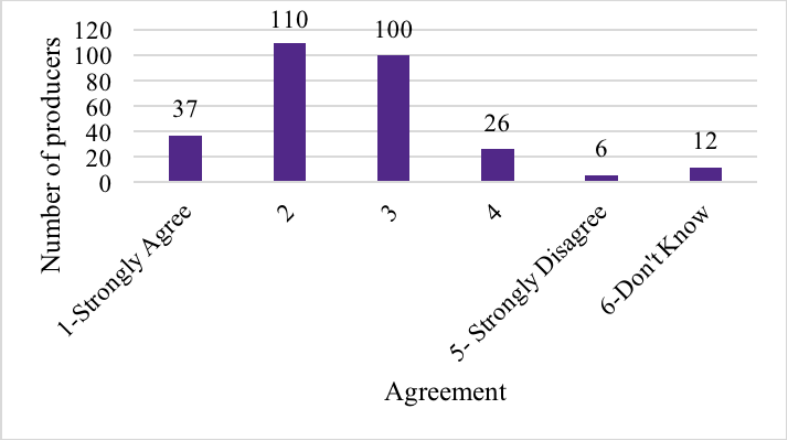

Figure 3.13. I am willing to adopt a new feeding method if carcass value is improved

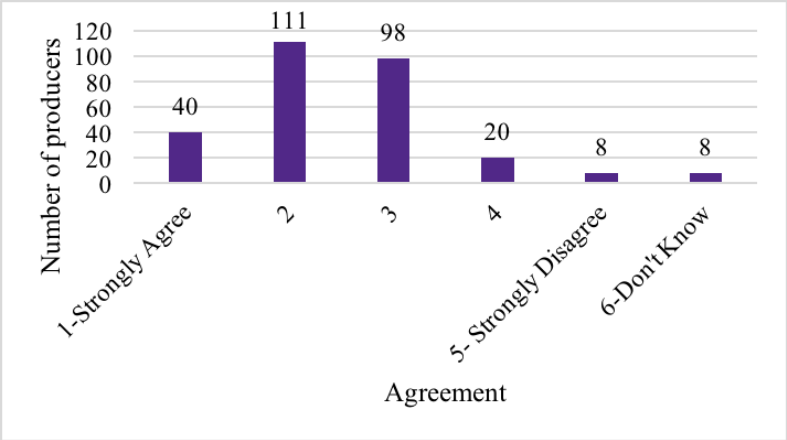

Figure 3.14. I make decisions while considering the impact on feedlot performance

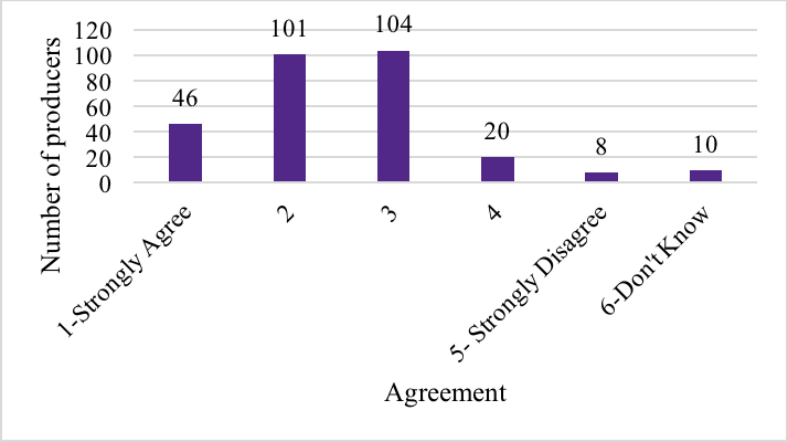

Figure 3.15. My decisions are impacted by the sustainability of a practice

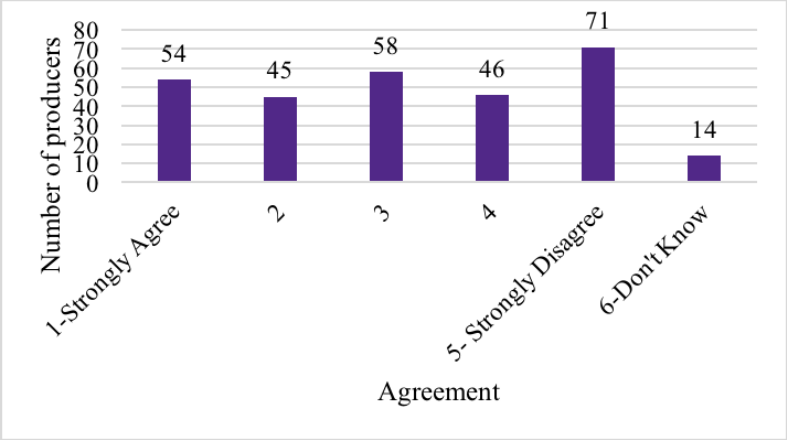

Figure 3.16. I prefer to background my cattle on grass instead of in a lot

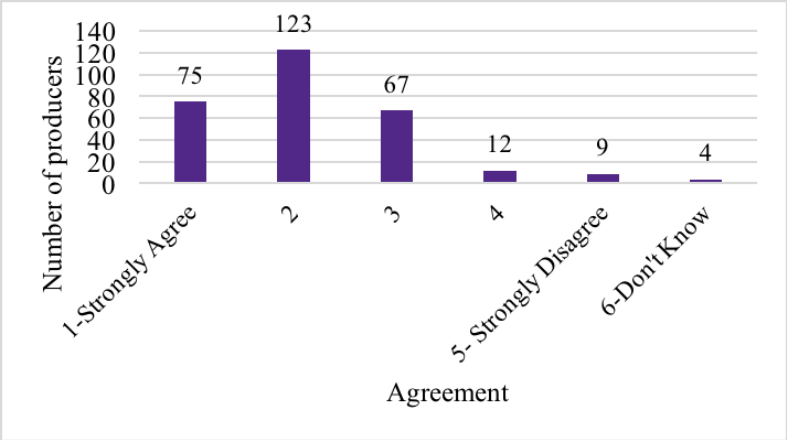

Figure 3.17. Economics is the number one factor that impacts my decision-making process

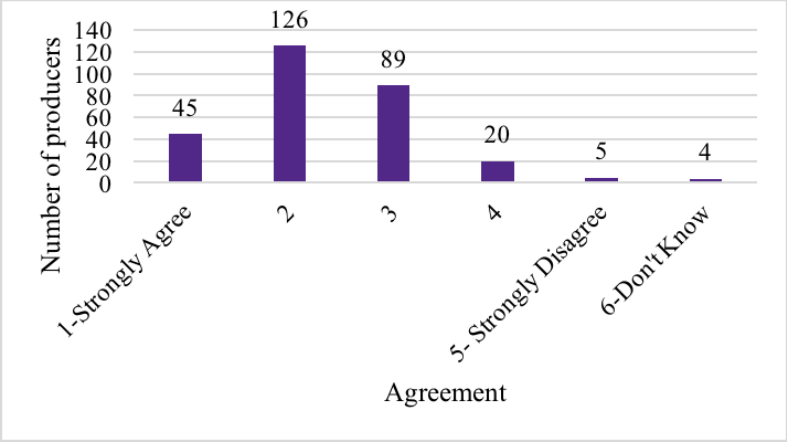

Figure 3.18. I am open to trying new management techniques

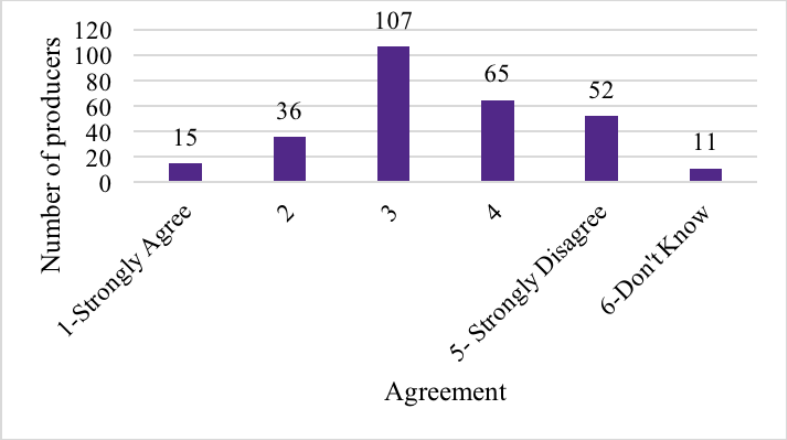

Figure 3.19. Manure output has a big impact on me adopting a new feeding type

Table 3.2. Mean rating for your agreement to the statement

Aspect	Mean
I am willing to install more bunk space if it means better feed efficiency	2.74
I am willing to devote more labor to feeding the same number of cattle	3.43
I am willing to adopt a new feeding type if carcass value is improved	2.62
I make decisions while considering the impact on feedlot performance	2.54
My decisions are impacted by the sustainability of a practice	2.56
I prefer to background my cattle on grass instead of in a lot	3.27

Economics is the number 1 factor that impacts my decision-making process	2.20
I am open to trying new management techniques	2.40
Manure output has a big impact on me adopting a new feeding type	3.48

Table 3.3. Does your stocker/ backgrounding operation currently limit feed?

Response	Frequency %	N
No	56.76	168
Yes	43.24	128
Total Responses		**296**

Table 3.4. Have you considered limit feeding cattle?

Response	Frequency %	N
No	52.43	151
Yes, and limit feed now	42.36	122
Yes, but we decided not to	5.21	15
Total Responses		**288**

Table 3.5. Does your stocker/ backgrounding operation have the availability to bunk feed cattle?

Response	Frequency %	N
No	28.81	70
Yes	76.19	224
Total Responses		**294**

Table 3.6. If yes, how many feet per animal?

	Mean	SD	N
Feet per animal	2.97	.35	131

Table 3.7. Referring to 2019, what was your average variable cost per head?

Response	Frequency %	N
Less than $26	6.76	14
$26-$75	21.26	44
$76-$125	25.12	52
$126-$175	17.39	36
$176-$225	13.53	28
$226-$275	4.83	10

$276-$325	4.35	9
More than $325	6.76	14
Total Responses		**207**

Table 3.8. Referring to 2019, what was your average fixed cost per head?

Response	Frequency %	N
Less than $6	3.41	7
$6-$15	15.61	32
$16-$25	16.59	34
$26-$35	21.95	45
$36-$45	9.76	20
$45-$55	13.66	28
More than $55	19.02	39
Total Responses		**205**

Table 3.9. Please rank the following aspects to your decision-making process, with 1 being most important and 7 being least important

Income over total cost		
Response	**Frequency %**	**N**
1	61.9	91
2	12.93	19
3	5.44	8
4	6.12	9
5	8.16	12
6	4.08	6
7	1.36	2
Total Responses		**147**
Labor requirement		
Response	**Frequency %**	**N**
1	2.04	3
2	16.33	24
3	15.65	23
4	14.97	22
5	10.2	15
6	14.97	22
7	25.85	38
Total Responses		**147**

Feed cost		
Response	**Frequency %**	**N**
1	10.2	15
2	30.61	45
3	26.53	39
4	13.61	20
5	11.56	17
6	6.12	9
7	1.36	2
Total Responses		**147**
Average daily gain		
Response	**Frequency %**	**N**
1	3.4	5
2	1.88	16
3	19.73	29
4	23.13	34
5	19.05	28
6	14.29	21
7	9.52	14
Total Responses		**147**
Carcass merit		
Response	**Frequency %**	**N**
1	3.4	5
2	5.44	8
3	7.48	11
4	9.52	14
5	22.45	33
6	26.17	37
7	26.53	39
Total Responses		**147**
Feedlot performance		
Response	**Frequency %**	**N**
1	6.12	9
2	10.2	15
3	19.05	28
4	17.01	25
5	17.01	25
•6	19.05	28
7	11.56	17
Total Responses		**147**

Sustainability		
Response	**Frequency %**	**N**
1	12.24	18
2	14.29	21
3	5.44	8
4	14.97	22
5	12.93	19
6	17.01	25
7	23.13	35
Total Responses		**147**

Table 3.10. Please rate your agreement with the following statements

I am willing to install more bunk space it if means better feed efficiency		
Response	**Frequency %**	**N**
1-Strongly agree	17.81	52
2	31.51	92
3	28.42	83
4	9.93	29
5-Strongly disagree	5.48	16
6-Don't know	6.85	20
Total Responses		**292**
I am willing to devote more labor to feeding the same number of cattle		
Response	**Frequency %**	**N**
1-Strongly agree	5.12	15
2	17.06	59
3	32.42	95
4	24.23	71
5-Strongly disagree	17.41	51
6-Don't know	6.85	11
Total Responses		**293**
I am willing to adopt a new feeding type if carcass value is improved		
Response	**Frequency %**	**N**
1-Strongly agree	12.71	38
2	37.8	110
3	34.36	100
4	8.93	26
5-Strongly disagree	2.06	6
6-Don't know	4.12	12

Total Responses		**291**
I make decisions while considering the impact on feedlot performance		
Response	**Frequency %**	**N**
1-Strongly agree	14.04	40
2	38.95	111
3	34.39	98
4	7.02	20
5-Strongly disagree	2.81	8
6-Don't know	2.81	8
Total Responses		**285**
My decisions are impacted by the sustainability of a practice		
Response	**Frequency %**	**N**
1-Strongly agree	15.92	46
2	34.95	101
3	35.99	104
4	6.92	20
5-Strongly disagree	2.77	8
6-Don't know	3.46	10
Total Responses		**289**
I prefer to background my cattle on grass instead of in a lot		
Response	**Frequency %**	**N**
1-Strongly agree	18.75	54
2	15.62	45
3	20.14	58
4	15.97	56
5-Strongly disagree	24.65	71
6-Don't know	4.86	14
Total Responses		**288**
Economics is the number 1 factor that impacts my decision-making process		
Response	**Frequency %**	**N**
1-Strongly agree	25.86	75
2	42.41	123
3	23.1	67
4	4.14	12
5-Strongly disagree	3.1	9
6-Don't know	1.38	4
Total Responses		**290**

I am open to trying new management techniques		
Response	**Frequency %**	**N**
1-Strongly agree	15.57	45
2	43.6	126
3	30.8	89
4	6.92	20
5-Strongly disagree	1.73	5
6-Don't know	1.38	4
Total Responses		**289**
Manure output has a big impact on me adopting a new feeding type		
Response	**Frequency %**	**N**
1-Strongly agree	5.24	15
2	12.59	36
3	37.41	107
4	22.73	65
5-Strongly disagree	18.18	52
6-Don't know	3.85	11
Total Responses		**286**

Producers were then given a choice experiment in their survey. There were 4 versions of the survey with 3 or 4 scenario questions in each choice experiment. Four versions were included to reduce respondent burden – otherwise each respondent would have received a long set of scenarios. Each version involved varying ADG, variable cost, and fixed cost. The respondents were asked to select which option they'd elect to feed or they could choose to not feed at all. The versions along with how the producers responded to the choice experiment are detailed in the tables 3.9-3.12. The overall frequency of ad libitum feeding selected in the choice experiment was 29.32%, the frequency of limit feeding selected was 33.83%, and the frequency of neither feeding method selected was 31.88%.

An example choice experiment scenario is:

	Ad Libitum Feeding	Limit Feeding	Neither
ADG (lbs/day)	1.5	2.5	I would choose not to Ad Lib or Limit Feed
Variable Costs (per head)	$275	$175	
Fixed Costs (per head)	$45	$45	
I would choose:	_____	_____	_____

A total of 180 responses were recorded for version 1. As shown in table 3.9 four respondents (6.25%) selected the ad libitum feeding option, 42 respondents (65.63%) selected the limit feeding option, and 18 respondents (28.13%) selected neither for scenario 1. In scenario 2, 12 respondents (20.69%) selected the ad libitum feeding option, 27 respondents (46.55%) selected the limit feeding option, and 19 respondents (32.76%) selected neither. In the third scenario, 4 respondents (6.9%) selected the ad libitum feeding option, 32 respondents (55.17%) selected the limit feeding option, and 22 respondents (37.93%) selected neither. When asked to select "what best describes your response and the question sequence just presented?" A majority, 38 respondents (48.72%) selected "the questions were easy and straight-forward to understand. Accordingly, I am confident in my selections." 16 respondents (20.51%) selected "the questions were easy and straight-forward to understand. However, I am not confident in my selections." 9 respondents (11.54%) selected "the questions were not easy and straight-forward to understand. However, I am confident in my selections." 15 respondents (19.23%) selected "the questions were not easy straight-forward to understand. Accordingly, I am not confident in my selections."

Table 3.11. Choice Experiment Questions Version 1

Description	Frequency	N
Scenario 1	**Indicate which option you prefer**	
Ad Libitum (1.5 ADG, $275 Variable Costs, $45 Fixed Costs)	6.25	4

Limit (2.5 ADG, $175 Variable Cost, $45 Fixed Costs)	65.63	42
Neither	37.41	18
Scenario 2	**Indicate which option you prefer**	
Ad Libitum (2.5 ADG, $275 Variable Costs, $30 Fixed Costs)	20.69	12
Limit (1.5 ADG, $175 Variable Cost, $15 Fixed Costs)	46.55	27
Neither	32.76	19
Scenario 3	**Indicate which option you prefer**	
Ad Libitum (1.5 ADG, $225 Variable Costs, $45 Fixed Costs)	6.90	4
Limit (1.5 ADG, $225 Variable Cost, $15 Fixed Costs)	55.17	32
Neither	37.93	22
Choice Experiment Response	**Which best describes your response and the question sequence just presented**	
The questions were easy and straight-forward to understand. Accordingly, I am confident in my selections.	48.72	38
The questions were easy and straight-forward to understand. However, I am not confident in my selections.	20.51	16
The questions were not easy and straight-forward to understand. However, I am confident in my selections.	11.54	9
The questions were not easy straight-forward to understand. Accordingly, I am not confident in my selections.	19.23	15

A total of 156 responses were recorded for version 2. 13 respondents (24.07%) selected the ad libitum feeding option, 19 respondents (35.19%) selected the limit feeding option, and 22 respondents (40.74%) selected neither for scenario 1 as show in table 3.10. In scenario 2, 28 respondents (53.85%) selected the ad libitum feeding option, 3 respondents (5.77%) selected the limit feeding option, and 21 respondents (40.38%) selected neither. In the third scenario, 9

respondents (18%) selected the ad libitum feeding option, 20 respondents (40%) selected the limit feeding option, and 21 respondents (42%) selected neither. When asked to select "what best describes your response and the question sequence just presented?" A majority, 33 respondents (46.48%) selected the questions were easy and straight-forward to understand. Accordingly, I am confident in my selections. 18 respondents (25.35%) selected the questions were easy and straight-forward to understand. However, I am not confident in my selections. 8 respondents (11.27%) selected the questions were not easy and straight-forward to understand. However, I am confident in my selections. 17 respondents (16.90%) selected the questions were not easy straight-forward to understand. Accordingly, I am not confident in my selections.

Table 3.12. Choice Experiment Questions Version 2

Description	Frequency	N
Scenario 1	**Indicate which option you prefer**	
Ad Libitum (2 ADG, $175 Variable Costs, $30 Fixed Costs)	24.07	13
Limit (2.5 ADG, $225 Variable Cost, $15 Fixed Costs)	35.19	19
Neither	40.74	22
Scenario 2	**Indicate which option you prefer**	
Ad Libitum (2.5 ADG, $225 Variable Costs, $15 Fixed Costs)	53.85	28
Limit (2.5 ADG, $275 Variable Cost, $30 Fixed Costs)	5.77	3
Neither	40.38	21
Scenario 3	**Indicate which option you prefer**	
Ad Libitum (1.5 ADG, $275 Variable Costs, $30 Fixed Costs)	18	9
Limit (2 ADG, $225 Variable Cost, $30 Fixed Costs)	40	20
Neither	42	21
Choice Experiment Response	**Which best describes your response and the question sequence just presented**	
The questions were easy and straight-forward to understand. Accordingly, I am confident in my selections.	46.48	33

The questions were easy and straight-forward to understand. However, I am not confident in my selections.	25.35	18
The questions were not easy and straight-forward to understand. However, I am confident in my selections.	11.27	8
The questions were not easy straight-forward to understand. Accordingly, I am not confident in my selections.	16.90	12

A total of 155 responses were recorded for version 3. As shown in table 3.11, 22 respondents (42.31%) selected the ad libitum feeding option, 9 respondents (17.31%) selected the limit feeding option, and 21 respondents (40.38%) selected neither for scenario 1. In scenario 2, 7 respondents (13.46%) selected the ad libitum feeding option, 30 respondents (57.69%) selected the limit feeding option, and 15 respondents (28.85%) selected neither. In the third scenario, 29 respondents (56.86%) selected the ad libitum feeding option, 10 respondents (19.61%) selected the limit feeding option, and 12 respondents (23.53%) selected neither. When asked to select "what best describes your response and the question sequence just presented?" A majority, 32 respondents (50%) selected the questions were easy and straight-forward to understand. Accordingly, I am confident in my selections. 11 respondents (17.19%) selected the questions were easy and straight-forward to understand. However, I am not confident in my selections. 8 respondents (12.5%) selected the questions were not easy and straight-forward to understand. However, I am confident in my selections. 13 respondents (20.31%) selected the questions were not easy straight-forward to understand. Accordingly, I am not confident in my selections.

Table 3.13. Choice Experiment Questions Version 3

Description	Frequency	N
Scenario 1	**Indicate which option you prefer**	
Ad Libitum (2 ADG, $275 Variable Costs, $15 Fixed Costs)	42.31	22
Limit (1.5 ADG, $225 Variable Cost, $45 Fixed Costs)	17.31	9
Neither	40.38	21
Scenario 2	**Indicate which option you prefer**	
Ad Libitum (2 ADG, $225 Variable Costs, $30 Fixed Costs)	13.46	7
Limit (2 ADG, $175 Variable Cost, $45 Fixed Costs)	57.69	30
Neither	28.85	15
Scenario 3	**Indicate which option you prefer**	
Ad Libitum (2.5 ADG, $175 Variable Costs, $45 Fixed Costs)	56.86	29
Limit (2 ADG, $225 Variable Cost, $45 Fixed Costs)	19.61	10
Neither	23.53	12
Choice Experiment Response	**Which best describes your response and the question sequence just presented**	
The questions were easy and straight-forward to understand. Accordingly, I am confident in my selections.	50	32
The questions were easy and straight-forward to understand. However, I am not confident in my selections.	17.19	11
The questions were not easy and straight-forward to understand. However, I am confident in my selections.	12.5	8
The questions were not easy straight-forward to understand. Accordingly, I am not confident in my selections.	20.31	13

A total of 195 responses were recorded for version 4. Table 3.12 shows 26 respondents (53.06%) selected the ad libitum feeding option, 12 respondents (24.49%) selected the limit

feeding option, and 11 respondents (22.45%) selected neither for scenario 1. In scenario 2, 31 respondents (62%) selected the ad libitum feeding option, 9 respondents (18%) selected the limit feeding option, and 10 respondents (20%) selected neither. In the third scenario, 6 respondents (12.24%) selected the ad libitum feeding option, 31 respondents (63.27%) selected the limit feeding option, and 12 respondents (24.49%) selected neither. When asked to select "what best describes your response and the question sequence just presented?" A majority, 27 respondents (45.76%) selected the questions were easy and straight-forward to understand. Accordingly, I am confident in my selections. 16 respondents (27.12%) selected the questions were easy and straight-forward to understand. However, I am not confident in my selections. 10 respondents (16.95%) selected the questions were not easy and straight-forward to understand. However, I am confident in my selections. 6 respondents (10.17%) selected the questions were not easy straight-forward to understand. Accordingly, I am not confident in my selections.

Table 3.14. Choice Experiment Questions Version 4

Description	Frequency	N
Scenario 1	**Indicate which option you prefer**	
Ad Libitum (2 ADG, $175 Variable Costs, $45 Fixed Costs)	53.06	26
Limit (1.5 ADG, $175 Variable Cost, $30 Fixed Costs)	24.49	12
Neither	22.45	11
Scenario 2	**Indicate which option you prefer**	
Ad Libitum (1.5 ADG, $175 Variable Costs, $30 Fixed Costs)	62	31
Limit (1.5 ADG, $275 Variable Cost, $45 Fixed Costs)	18	9
Neither	20	10

Scenario 3	**Indicate which option you prefer**	
Ad Libitum (2 ADG, $275 Variable Costs, $45 Fixed Costs)	12.24	6
Limit (2 ADG, $275 Variable Cost, $15 Fixed Costs)	63.27	31
Neither	24.49	12
Scenario 4	**Indicate which option you prefer**	
Ad Libitum (1.5 ADG, $175 Variable Costs, $15 Fixed Costs)	8.51	4
Limit (2 ADG, $175 Variable Cost, $15 Fixed Costs)	74.47	35
Neither	17.02	8
Choice Experiment Response	**Which best describes your response and the question sequence just presented**	
The questions were easy and straight-forward to understand. Accordingly, I am confident in my selections.	45.76	27
The questions were easy and straight-forward to understand. However, I am not confident in my selections.	27.12	16
The questions were not easy and straight-forward to understand. However, I am confident in my selections.	16.95	10
The questions were not easy straight-forward to understand. Accordingly, I am not confident in my selections.	10.17	6

3.3 Models

3.3.1 Logit

The first assessment was examining influencers for those producers that currently limit feed. We sought to identify what operational or operator characteristics impact that decision. To determine if being a male (*male*), receiving a bachelor's degree or higher (*bachabove*), having 30 years of experience or more (*30yrsmore*), the amount of stocker cattle an operation has

(*stockers*), being from Kansas (*Kansas*), obtaining half their income or more from beef cattle production (*halfincome*), placing multiple sets of stocker cattle within a year (*multisets*), and the ability to bunk feed (*bunk*) influences a producer's decision to currently limit feed a logit model was used. As shown in equation 1, β are parameters to estimate and ε is an error term.

It can be expressed as:

Equation 1

$$\text{Decision} = \beta_1 male + \beta_2 bachabove + \beta_3 30yrsmore + \beta_4 stockers + \beta_5 kansas + \beta_6 halfincome + \beta_7 multisets + \beta_8 bunk + \varepsilon$$

Dummy coding was utilized on the variables, expect for *stockers*. A 1 signified the variable applied to that respondent, a 0 signified the variable did not apply to that respondent. For the decision, a 1 represented the respondent currently limit feeds and a 0 represented that they do not currently limit feed.

3.3.2 Choice Experiment

Choice experiments are designed to portray a real-life decision which then allows for tradeoffs among variables to be analyzed. This choice experiment evaluated producer's willingness to select a feeding method based on ADG, variable costs, and total costs. Survey respondents received one of the four versions of the choice experiment discussed above. Versions 1, 2, and 3 had three scenarios in each choice experiment section, while version 4 had four scenarios. Version 1 was completed by 95 respondents, version 2 was completed by 89 respondents, version 3 was completed by 88 respondents, and version 4 was completed by 86 respondents.

Within each scenario, respondents were presented the option to select the ad libitum feeding option, limit feeding option, or neither meaning they would choose not to ad libitum or

limit feed. Producers were asked to select which option they prefer given the ADG, variable cost, and fixed cost of each. Prior to the choice experiment questions producers were given the following prompt:

"For the remaining questions please respond given the following information: Suppose feeder cattle are on your operation for 90 days and then shipped to the feedlot. You have the option to decide which feeding type you would select given different ADG, variable cost, and fixed cost situations as presented below."

Choice experiments are often developed around the theory of utility maximization. Producers are presented with a choice and they select the option that combines the varying attributes to provide them with the highest utility. A fair assumption to make when looking at producers' decision-making process is the utility of a practice must be greater than the utility a producer would gain from any other alternative for the producer to adopt that practice (Johnson et al., 2010). In the survey, producers were given three alternatives, two feeding options with varying ADG, variable costs, and fixed costs and an opt out option. The data from the choice experiment was analyzed using a conditional logit choice model. Conditional logit choice model also known as McFadden's choice model, is a discrete choice model that uses conditional logit. In a conditional logit model, for each individual response there are multiple observations; an observation for each of the alternatives the producer could have chosen.

Random utility theory can be explained by equation 2 (Schulz and Tonsor, 2010):

Equation 2

$$U_{jt} = v_{jt} + \varepsilon_{jt}$$

Where U_{jt} is the utility from selecting alternative j in choice scenario t, v_{jt} is the part of utility that is determined by attributes within the scenario and their values, and ε_{jt} is a random, unobservable of logit models, independently and identically distributed over all alternatives and

choice scenarios (Schulz and Tonsor, 2010). *J* is the number of available alternatives in the choice set (Hensher et al., 2005). The probability of an individual selecting alternative *i* is equal to the probability that the utility of alternative *i* is greater than or equal to the utility of alternative *j* after evaluating and comparing all alternatives in the choice set (Hensher et al., 2005). This is represented as equation 3 (Hensher et al., 2005):

Equation 3

$$\text{Prob}_i = \text{Prob}\ (U_i \geq U_j)\ \forall\ j \in j = 1,\ldots, J;\ i \neq j$$

Also, written as equation 4 (Hensher et al., 2005):

Equation 4

$$\text{Prob}_i = \text{Prob}[(V_i + \varepsilon_i) \geq (V_i + \varepsilon_j)\ \forall\ j \in j = 1,\ldots, J;\ i \neq j]$$

This equation incorporates how the respondent's lack of full information limits the analysis to a behavioral choice rule which states that "the information available to the analyst conditions the individual decision maker's utility maximization rule to be a *random utility maximization rule"* (Hensher et al., 2005). "The probability of a respondent choosing alternative *i* is equal to the probability that the difference in the unobserved sources of utility of alternative *j* compared to *i* is less than or equal to the difference in the observed sources of utility associated with alternative *i* compared to alternative *j* after evaluating each and every alternative in the choice set of $j = 1, \ldots i \ldots J$ alternatives" (Hensher et al., 2005).

Additionally, in conditional logit choice models, it is assumed there are *p* alternative-specific variables so that for each case *i* there is a *J* x *p* data matrix X_i. Also, assume that there is a *q* case-specific variables so that we also have a 1 x *q* data vector z_i for case *i*. (StataCorp, 2019). The random utility model can then be expressed as equation 5 (StataCorp, 2019).

Equation 5

$$u_i = X_i\ \beta + (z_i\ A)` + \in_i$$

U_i is the utility for case *i*, β is a *p* x 1 vector of alternative- specific regression coefficients. A= ($\alpha_1, \ldots, \alpha_J$) is a *q* x J matrix of case-specific regression coefficients. The elements of the matrix are independent type 1 extreme random variables with mean γ and variance $\pi^2/6$ (StataCorp, 2019).

With the analysis, the producer's utility was defined by choosing one of the feeding types or choosing to not ad libitum or limit feed. The options are associated with an ADG value, a variable cost value, and a fixed cost value. For simplicity and to potential remove any errors that may have occurred from producers being unsure of what is classified as a fixed cost versus a variable cost the variable cost value and fixed cost value were summed together. The equation can be written as equation 6:

Equation 6

$$v_j = \beta_1 \text{Feedchoice1} + \beta_2 \text{Feedchoice2} + \beta_3 \text{ADG} + \beta_4 \text{SumVCFC} + \varepsilon$$

In equation 6, feedchoice1 and feedchoice2 are dummy variables of 0 or 1 that indicate the presented choice. These dummy variables have mean value of .333 as we omit the neither dummy. ADG and SumVCFC are dummy variables that take on the value within each scenario.

To better evaluate producer's selection and perhaps remove any bias that may have occurred from the presented ADG and cost variables, the difference between the ADG and cost variables they provided earlier in the survey relating to their operation and the ADG and cost presented in the scenario was taken. This difference in values is represented as ADGdiff and sumvcfcdiff. From there, additional variables that may impact a producer's decision were also included in the model. The list of variables included in evaluating explanatory variables included: being from Kansas (*Kansas*), being male (*male*), having a bachelor's degree or higher (*bachabove*), obtaining half or more of your income from beef production (*halfincome*), currently limit feeding (*limitnow*), paying a labor wage of $12 or more (*wage12more*), managing

cattle for 121 days or more (*121daysmore*), selling 50% or more of cattle at a traditional auction market (*sellthroughauction*), strictly a stocker operation (*stocker*), placing multiple sets of stocker cattle each year (*multisets*), and retaining ownership to the feedyard (*feedlot*). The only significant variables turned out to be, *bachabove*, *limitnow*, and *sellthroughauction*. A conditional logit choice model was used. Equation 7 shows the model used. Feedchoice1 and feedchoice2 are dummy variables of 0 or 1 that indicate the choice. The difference in ADG that they typically manage for and the ADG in the selected scenario and the difference in the sum of the variable cost and fixed cost associated with their operation in 2019 and the sum of the variable cost and fixed cost in the selected scenario was also included. Given the nature of survey data in panel form, a dummy variable of 0 or 1 was interacted with *limitnow*, *bachabove*, and *sellthroughauction* if that characteristic represented the respondent in the scenario. A value of "1" interacted on the variables represents that the characteristic applies to the respondent while a value of "0" represents that the characteristic does not apply to the respondent.

Equation 7

$$v_j = \beta_1 \text{Feedchoice1} + \beta_2 \text{Feedchoice2} + \beta_3 \text{ADGdiff} + \beta_4 \text{SumVCFCdiff} + \beta_5 \text{limitnow*limit} + \beta_6 \text{limitnow*adlib} + \beta_7 \text{bachabove*limit} + \beta_8 \text{bachabove*adlib} + \beta_9 \text{sellthroughauction*limit} + \beta_9 \text{sellthroughauction*adlib}$$

3.4 Results

3.4.1 Logit Results

Table 3.13 shows the coefficients of each variable in the logit model. A significance level of 0.10 was used due to the smaller sample size. With the statistical significance level of 0.10, 30 years or more of experience and placing multiple sets proved to be the only significant impacts for currently limit feeding. As a producer goes from less than 30 years of experience to 30 years

or more, a .6804408 decrease in the log-odds of a producer's decision to currently limit feeding is expected. Additionally, as a producer goes from only placing one set of stocker cattle a year to placing multiple sets within a year, a .8641542 decrease in the log-odds of a producer's current decision to limit feed. All other variables included within the model (*male, bachabove, stockers, Kansas, halfincome,* and *bunk*) were not significant. Therefore, main socioeconomic variables do not explain the decision to limit feed and other considerations that most likely were not included within the survey drive the producer choice to limit feed.

Table 3.15. Logit results for currently limit feeding

Decision	Coefficient	Std. Err.	z	P> |z|	95% Conf. Interval	
Male	.3333614	.787316	.42	.672	-1.20975	1.876472
bachabove	-.0839417	.3005135	-.28	.780	-.6729373	.5050539
30 yrsmore	-.6804408	.3905474	-1.74	.081	-1.4459	.0850181
stockers	.0002178	.0001846	1.18	.238	-.000144	.0005796
kansas	.1805085	.465545	.39	.698	-.7319429	1.09296
halfincome	.1752927	.3020969	.58	.562	-.4168063	.7673917
multisets	-.8641542	.2904353	-2.98	.003	-1.433397	-.2949114
bunk	.425487	.3427548	1.24	.214	-.2463	1.097275
_cons	-.0948732	.8442226	-.11	.911	-1.749519	1.559773

3.4.2 Choice Experiment Results

The output from conditional logit choice model can be found in table 3.14. Using a statistical significance level of 0.10 ADGdiff is not significant; although, the sign is as expected. Showing that if a producer is offered a system that performs better than the system they currently use then they are more likely to select it. Additionally, sumvcfcdiff is significant at a statistical significance level of 0.01 and the sign is negative. This shows that if a producer is offered a system that is less expensive than the system they currently use then they are more likely to select that option.

Table 3.14 also shows a producer that currently limit feeds is more likely to select limit feeding, but is also more likely to select ad libitum feeding than opting out of feeding. A producer with a bachelor's degree or above is more likely to select ad libitum feeding than limit feeding. Again, the respondents are more likely to select either of the feeding options over opting out of feeding. Producers that sell 50% or more of their cattle through auction are more likely to select ad libitum feeding over limit feeding, but are also more likely to choose limit feeding over neither.

Table 3.16. Conditional logit results from choice experiment

Decision	Coefficient	Robust Std. Err.	z	P> |z|	95% Conf.	Interval
Feed Choice						
ADGdiff	.1536317	.2035389	.75	.450	-.2452561	.5525606
SumVCFCdiff	-.0042134	.0021105	-2.00	.046	-.00835	-.000769
Ad Libitum						
Limitnow	.75771	.439906	1.72	.085	-.10449	1.61991
Bachabove	1.488854	.4535844	3.28	.001	.599845	2.377863
Sellthroughacution	.77422177	.4267637	1.81	.070	-.0622237	1.610659
_cons	-1.050759	.3889173	-2.7	.007	-1.813023	-.2884951
Limit						
Limitnow	1.371053	.4351504	3.15	.002	.5181737	2.223932
Bachabove	.8073998	.462616	1.75	.081	-.0993111	1.71411
Sellthroughacution	.4534794	.4446952	1.02	.308	-.4181072	1.325066
_cons	-.435926	.3819674	-1.14	.254	-1.184568	.3127164

Furthermore, a predicted probability analysis was conducted on variables included within the conditional logit choice model. As shown in figure 3.20 the base predicted probability of each feeding option when all variables are at the mean level shows the probability of a respondent selecting to feed ad libitum is 31.97%, the probability of a respondent selecting to limit feed is 42.7%, and the probability of a respondents selecting to not limit feed or ad libitum feed is 25.32%.

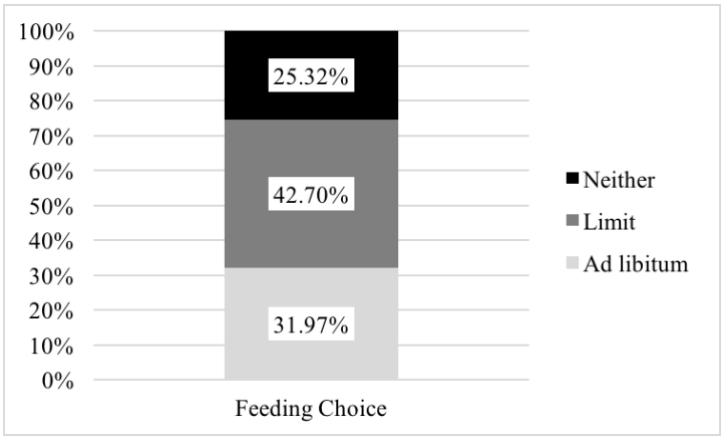

Figure 3.20. Base predicted probability of each feeding option

From the base probability's means, varying levels of ADG gains were applied to the limit feeding option to evaluate the marginal changes in probability. An ADG increase of 0.13 lbs./day was found from the research trial at Kansas State (Scilacci et al., 2020). Therefore, the limit fed ADG was increased by 0.13 pounds/day while the ad libitum and neither ADG was held constant and predicted probabilities were evaluated. We expect the improved cattle performance to result in a larger share of producers selecting limit feeding. This evaluates the percentage of producers that are likely to switch their feeding preference based on this increase in ADG for limit feeding. With the increase, 43.17% is the probability of limit feeding being selected if limit has the base ADG +0.13 as shown in figure 3.21. The probability of ad libitum being selected if limit has the base ADG +0.13 is 31.7%. The probability of neither ad libitum or limit being selected if limit had the base ADG +0.13 is 25.12%. Therefore, 0.27% of producers would likely move from ad libitum to limit feeding if limit feeding had the base ADG +0.13, 0.2% of producers would likely move from neither feeding option to limit feeding if limit feeding had the base ADG +0.13. Limit feeding increases by a total of 0.47%. For completeness, figure 3.21 also includes predicated probability of increases to limit feeding by 0.05 and 0.15. As observed in figure 3.21 the changes in probability are not linear across increases.

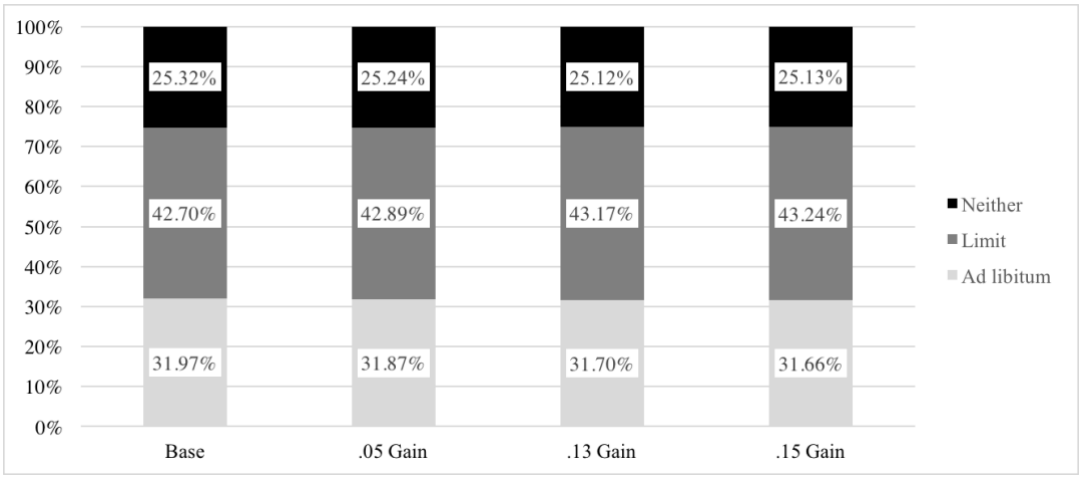

Figure 3.21. Predicted probabilities with ADG gains for limit feeding

Within the research trial, a net benefit was observed for limit feeding stocker cattle during the stocker/backgrounding phase. This resulted from lower feed costs, a reduced labor requirement, and a higher ending weight. To incorporate this finding, here a cost reduction (reflecting a net benefit gain) of $50 per head was applied to the limit feeding option to quantify the impact on the percentage of producers that select each option. A benefit of $50 was found to be more on the conservative side of findings from the research trial. With the cost benefit of $50, 47.62% is the probability of limit feeding being selected if limit has the base cost -$50 as shown in figure 3.22. The probability of ad libitum being selected if limit has the base cost -$50 is 29.16%. The probability of neither ad libitum or limit being selected if limit had the base cost -$50 is 23.22%. With the cost benefit 2.81% of producers are likely to move from ad libitum feeding to limit feeding. Additionally, 2.1% of producers are likely to move from feeding neither to limit feeding. The total increase in limit feeding is 4.91%.

A higher cost benefit may be observed given varying days on feed, starting weight, ending weight, and ADG. Therefore, some producers may see a cost benefit of up to $70 per head. When a cost benefit of $70 is applied to the limit feeding option, 49.6% is the probability

of limit feeding being selected if limit feeding has the base cost -70 as shown in figure 3.22. The probability of ad libitum being selected if limit feeding has the base cost -70 is 28.03%. The probability of neither ad libitum or limit being selected if limit had the base cost -70 is 22.37%. With the cost benefit of $70 3.94% of producers are likely to move from ad libitum feeding to limit feeding. Additionally, 2.96% of producers are likely to move from feeding neither to limit feeding. The total increase in limit feeding is 6.89%.

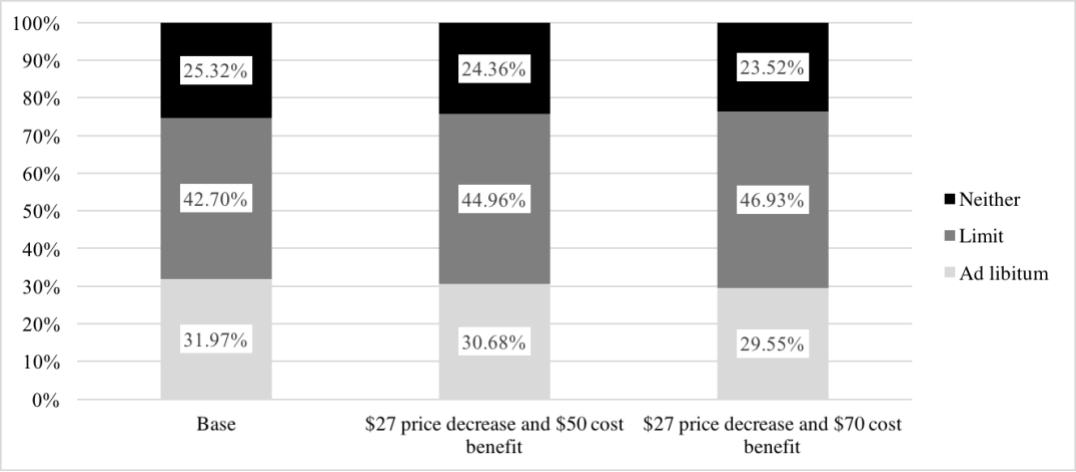

Figure 3.22. Predicted probabilities with cost benefit for limit feeding

While a cost benefit was found for limit feeding stocker cattle during the stocker phase an increase in cost of gain was found during the feedlot phase. With this increase in cost at the feedlot phase it can be anticipated that feedlot operators may discount the price they are willing to pay for stocker cattle that have been limit fed. Within the research trial an additional cost of gain for limit fed cattle of $6/cwt was found. Assuming a feedlot operation buys a 800-pound calf and feeds that animal to 1250 pounds, the additional cost of gain for a limit fed calf is about $27. Continuing with the $50 per head cost benefit and accounting for a potential $27 per head decrease in price, stocker operators would see a cost benefit of $23. With this cost benefit of $23, 44.96% is the probability of limit feeding being selected if limit has the base cost +$23 as shown

in figure 3.23. The probability of ad libitum being selected if limit has the base cost +$23 is 30.68%. The probability of neither ad libitum or limit being selected if limit had the base cost +23 is 24.36%. In comparison to the base margins, the likeliness of a producer selecting limit feeding increases by 2.26%.

Suppose the selling price decrease of $27 per head is applied to the cost benefit of $70 per head for a total cost benefit of $43 per head. When a cost benefit of $43 is applied to the limit feeding option, 46.93% is the probability of limit feeding being selected if limit has the base cost -$43 as shown in figure 3.23. The probability of ad libitum being selected if limit has the base cost -$43 is 29.55%. The probability of neither ad libitum or limit being selected if limit had the base cost -$43 is 23.52%. With the cost benefit of $43, 1.8% of producers are likely to move from ad libitum feeding to limit feeding. Additionally, 2.42% of producers are likely to move from feeding neither to limit feeding. The total increase in limit feeding is 4.23%.

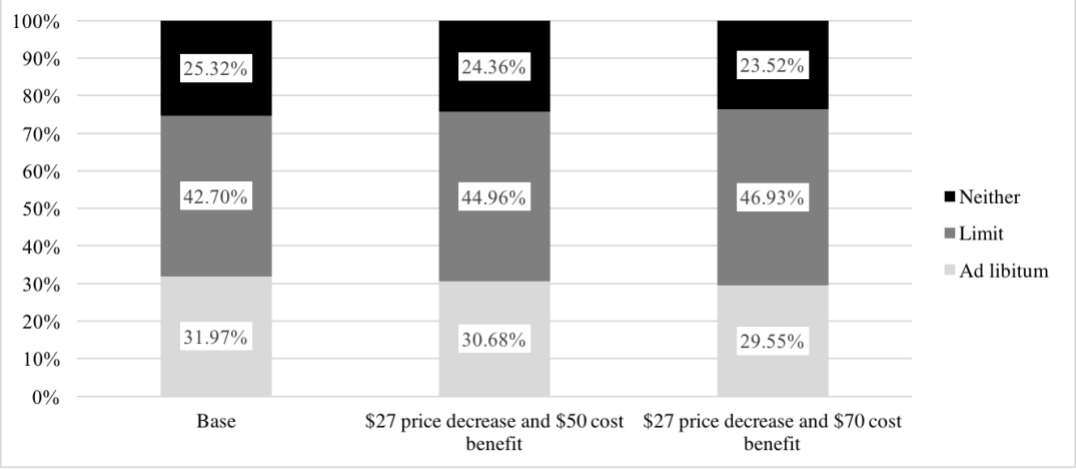

Figure 3.23. Predicted probabilities with price decrease and cost benefit for limit feeding

Chapter 4 - Conclusions and Implications

Limit feeding at the stocker stage did provide some benefits. Throughout the stocker phase, improved ADG, increased feed efficiency, reduced tractor and mixer usage, and a lower labor requirement shows limit feeding has the potential to be more profitable than ad libitum feeding. However, when evaluating the profitability of finishing cattle that have been limit fed, research shows ad libitum feeding at the stocker stage may be more beneficial. Ad libitum fed stocker calves outperformed limit fed cattle in terms of ADG and cost of gain during the finishing phase. Additionally, calves fed ad libitum at the stocker phase achieved lower yield grades, higher quality grades, and hung heavier carcasses; overall, providing more premium on the grid.

Although the research conducted showed which feeding type was more profitable during the research trial, profitability can fluctuate over time as the costs of inputs change. Therefore, producers are encouraged to use the budget sheets created to compare the profitability after inserting feed prices, cattle prices, and operation-specific values for the time they are making their assessment. After comparing the profitability of each, operators will be more informed and able to make a more educated feeding decision for their stocker operation.

Limit feeding stocker cattle may have the potential to produce more beef at a lower cost given increased feed efficiency and fewer days on feed during the stocker phase. This has been an ongoing goal of the cattle industry as sustainability has become more of a focus. Limit feeding may hold additional value for specific operations that was not quantified throughout the trial. Geographical, political, and operational differences among operations may compound the value of limit feeding through improved feed efficiency and less manure output. Forage availability is a top concern for some operators depending on feed and forage resources, so that

component also contributes to a producer's decision and profitability. Operations face different resource constraints, so evaluating those constraints in the decision-making process holds value that was not quantified through this research.

If stocker operators choose to adopt limit feeding they may see some initial benefits. Furthermore, they may be able to capture some profit through decreased costs and improved calf performance. However, if a large industry shift to limit feeding occurs, feedlots may discover that the cost of finishing cattle that have been limit fed increases in comparison to cattle fed ad libitum. With this knowledge feedlot operators may inquire if stocker cattle have been limit fed, and those cattle may receive a discount to stocker cattle that had been fed ad libitum. Stocker operators may then see some potential cost benefits, but a lower sale price. For example, feedlot operators may discount limit fed cattle to cover the additional cost of gain. Within the research at Kansas State that difference was about $6/cwt, so stocker operators can take that into consideration when evaluating the profitability of limit feeding stocker cattle.

This first part of this analysis looked at quantifying the impacts of limit feeding during the stocker/backgrounder phase for the stocker and feedlot sectors. It would be interesting for future research to focus on quantifying the market impact if a large adoption of limit feeding stocker cattle occurred. Depending on the rate of adoption, significant industry changes may be observed. For example, what cost benefit do stocker operators capture, how the feeder calf and fed cattle price spread is impacted for ad libitum or limit fed stockers, and do cow-calf operators experience any price changes for calves sold to stocker operations. Additionally, quantifying the consumer side through a willingness to pay analysis would provide a better understanding of consumers' willingness to pay for cattle that are produced more efficiently. Combining each of these aspects to evaluate the impact to the beef production cycle would be beneficial.

The second part of this analysis focused on looking at what factors influence a stocker producer's decision to limit feed cattle through a producer survey. Findings from the survey showed that for producers that currently limit feed their decision is not influenced by main socioeconomic variables. It can be concluded that variables that were not included within the survey drive the producer choice to limit feed. Furthermore, the choice experiment within the survey simulated a real-life decision for feeding options. Producers evaluated costs and performance and made a feed decision based off their personal preferences. Again, within the choice experiment, main socioeconomic variable were not significant drivers in a producer's feeding decision. Although, producers that currently limit feed are more likely to select limit feeding, producers that have a bachelor's and above are more likely to select ad libitum feeding, and producer's that sell 50% or more of their cattle through a traditional auction market are more likely to select ad libitum feeding.

Base predicted probability analysis estimated that the probability of a producer limit feeding is 42.72%, the probability of a producer ad libitum feeding is 31.97%, and the probability of a producer opting out of limit or ad libitum feeding is 25.32%. As different ADG increases, cost benefits and decreases in sales price were applied to the analysis the probability of producers selecting the different feeding types changed. The 0.13 lbs./ day ADG increase for limit feeding that was found in the trial, increased the likeliness of a producer selecting limit feeding by 0.5%. The cost benefit of $50 and $70 for limit feeding that was found during the research trial increased the probability of a producer selecting limit feeding by approximately 5-7%. Although, a decrease in the sales price that feedlots are willing to pay for stocker cattle that have been limit fed is anticipated if a large shift to limit feeding occurs. When a $27 price decrease is applied to the cost benefit of $50 and $70 the probability of a producer selecting limit

feeding ranges from an increase of 2-4%. Showing us that the probability of adopting limit feeding increases if producers see an increase in ADG and some cost benefit.

Future research could attempt to further define what variables influence producer's adoption of different feeding practices. Defining those variables will aid in implementing educational programs that are most beneficial to producers and address key factors in their decision-making process.

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Appendix A - Survey Instrument

1. How would you describe your operation?

- ❍ 100% Stocker/ Backgrounder
- ❍ Stocker/ Backgrounder with cow-calf
- ❍ Stocker/ Backgrounder with feedlot
- ❍ Stocker/ Backgrounder with both cow- calf and feedlot
- ❍ Other (specify): _____

2. For this operation I am the:

- ❍ Owner and Manager
- ❍ Owner
- ❍ Manager
- ❍ Other (specify): _____

3. I am:

- ❍ Male
- ❍ Female
- ❍ Wish to not disclose

4. How old are you? _____ Years

5. My operation is located in which state? (If multiple states, indicate your primary state):

_____

6. The best description of my educational background is:

- ❍ Did not obtain a High School Diploma
- ❍ High School Diploma
- ❍ Technical training (certification or associates degree)
- ❍ Bachelor's Degree
- ❍ Graduate or Professional Degree (M.S., Ph.D., D.V.M., Law Degree)
- ❍ Other (specify): _____

7 How many years have you been raising cattle?

- ❍ Less than 10 years
- ❍ 11-20 years
- ❍ 21-29 years
- ❍ 30 years or more

8. Please estimate your annual pre- tax household income:

- ❍ Less than $25,000
- ❍ $25,000- $49,999
- ❍ $50,000- $74,999
- ❍ $75,000- $99,999
- ❍ $100,000- $124,999
- ❍ $125,000 or more

9. Approximately what proportion of your household income is from the beef cattle operation?

- ❍ Less than 25%
- ❍ 26% to 50%
- ❍ 51% to 75%
- ❍ 76% to 99%
- ❍ 100%

10. How many employees does your operation employ?

- ❍ Less than 5
- ❍ 5 to 14
- ❍ 15 to 24
- ❍ 25 or more

11. What is your current average labor wage paid to employees? (wage/ hour)

- ❍ Under $7.25
- ❍ $7.25- $11.99
- ❍ $12.00-$14.99
- ❍ $15.00- $17.99
- ❍ $18.00- $20.99
- ❍ $21.00 or more
- ❍ Non-applicable, I do not have paid employees

12. How many cattle (# head) did your operation have in inventory at the following production stages on January 1st, 2020? (a best guess is acceptable)

_____ Cows
_____ Calves
_____ Yearlings
_____ Finished cattle

13. Who owns the land or lot in which you raise the majority of your cattle? (select all that apply)

- ❑ I lease land from the government, school sections, etc.

- ❑ I lease the land from a private individual or other operation.
- ❑ My Family and/or I own the land
- ❑ Other (specify): _____

14. Referring to 2019, what percentage of feeder cattle placed in your backgrounding/ stocker operation were sourced from each of the following sources:

_____ Retained from my own cow-calf operation
_____ Purchased from auction market without knowledge of source ranches
_____ Purchased from auction market with knowledge of source ranches
_____ Purchased direct from individual cow-calf ranches
_____ Purchased from internet/ video auctions
_____ Other (specify):

15. What month and weight do you usually BUY stocker/ backgrounders?

_____ Month
_____ Weight

16. What month and weight do you usually SELL stocker/ backgrounders?

_____ Month
_____ Weight

17. Once you place your cattle on grass or in a lot, do you usually:

- ❍ Take them all out at the same time
- ❍ Take some out, and take the rest out at a later date
- ❍ Other (specify): _____

18. How would you describe the cattle you typically purchase? (Select all that apply)

- ❑ Black hided
- ❑ Colored
- ❑ Eared or some Brahman influence
- ❑ Purebred
- ❑ Crossbred

19. What best describes the frequency and seasonality of your background/ stocker operation?

- ❍ Typically place one set of feeder cattle in the spring
- ❍ Typically place one set of feeder cattle in the fall
- ❍ Typically place multiple sets of feeder cattle within one year

20. What is the total length of time you typically own/ manage most stocker/ backgrounders?

- ❍ 30 days or fewer
- ❍ 31 to 60 days
- ❍ 61 to 90 days
- ❍ 91 to 120 days
- ❍ 121 to 180 days
- ❍ More than 180 days

21. Referring to 2019, what percentage of your total stocker/ backgrounder cattle were on each of the following and for how long:

	Average % Cattle	Days
Cool season grass pasture (brome, fescue, perennial, ryegrass, etc.)		
Warm season grass pasture (switchgrass, big bluestem, etc.)		
Warm season annual (annual planted specifically for cattle grazing, i.e. Sudan)		
Fall cereal pasture (cereal grain pastures such as winter wheat, oats or ryegrass)		
Dormant Winter feed (stockpiled dormant forage and crop residue)		
Dry lot (bunk fed forage, confined management of harvested feed)		
Other (specify):		

22. When placing cattle in your stocker/ backgrounder operation, what average daily gain (lbs/ day) do you typically manage for?

- ❍ Less than 1.26
- ❍ 1.26 to 1.5
- ❍ 1.51 to 1.75
- ❍ 1.76 to 2.0
- ❍ 2.01 to 2.25
- ❍ More than 2.25

23. What is your current stocking rate?

_____ head/acre

24. Has your stocking rate changed in the last 5 years?

- ❍ No
- ❍ Yes, If yes, please explain: _____

25. Which practices do you typically use to manage market or price risk? (select all that apply)

- ❑ Paying a premium to buy high quality cattle
- ❑ Focus on low cost production
- ❑ Buying lower priced cattle
- ❑ Retained ownership to the feed yard
- ❑ Forward contracting inputs/ outputs
- ❑ Futures market contracts
- ❑ Options on future market contracts
- ❑ Livestock Risk Protection (LRP) Insurance
- ❑ Livestock Gross Margin (LGM) Insurance
- ❑ Other (specify): _____

26. Referring to 2019, what percentage of cattle do you market using the following options:

_____ Retain ownership at the feedlot
_____ Sell directly to the feedlot
_____ Sell through a traditional auction market
_____ Sell through internet/ video auction
_____ Other, (specify)

27. Please rate your agreement with these statements

	1	2	3	4	5	Unsure
I usually like playing it safe by doing what I have done for many years.	❍	❍	❍	❍	❍	❍
During my time as a cattle producer, I have tried new technology.	❍	❍	❍	❍	❍	❍
If there is a new practice, I want to be the first one to implement it in my operation.	❍	❍	❍	❍	❍	❍
With respect to my conduct of business, I dislike risk.	❍	❍	❍	❍	❍	❍

Limit Feeding:

The following questions will be regarding limit feeding. Limit feeding is a management practice which restricts the feed intake of cattle in comparison to conventional, ad libitum feeding. Recent research conducted at the Kansas State University Stocker Unit found, limit fed cattle achieved a higher ADG and greater feed efficiency. Additionally, the limit fed diet may have a lower labor requirement due to less time required to mix and deliver the diet. At the feedlot, cattle fed ad libitum during the backgrounding phase may outperform limit fed cattle and may earn better yield and quality grades at slaughter.

28. Does your stocker/ backgrounding operation currently limit feed cattle?

- ❍ No
- ❍ Yes

29. Have you considered limit feeding cattle?

- ❍ No
- ❍ Yes, and we limit feed now
- ❍ Yes, but we decided not to.
- ❍ **Why did you decide not to? _____**

30. Does your stocker/ backgrounding operation have the availability to bunk feed cattle?

- ❍ No
- ❍ Yes, how many feet per animal _____

31. Referring to 2019, what was your average variable cost per head?

- ❍ Less than $26
- ❍ $26-$75
- ❍ $76-$125
- ❍ $126- $175
- ❍ $176-$225
- ❍ $226- $275
- ❍ $276- $325
- ❍ More than $325

32. Referring to 2019, what was your average fixed cost per head?

- ❍ Less than $6
- ❍ $6- $15
- ❍ $16- $25
- ❍ $26- $35
- ❍ $36- $45
- ❍ $45- $55
- ❍ More than $55

33. Please rank the following aspects to your decision-making process, with 1 being most important and 7 being least important.

	1	2	3	4	5	6	7
Income over total costs	❍	❍	❍	❍	❍	❍	❍
Labor requirement	❍	❍	❍	❍	❍	❍	❍
Feed cost	❍	❍	❍	❍	❍	❍	❍
ADG	❍	❍	❍	❍	❍	❍	❍
Carcass merit	❍	❍	❍	❍	❍	❍	❍
Feedlot performance	❍	❍	❍	❍	❍	❍	❍
Sustainability	❍	❍	❍	❍	❍	❍	❍

34. Please rate your agreement with the following statements

	1- Strongly agree	2	3	4	Strongly disagree	Don't know
I am willing to install more bunk space if it means better feed efficiency	❍	❍	❍	❍	❍	❍
I am willing to devote more labor to feeding the same number of cattle	❍	❍	❍	❍	❍	❍
I am willing to adopt a new feeding type if carcass value is improved	❍	❍	❍	❍	❍	❍
I make decisions while considering the impact on feedlot performance	❍	❍	❍	❍	❍	❍
My decisions are impacted by the sustainability of a practice	❍	❍	❍	❍	❍	❍
I prefer to background my cattle on grass instead of in a lot	❍	❍	❍	❍	❍	❍
Economics is the number 1 factor that impacts my decision-making process	❍	❍	❍	❍	❍	❍
I am open to trying new management techniques	❍	❍	❍	❍	❍	❍
Manure output has a big impact on me adopting a new feeding type	❍	❍	❍	❍	❍	❍

Choice Experiment

For the remaining questions please respond given the following information: Suppose feeder cattle are on your operation for 90 days and then shipped to the feedlot. You have the option to decide which feeding type you would select given different ADG, variable cost, and fixed cost situations as presented below.

Version 1:

35. Please select the option you prefer:

	Ad Libitum Feeding	Limit Feeding	Neither
ADG (lbs/day)	1.5	2.5	I would choose not to Ad Lib or Limit Feed
Variable Costs (per head)	$275	$175	
Fixed Costs (per head)	$45	$45	
I would choose:	_____	_____	_____

36. Please select the option you prefer:

	Ad Libitum Feeding	Limit Feeding	Neither
ADG (lbs/day)	2.5	1.5	I would choose not to Ad Lib or Limit Feed
Variable Costs (per head)	$275	$175	
Fixed Costs (per head)	$30	$15	
I would choose:	_____	_____	_____

37. Please select the option you prefer:

	Ad Libitum Feeding	Limit Feeding	Neither
ADG (lbs/day)	1.5	1.5	I would choose not to Ad Lib or Limit Feed
Variable Costs (per head)	$225	$225	
Fixed Costs (per head)	$45	$15	
I would choose:	_____	_____	_____

38. What best describes your response and the question sequence just presented?

- ❍ The questions were easy and straightforward to understand. Accordingly, I am confident in my selections
- ❍ The questions were easy and straightforward to understand. However, I am <u>not</u> confident in my selections
- ❍ The questions were <u>not</u> easy and straightforward to understand. However, I am confident in my selections
- ❍ The questions were <u>not</u> easy and straightforward to understand. Accordingly, I am <u>not</u> confident in my selections

Version 2:

35. Please circle the option you prefer:

	Ad Libitum Feeding	Limit Feeding	Neither
ADG (lbs/day)	2.0	2.5	I would choose not to Ad Lib or Limit Feed
Variable Costs (per head)	$175	$225	
Fixed Costs (per head)	$30	$15	
I would choose:	_____	_____	_____

36. Please circle the option you prefer:

	Ad Libitum Feeding	Limit Feeding	Neither
ADG (lbs/day)	2.5	2.5	I would choose not to Ad Lib or Limit Feed
Variable Costs (per head)	$225	$275	
Fixed Costs (per head)	$15	$30	
I would choose:	_____	_____	_____

37. Please circle the option you prefer:

	Ad Libitum Feeding	Limit Feeding	Neither
ADG (lbs/day)	1.5	2.0	I would choose not to Ad Lib or Limit Feed
Variable Costs (per head)	$275	$225	
Fixed Costs (per head)	$30	$30	
I would choose:	_____	_____	_____

38. What best describes your response and the question sequence just presented?

- ❍ The questions were easy and straightforward to understand. Accordingly, I am confident in my selections
- ❍ The questions were easy and straightforward to understand. However, I am not confident in my selections
- ❍ The questions were not easy and straightforward to understand. However, I am confident in my selections
- ❍ The questions were not easy and straightforward to understand. Accordingly, I am not confident in my selections

Version 3:

35. Please circle the option you prefer:

	Limit Feeding	Ad Libitum Feeding	Neither
ADG (lbs/day)	1.5	2.0	I would choose not to Limit or Ad Lib Feed
Variable Costs (per head)	$225	$275	
Fixed Costs (per head)	$45	$15	
I would choose:	_____	_____	_____

36. Please circle the option you prefer:

	Limit Feeding	Ad Libitum Feeding	Neither
ADG (lbs/day)	2.0	2.0	I would choose not to Limit or Ad Lib Feed
Variable Costs (per head)	$175	$225	
Fixed Costs (per head)	$45	$30	
I would choose:	_____	_____	_____

37. Please circle the option you prefer:

	Limit Feeding	Ad Libitum Feeding	Neither
ADG (lbs/day)	2.0	2.5	I would choose not to Limit or Ad Lib Feed
Variable Costs (per head)	$225	$175	
Fixed Costs (per head)	$45	$45	
I would choose:	_____	_____	_____

38. What best describes your response and the question sequence just presented?

- ❍ The questions were easy and straightforward to understand. Accordingly, I am confident in my selections
- ❍ The questions were easy and straightforward to understand. However, I am <u>not</u> confident in my selections
- ❍ The questions were <u>not</u> easy and straightforward to understand. However, I am confident in my selections
- ❍ The questions were <u>not</u> easy and straightforward to understand. Accordingly, I am <u>not</u> confident in my selections

Version 4:

35. Please circle the option you prefer:

	Limit Feeding	Ad Libitum Feeding	Neither
ADG (lbs/day)	1.5	2.0	I would choose not to Limit or Ad Lib Feed
Variable Costs (per head)	$175	$175	
Fixed Costs (per head)	$30	$45	
I would choose:	_____	_____	_____

36. Please circle the option you prefer:

	Limit Feeding	Ad Libitum Feeding	Neither
ADG (lbs/day)	1.5	1.5	I would choose not to Limit or Ad Lib Feed
Variable Costs (per head)	$275	$175	
Fixed Costs (per head)	$45	$30	
I would choose:	_____	_____	_____

37. Please circle the option you prefer:

	Limit Feeding	Ad Libitum Feeding	Neither
ADG (lbs/day)	2.0	2.0	I would choose not to Limit or Ad Lib Feed
Variable Costs (per head)	$275	$275	
Fixed Costs (per head)	$15	$45	
I would choose:	_____	_____	_____

38. Please circle the option you prefer:

	Limit Feeding	Ad Libitum Feeding	Neither
ADG (lbs/day)	2.0	1.5	I would choose not to Limit or Ad Lib Feed
Variable Costs (per head)	$175	$175	
Fixed Costs (per head)	$15	$15	
I would choose:	_____	_____	_____

39. What best describes your response and the question sequence just presented?

- ❍ The questions were easy and straightforward to understand. Accordingly, I am confident in my selections
- ❍ The questions were easy and straightforward to understand. However, I am <u>not</u> confident in my selections
- ❍ The questions were <u>not</u> easy and straightforward to understand. However, I am confident in my selections
- ❍ The questions were <u>not</u> easy and straightforward to understand. Accordingly, I am <u>not</u> confident in my selections

Appendix B - IRB Approval

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Dr. Glynn Tonsor
Agricultural Economics
Waters Hall

Proposal Number: 10166

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 06/04/2020

RE: Proposal Entitled, "Stocker Producer Survey 2020"

The Committee on Research Involving Human Subjects / Institutional Review Board (IRB) for Kansas State University has reviewed the proposal identified above and has determined that it is EXEMPT from further IRB review. This exemption applies only to the proposal - as written – and currently on file with the IRB. Any change potentially affecting human subjects must be approved by the IRB prior to implementation and may disqualify the proposal from exemption.

Based upon information provided to the IRB, this activity is exempt under the criteria set forth in the Federal Policy for the Protection of Human Subjects, **45 CFR §46.101, paragraph b, category: 2, subsection: ii.**

Certain research is exempt from the requirements of HHS/OHRP regulations. A determination that research is exempt does not imply that investigators have no ethical responsibilities to subjects in such research; it means only that the regulatory requirements related to IRB review, informed consent, and assurance of compliance do not apply to the research.

Any unanticipated problems involving risk to subjects or to others must be reported immediately to the Chair of the Committee on Research Involving Human Subjects, the University Research Compliance Office, and if the subjects are KSU students, to the Director of the Student Health Center.

Appendix C - Stocker Survey Summary

U.S Stocker Operations 2020 Survey Summary

Written By: Claudia Hissong and Meghan Brence

Objective

This survey was conducted to understand demographics of U.S stocker producers, current management decisions, and their risk management views and practices. Operations included in the survey are purely stocker operations or stocker operations that engage in another sector of the beef industry.

Survey and Sample Design

This survey was developed by Claudia Hissong and Meghan Brence, both M.S. students at Kansas State University, and Glynn Tonsor, professor of agricultural economics at Kansas State University. After developing the survey instrument, Informa Engage formatted the final copy sent to producers.

The survey was sent to producers from a BEEF Magazine subscriber list. To encourage participation, a $1 bill, cover letter and postage-paid return envelope were included with each survey.

Data Collection and Survey Responses

Survey procedures were approved by the Kansas State University Committee on Research Involving Human Subjects, approval #10166. On April 8th, 2020 3,500 surveys were sent out through BEEF Magazine. There was a total of 645 surveys completed for a response rate of 18.43%.

The survey included questions regarding numerous aspects of stocker cattle operations and production practices. Topics included management demographics, operation characteristics, seasonality, cattle source, employees and labor wage, stocking rate, marketing preferences, and risk management practices and views. The survey involved a variety of questions from write in, select one, select multiple, and rate your agreement to the statement.

Table 1 provides summary statistics for operator characteristics from the survey responses. The number of responses reported in the table for specific questions does not always

equal the total number of survey responses due to some questions being left unanswered by the respondent.

The mean age of survey respondents was 63.68 years old with 94.13% (593 survey respondents) being male, 4.92% (31 survey respondents) being female, and .95% wished not to respond (6 survey respondents). Of the 638 respondents, 520 (81.5%) were the owner and manager of the operation, 101 (15.83%) were the owner, and 6 (.94%) were the manger as shown in figure 1.

Figure 1 Producer's Management Title

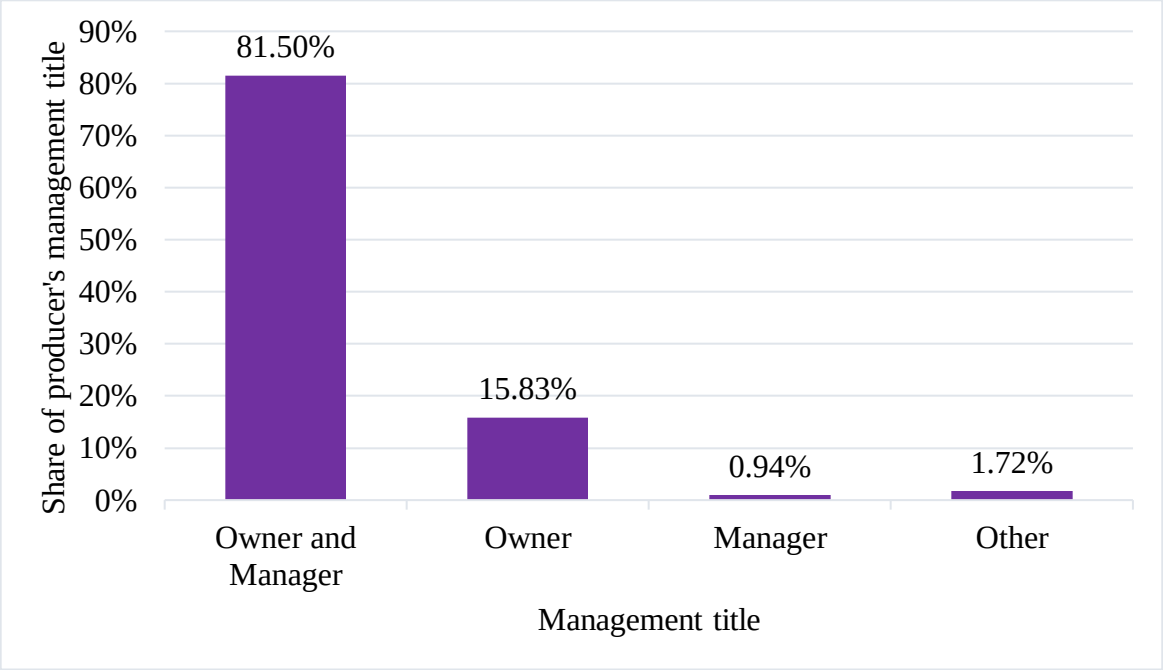


Figure 2 shows the number of responses per state, 38 of 50 states are represented in this survey. Nebraska had the highest number of responses with 63. Kansas and Missouri had the second and third highest with 56 and 55, respectively. Iowa had 51 responses, South Dakota had 45, North Dakota had 32 and Texas had 31. All other states had less than 30 and can be found in Table 1.

Additionally, most of the producers noted they had received at least a high school diploma when asked about the best description of their educational background. As shown in figure 3 producers with at least a high school diploma totaled 254 (39.94%). Those that selected they obtained a bachelor's degree comprised 176 (27.67%) respondents, followed by 122 (19.18%) respondents that received technical training. Survey respondents that had earned a

graduate or professional degree totaled 56 (8.81%) and those that did not obtain a high school diploma accounted for 16 (2.52%) respondents.

Figure 2 Responses by State

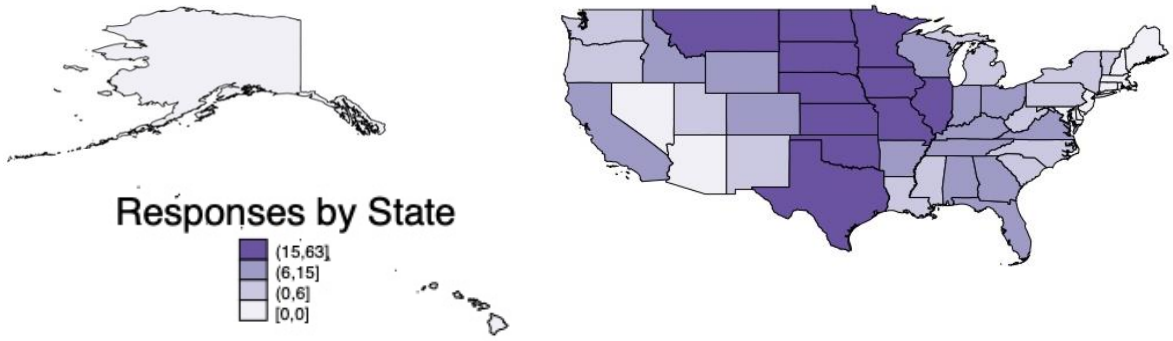
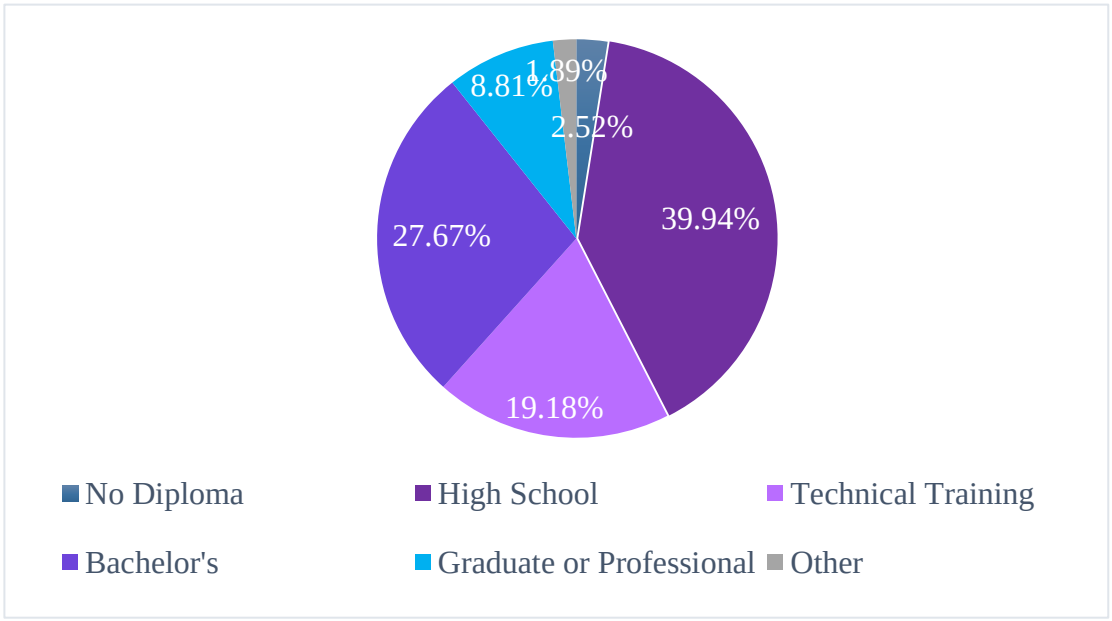
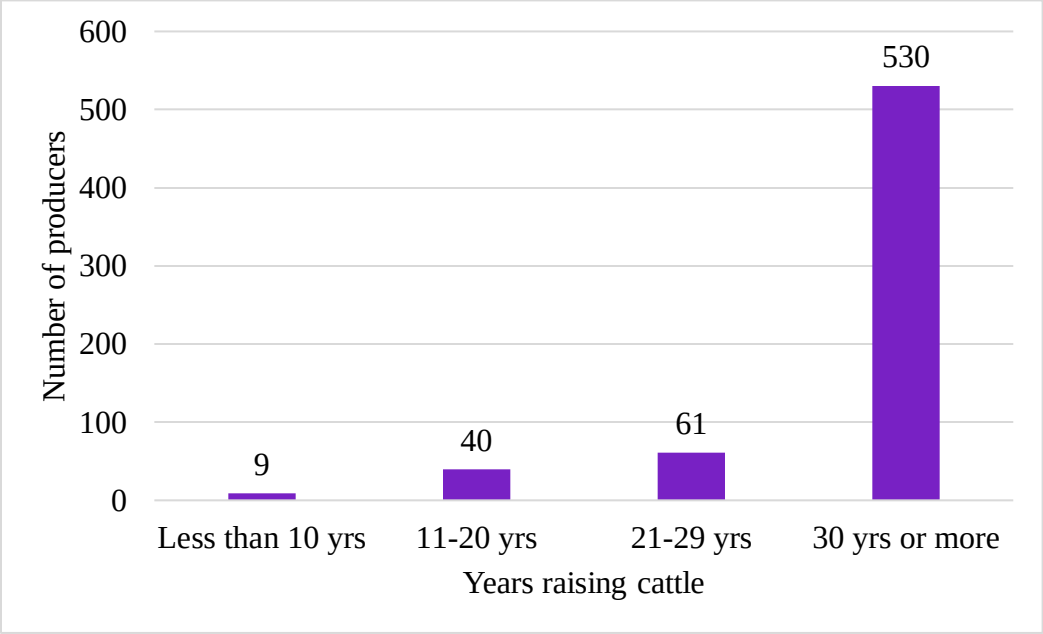


Figure 3 Producer's Educational Background



Survey respondents were asked to select how many years they have been raising cattle. Figure 4 shows 82.81% (530 survey respondents) indicated that they had been raising cattle for 30 years or more. Following this was 9.53% (61 survey respondents) who selected that had been raising cattle for 21- 29 years. Additionally, 6.25% (40 survey respondents) and 1.41% (9 survey respondents) indicated they had 11- 20 years of experience or less than 10 years, respectively.

Figure 4 Producer's Experience



When producers indicated their pre-tax household income, the most selected answer was $125,000 or more as shown in figure 5. This included 162 respondents (29.51%). Producers with a pre-tax household income of $75,000-$99,000 was comprised of 117 respondents (21.31%) which was followed by 88 respondents (16.03%) who indicated they had a pre-tax household income of $50,000-$74,000. Those with a pre-tax income of $100,000-$124,000 encompassed 78 respondents (14.21%). Additionally, 76 respondents (13.84%) and 28 respondents (5.10%) indicated their pre-tax household income was $25,000- $49,000 and less than $25,000, respectively.

In the survey producers were asked what proportion of their household income is from the beef cattle operation. Figure 6 shows that 29.47% (173 survey respondents) indicated that 26%-50% of their income comes from the cattle operation. This was followed by 25.04% (147 survey respondents) and 22.83% (134 survey respondents) who selected less than 25% and 51%-75% of their income comes from the beef cattle operation, respectively. Additionally, 13.97% (82 survey respondents) indicated that 76%-99% of their income comes from the operation while 8.69% (51 survey respondents) 100% of their income comes from the cattle operation.

Figure 5 Pre-Tax Household Income

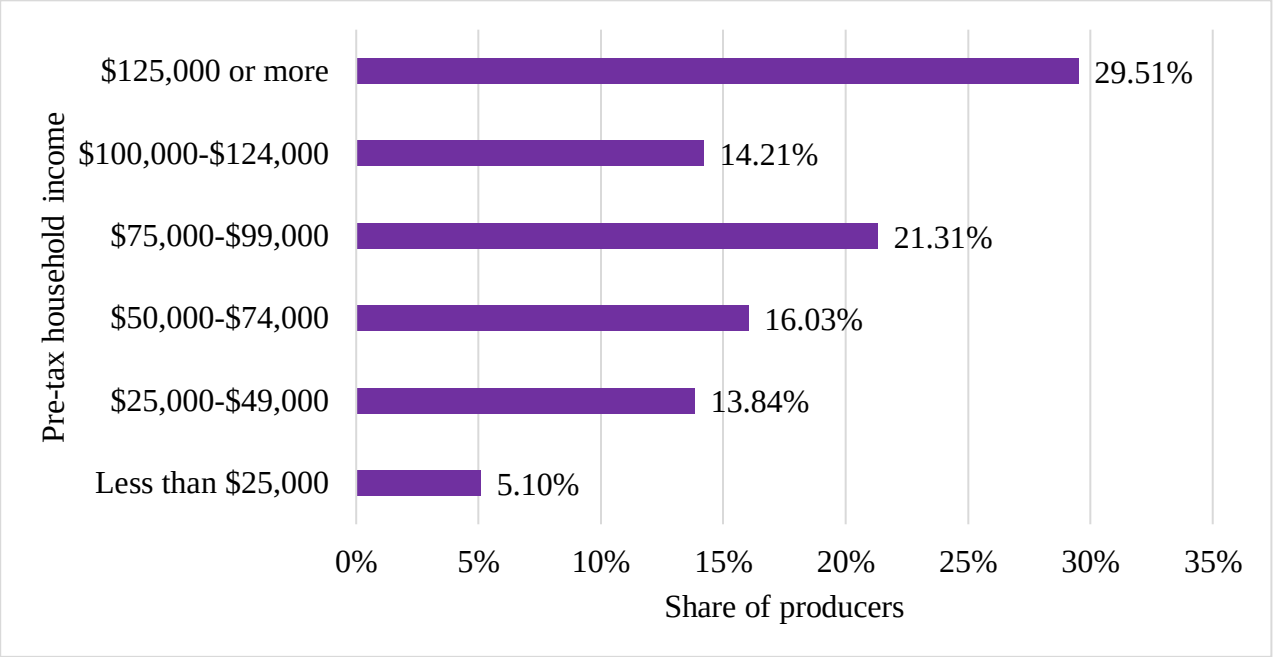
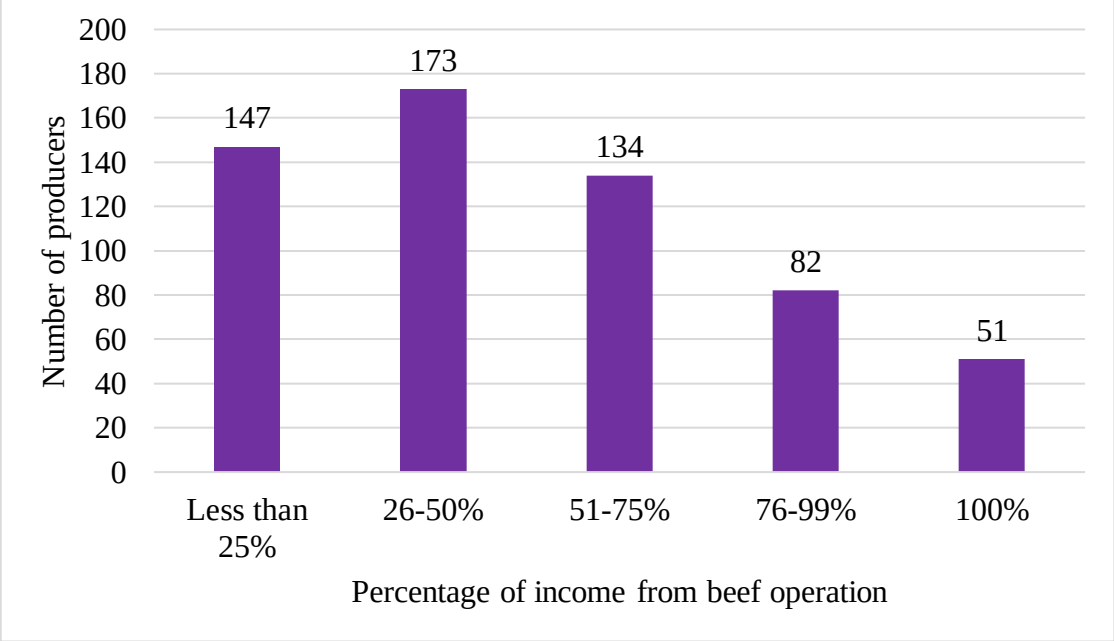


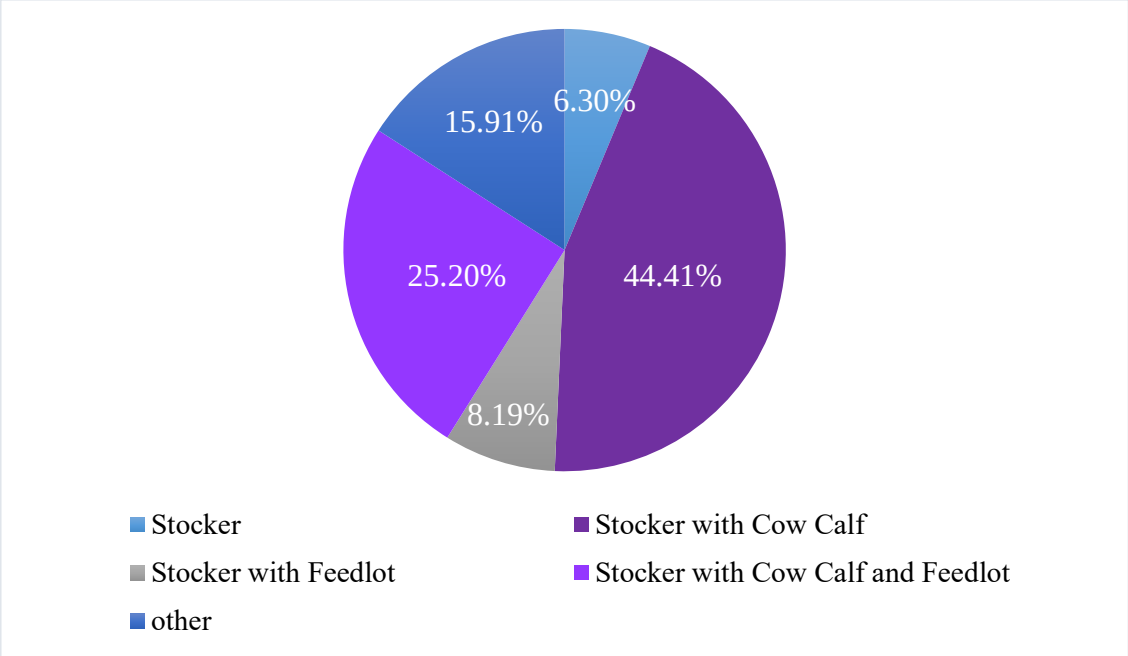
Figure 6 Percentage of Income from Beef Operation



As figure 7 shows the majority of the survey respondents describe their operation as a stocker/backgrounder with cow-calf. This included 282 respondents (44.41%) of the total 635 producers. Producers that describe their operation as stocker/backgrounder with cow-calf and feedlot totaled 160 respondents (25.2%). This was followed by stocker/backgrounder with

feedlot which was comprised of 52 respondents (8.19%) and then purely stocker/backgrounder operations accounted for 40 respondents (6.3%).

Figure 7 Operation Description

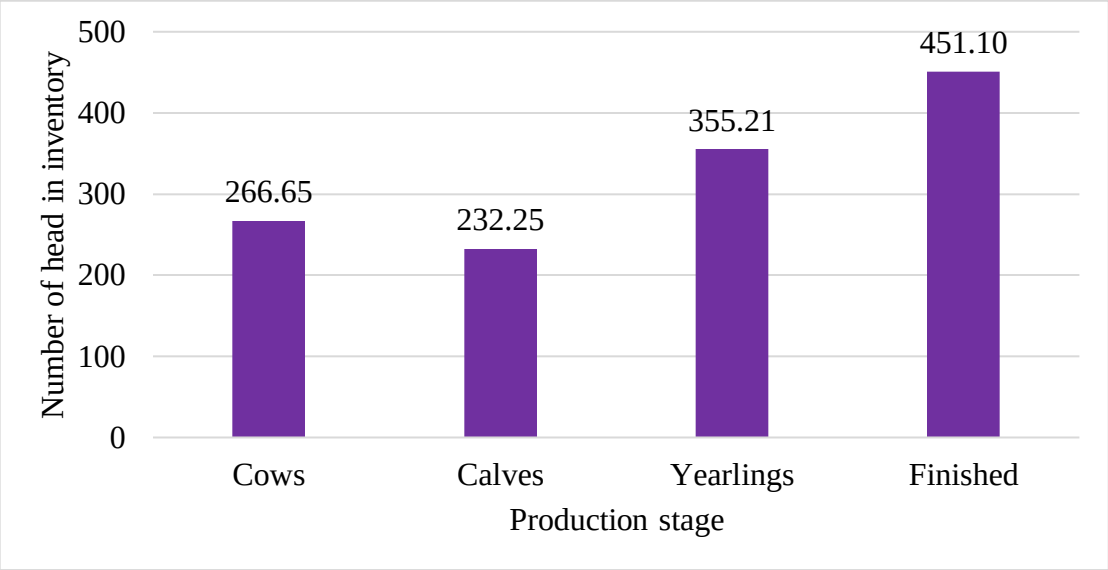


Operation and Management Characteristics

Table 2 continues to summarize operation and management characteristics. Producers were asked questions regarding cattle they had in inventory at varying production stages, the number of employees employed at the operation and labor wage if applicable. Additionally, they were asked questions relating to land ownership, cattle source, seasonality, frequency, cattle description, forage source, the typical length of time they manage cattle for, what ADG they manage to achieve, their current stocking rate, and then how they market their cattle.

The survey asked respondents how many head of cattle their operation had in inventory at each production stage on January 1, 2020. Of the 506 survey respondents that had cows, the average was 266.65 head as shown in figure 8. In terms of calves, 416 respondents had an average of 232.25. At the beginning of the year, 378 respondents had yearlings in production with an average of 355.21 head. Regarding finished cattle, 168 survey respondents averaged 451.1 head of finished cattle. Indicating the number of survey respondents decreased when moving through the production cycle, but the average head per operation increased with the exception of calves.

Figure 8 Cattle Inventory



Survey respondents were then asked to select how many employees their operation employs. As shown in figure 9 most respondents selected less than 5 for a total of 523 respondents (92.57%) out of 565 respondents who answered the question. Followed by 34 respondents (6.02%) who selected 5-14 employees. 15-24 and 25 or more were each selected by 4 respondents (0.71%). As a follow up, producers were asked what the current average labor wage paid to their employees is. The most common answer was non-applicable, I do not have paid employees which 31.91% (179 survey respondents) of respondents selected that, as shown in figure 10. This was followed with 23.17% (130 survey respondents) of producers selecting $12-$14.99. At a labor wage of $7.25-$11.99 17.29% (97 survey respondents) indicated that was the current average wage of their employees. Additionally, 15.51% (87 survey respondents), 7.84% (44 survey respondents), and 2.32% (13 survey respondents) selected $15.00-$17.99, %18.00-$20.99, and under $7.25, respectively. The least number of producers indicated the current average labor wage is $21.00 or more, which accounted for 1.96% (11 survey respondents).

Figure 9 Number of Employees

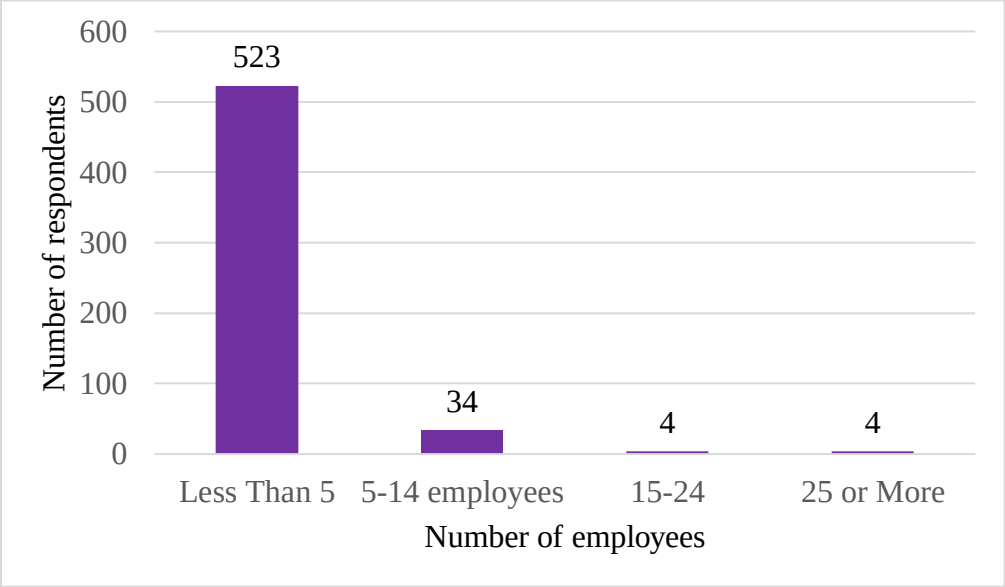
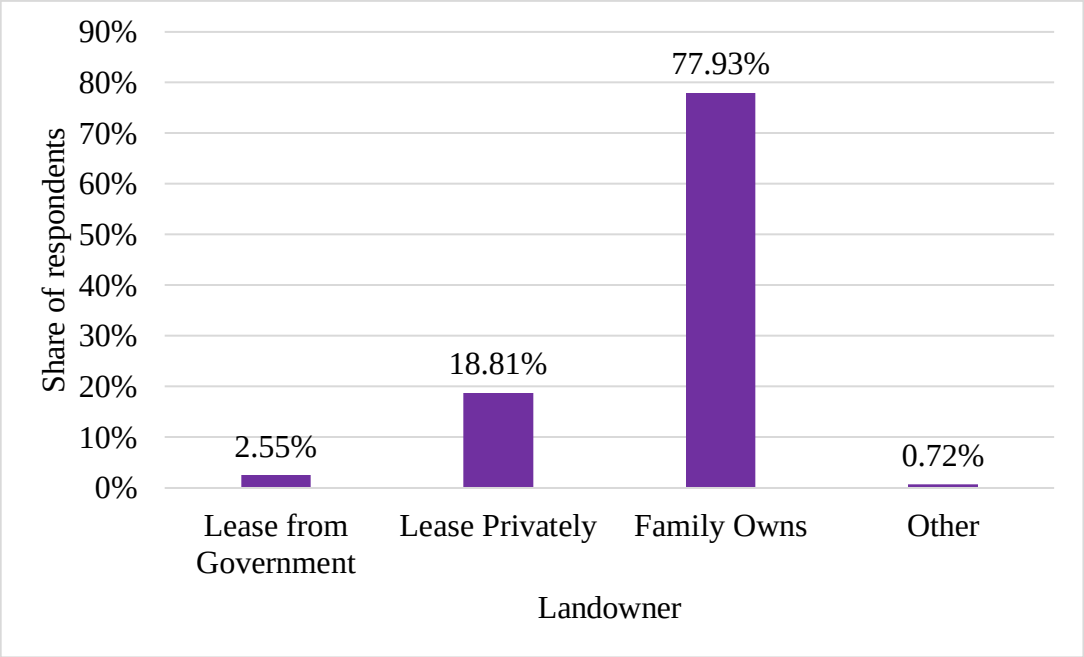


Figure 10 Labor Wage

Producers were also asked to indicate who owns the land or lot in which they raise most of their cattle. For this question, survey respondents could select all that applied to their operation. Responses totaled 707, of the 645 surveys returned, many of those surveyed selected more than one landowner in their operation. The majority of respondents selected my family and/or I own the land as shown in figure 11. This included 551 respondents (77.93%). Following

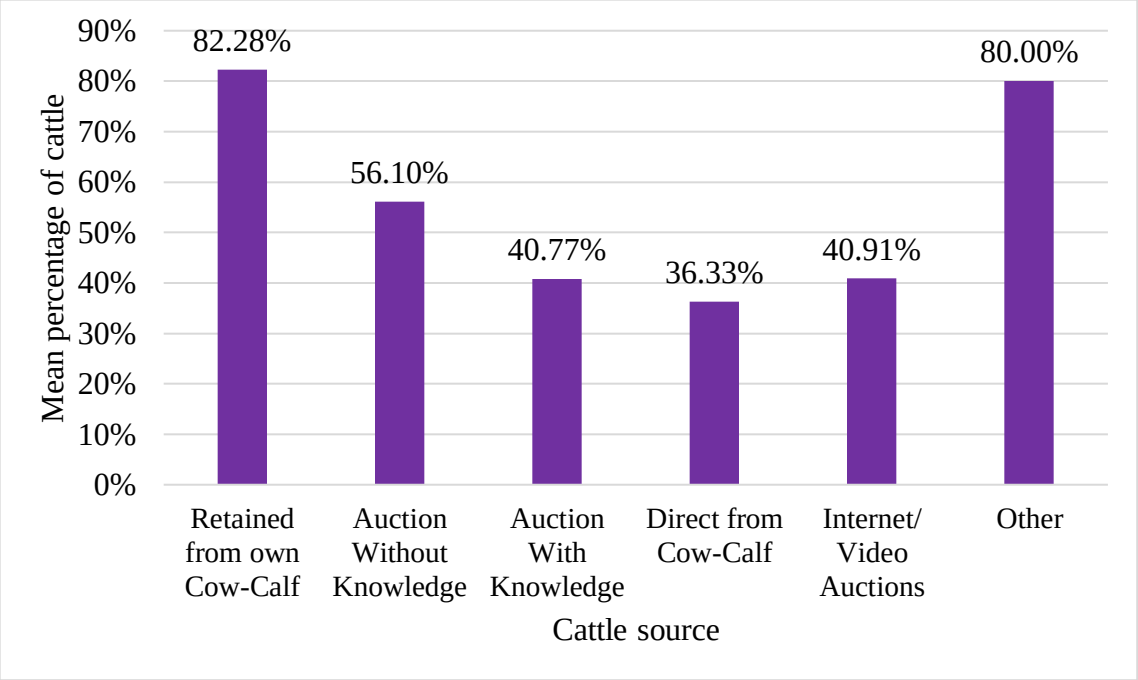
this was 133 respondents (18.18%) who indicated they lease the land from a private individual or other operation. Additionally, 18 producers (2.55%) selected that they lease the land from the government, school sections, etc.

Figure 11 Land Ownership



Survey respondents were asked to refer to 2019 to indicate the percentage of feeder cattle placed in their backgrounding/ stocker operation that were sourced from each option provided. Figure 12 shows 763 total responses were recorded with the majority selecting retained from my own cow-calf operation (414 survey respondents). The mean percentage for this category was 82.28%. In terms of purchasing at auction, 125 producers selected purchased from auction without knowledge of source ranches and 93 producers selected purchased from auction with knowledge of source ranches. The mean percentages were 56.1% and 40.77% of feeder cattle, respectively. Respondents also indicated 95 producers purchased direct from individual cow-calf ranches with a mean percentage of 36.33% of cattle. Additionally, 22 producers selected that they purchased cattle from internet or video auctions with a mean percentage of 40.91%.

Figure 12 Mean Percentage of Cattle from Each Source



As figure 13 shows, the most common month for producers to purchase stocker/ backgrounders is October with 44 producers selecting that month. All year, November, and December followed with 39, 34, and 33 producers indicating that is when they purchase cattle. Only two producers indicated that they purchase stockers/ backgrounders in July. This was followed by 5 and two sets of 6 producers which indicated they purchase cattle in June, February, and May, respectively. Producers were also asked to indicate the weight they usually buy stocker/ backgrounders at. The mean weight was 531.5 pounds with the minimum weight being 100 pounds and the maximum weight being 900 pounds.

As shown in figure 14 the month that the majority of producers indicated they sell stocker/ backgrounders is January. Of the 403 responses, 43 indicated January. March followed with 42 producers indicated that was the month they sell stockers. April and November followed with 38 and 37 producers indicating those months, respectively. In comparison to when producers purchase stockers/ backgrounds the months when they sell cattle vary much more showing the diversity in management at the stocker level. Only 12 producers indicated that they sell stockers/ backgrounders in July. This was followed by June which 23 producers indicated that was then they sell stockers/ backgrounders. The mean weight that producers usually sell

stocker/backgrounds was 828.45 pounds with the minimum weight being 250 pounds and the maximum weight being 1650 pounds.

Figure 13 Month Producers Purchase Cattle

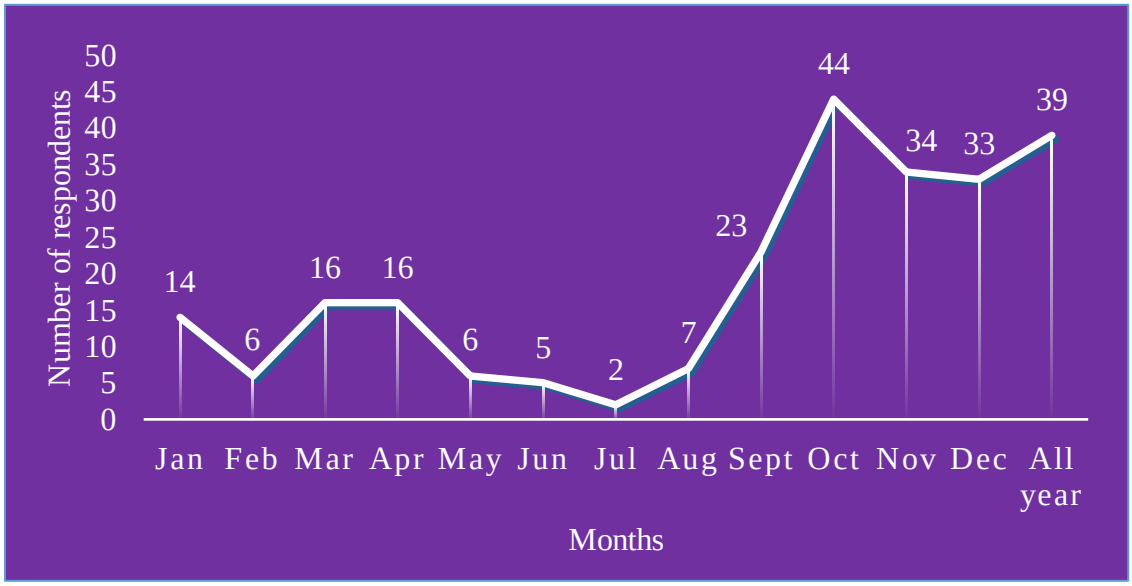
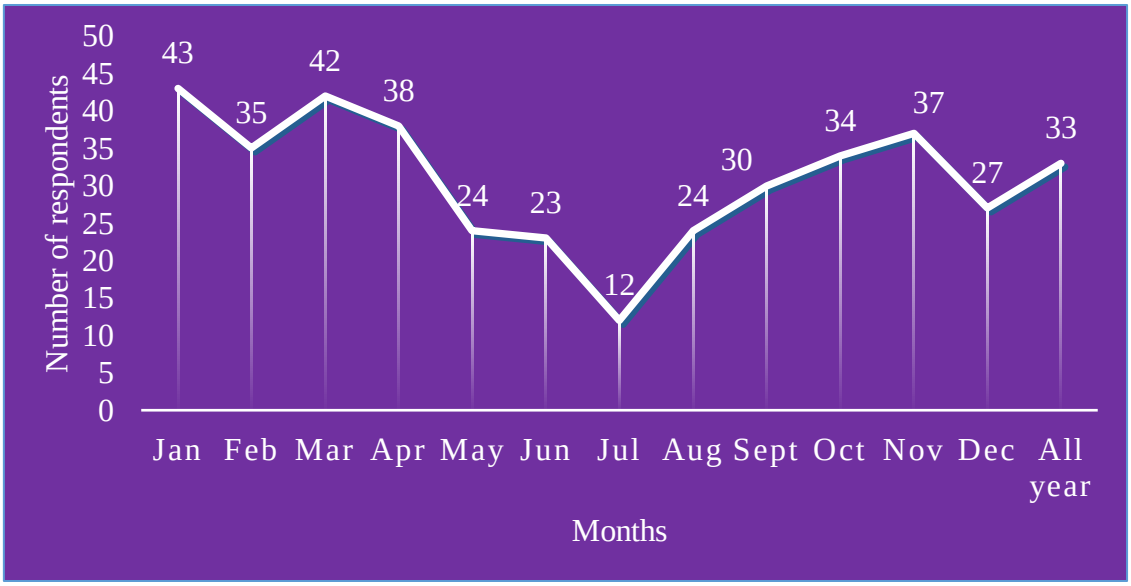
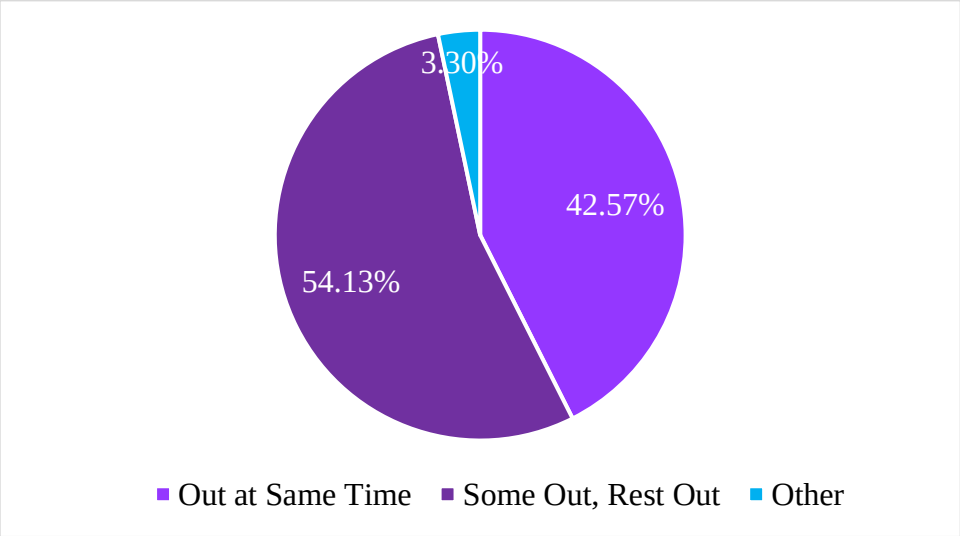


Figure 14 Month Producers Sell Cattle



Producers were then asked, once they place cattle on grass or in a lot, do they usually take them out at the same time, take some out, and take the rest out at a later date, or another management strategy. Taking some out, and taking the rest out later was selected by 295 producers (54.13%) while 232 survey respondents (42.57%) indicated that they take them all out at the same time as shown in figure 15.

Figure 15 Cattle Placement and Removal



Survey respondents were then asked how they would describe the cattle they typically purchase. The options included black hided, colored, eared or some Brahman influence, purebred, and crossbred. For this question, survey respondents could select all that applied to their operation. Responses totaled 750, of the 645 surveys returned, Producers were asked to select all that apply. Figure 16 shows a majority (334 responses) selected black hided. This was followed by 179 responses and 135 responses which selected crossbred and colored, respectively. Purebred was selected by 71 responses. Additionally, 31 responses indicated that they typically purchase eared or some Brahman influenced cattle.

The survey then asked producers to select the best description of the frequency and seasonality of their backgrounder/ stocker operation. Of the total 498 respondents, 220 producers (44.18%) selected that they typically place multiple sets of feeder cattle within one year as shown in figure 17. That was followed with 193 survey respondents (38.76%) who indicated they typically place one set of feeder cattle in the fall and 85 survey respondents (17.07%) who indicated they typically place one set of feeder cattle in the spring.

Figure 16 Description of Cattle

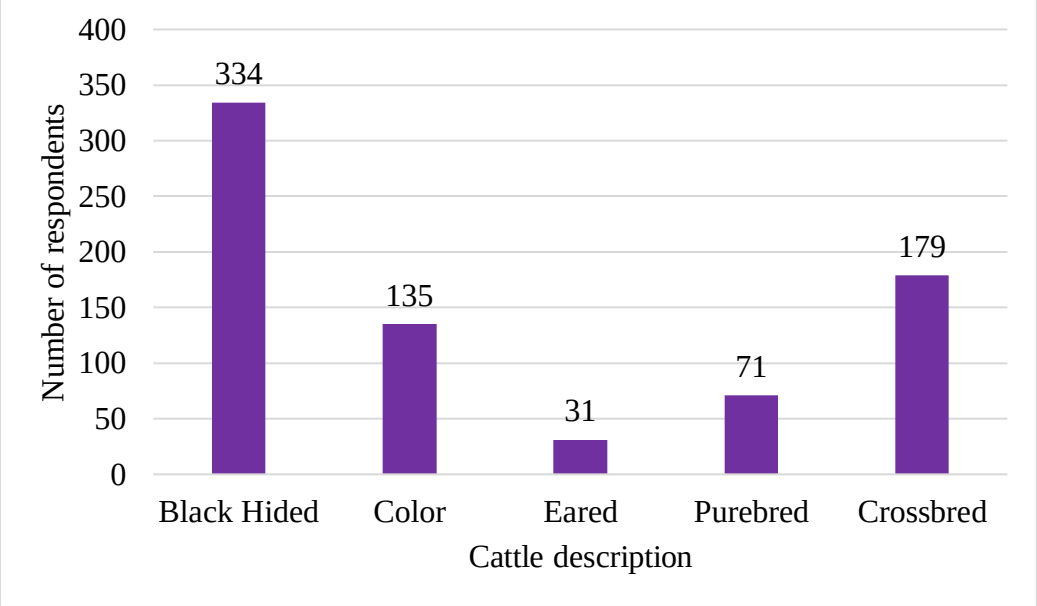
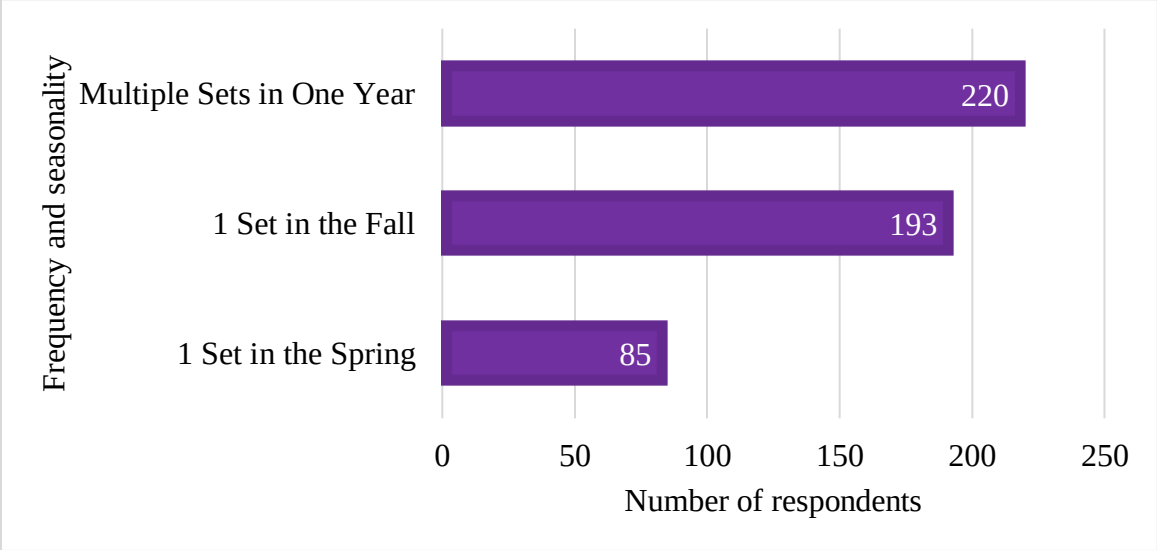


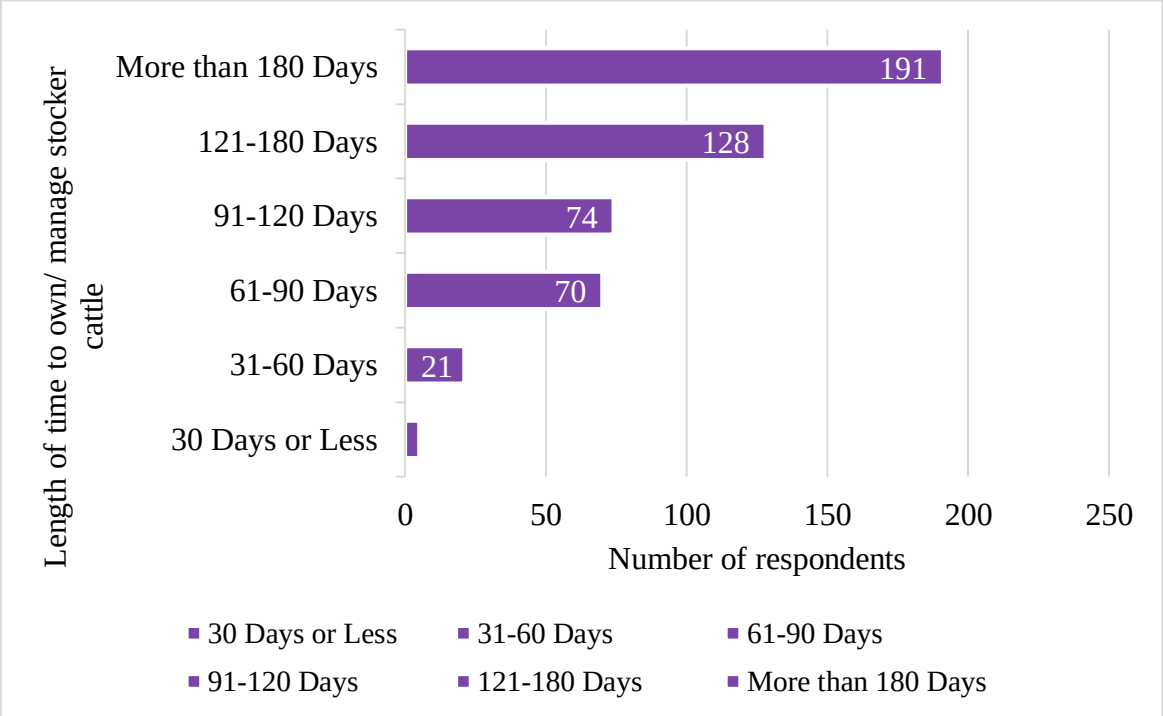
Figure 17 Frequency and Seasonality



The most common response regarding stocker/ backgrounders was producers indicated that they own/ manage stocker/ backgrounders for More than 180 days. As figure 18 shows this group was comprised of 191 producers (39.06%). The group of producers that typically own/ manage stocker cattle for 121-180 days consisted of 128 (26.18%) and this was followed by 74 producers that manage/ own cattle for 91-120 days (15.13%). Additionally, 70 (14.31%), 21

(4.29%), and 5 (1.02%) survey respondents indicated they typically own/ mange cattle for 61-90 days, 31-60 days and 30 days or fewer, respectively.

Figure 18 Length of Time to Own/ Manage Stocker Cattle



To obtain an understanding of different forage types that stocker/ backgrounders utilize survey respondents were asked to indicate what percentage of their total stocker/ backgrounder cattle were on each forage type and for how many days. The most popular forage source among respondents was dry lot (bunk fed forage, confined management of harvested feed). According to figure 19, 189 producers indicated that they have a mean percentage of 88.1% of their cattle on dry lot for an average of 176.09 days as shown in figure 20. Producers (97) who indicated a mean of 68.09% of their cattle are on cool season grass pasture (brome, fescue, perennial, ryegrass, etc.) for an average of 134.72 days. This was followed by 58 producers who indicated they have an average of 53.33% of their cattle on warm season grass pasture (switchgrass, big bluestem, etc.) for a mean of 141.67 days. Additionally, 28 producers indicated that they have a mean percentage of 62.82% of their cattle on fall cereal pasture (cereal grain pastures such as winter wheat, oats or ryegrass) for an average of 127.14 days, and 26 respondents indicated a mean percentage of 63.08% of their cattle on dormant winter feed (stockpiled dormant forage and crop residue) for a mean of 114.81 days. The least selected forage type was warm season annual (annually planted specifically for cattle grazing). This group included 11 producers who

indicated they have an average of 48.73% of their cattle on warm season annual for a mean of 110 days.

Figure 19 Forage Source

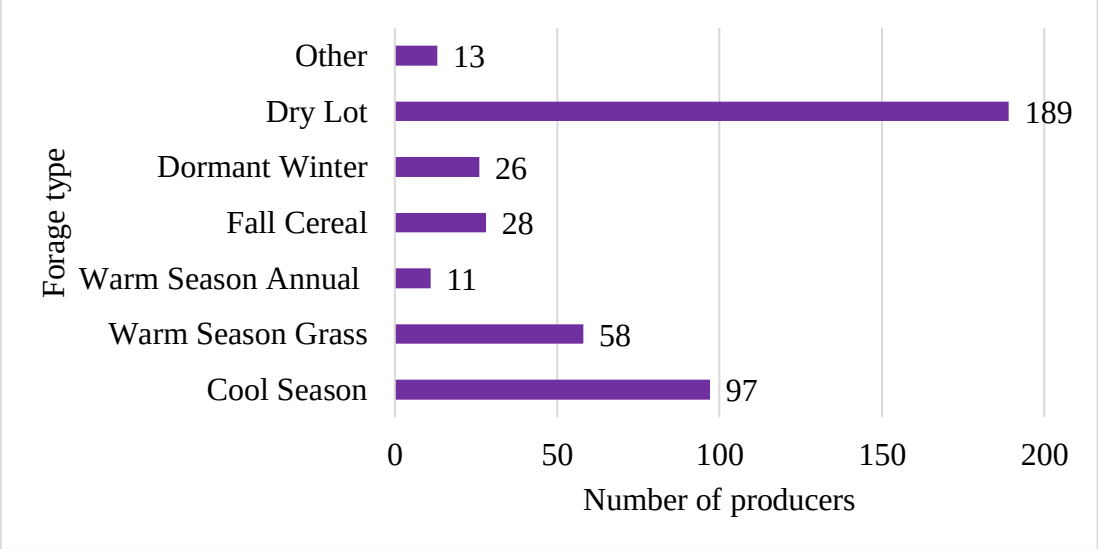
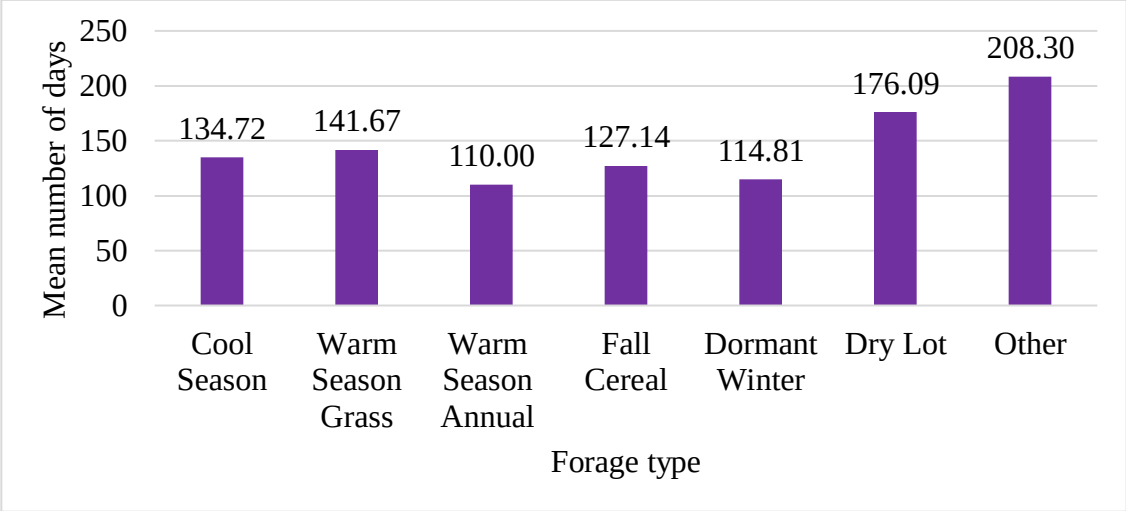


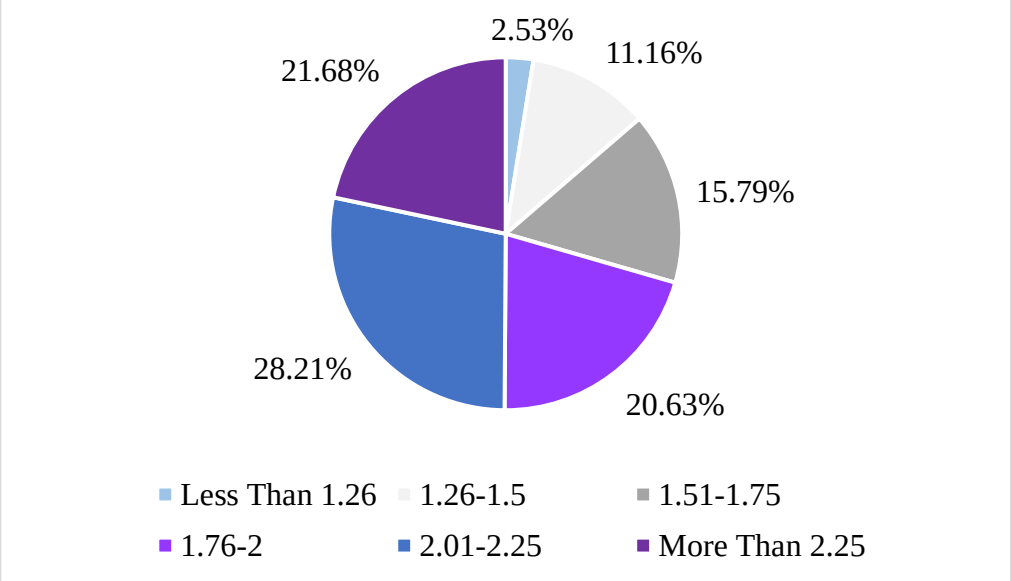
Figure 20 Mean Days on Forage Source



Another component that impacts the diversity of stocker production is the average daily gain (ADG) in which a producer manages to attain. Therefore, the survey asked producers to select which ADG they typically manage. As figure 21 shows most producers selected that they manage for an ADG of 2.01-2.25. This included 28.21% of respondents (134 producers). This was followed by 21.68% (103 producers) and 20.63% (98 producers) of respondents that indicated they manage for an ADG of more than 2.25 and 1.76-2 pounds/ day, respectively. Producers who selected they manage cattle for an ADG of 1.51-1.75 were 15.79% of

respondents (75 producers). Additionally, there were 53 (11.16%) and 12 (2.53%) survey respondents who selected they manage for an ADG of 1.26-1.5 and less than 1.26, respectively.

Figure 21 ADG (lbs./day) Manage for



The survey also gathered information regarding stocking rate. Producers were asked to respond with their current stocking rate in terms of head per acre. The mean stocking rate among 279 producers was 19.14 with a minimum of .03 and a maximum of 500. This question was followed with has your stocking rate changed in the last 5 years? A majority of respondents indicated that their stocking rate has not changed in the last 5 years. This included 343 respondents (76.73%) that indicated their stocking rate has not changed and 104 respondents (23.37%) that indicated their stocking rate has changed.

Survey respondents were then asked, referring to 2019, what percentage of cattle do you market using the following options. Figure 22 shows most respondents (274 producers) indicated that they sell through a traditional live auction. This group of producers indicated that the mean percentage of their cattle sold through a traditional auction market is 84.28%. Following this was 147 producers who indicated that they retain an average percent of 79.63% of their cattle ownership at the feedlot. Producers who sell directly to the feedlot was much lower at 73 survey respondents who indicated that the average percentage of cattle they market this way is 71.37%. Additionally, 35 respondents indicated that they market 71.23% of their cattle through internet/ video auctions.

Figure 22 Cattle Marketing

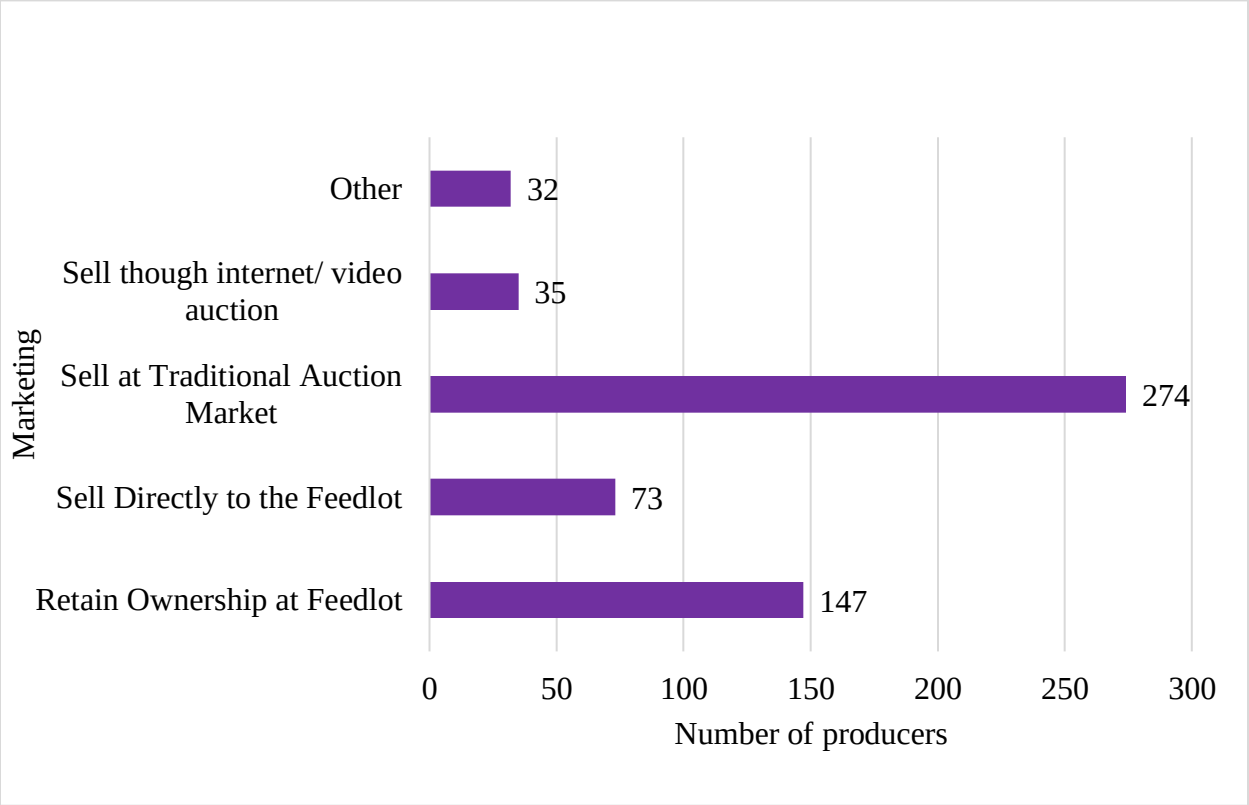
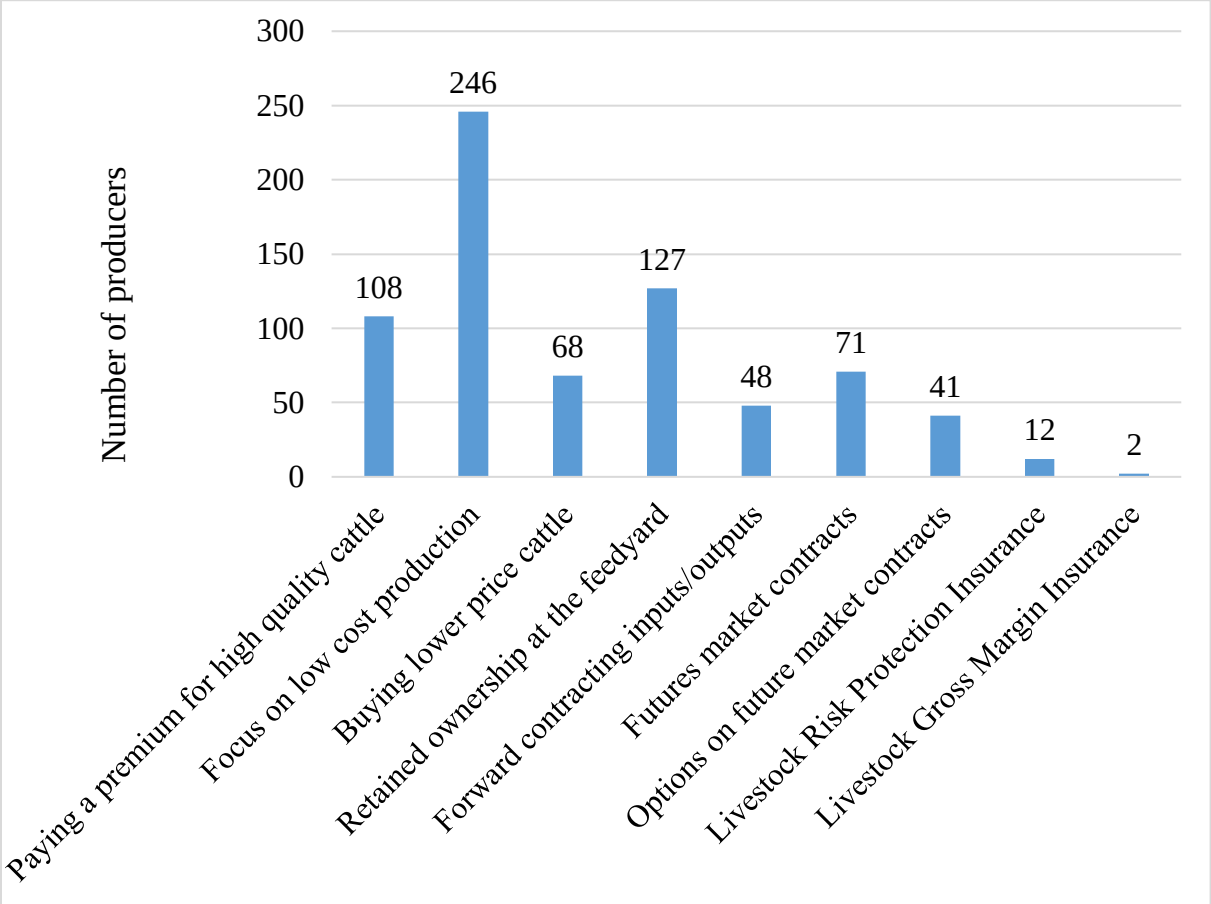


Table 3 shows risk management practices that stocker/ backgrounder producers utilize and their preference when it comes to risk, new technology, and adopting new practices.

Table 3 Risk Management and Preferences

Focusing on low cost production is a practice that most producers indicated that they use to manage market or price risk as shown in Figure 23. This included 246 producers. Producers indicating they retained ownership at the feed yard to manage risk totaled 127 respondents. Paying a premium to buy high quality cattle was another way a producer manages risk. This group totaled 108 respondents. Additionally, 71 and 68 producers indicated they utilize futures market contracts and buy lower priced cattle, respectively. Forward contracting inputs/ outputs is a risk management practice for 48 survey respondents. This is followed with 41 respondents which selected that they typically utilize options on future market contracts. Finally, 12 and 2 producers indicated that they use Livestock Risk Protection (LRP) Insurance or Livestock Gross Margin (LGM) Insurance, respectively.

Figure 23 Risk Management Practices



Survey respondents were then asked to rate their agreement to the risk related statements listed in table 3. Of the 571 producers that answered, "I usually like playing it safe by doing what I have done for many years," 124 producers (21.72%) selected they strongly agree, 24 (4.2%) selected they strongly disagree, 3 (.53%) selected they were unsure with 420 producers (73.56%) falling in the middle of strongly agree and strongly disagree. Of the 569 producers that answered, "During my time as a cattle producer, I have tried new technology," 120 producers (21.09%) selected they strongly agree, 22 (3.87%) selected strongly disagree with 420 producers (73.81%) selecting a rating in the middle, and 7 producers (1.23%) indicating they were unsure. Of the 556 producers that answered, "If there is a new practice, I want to be the first one to implement it in my operation," 19 (3.42%) selected they strongly agree, 95 (17.09%) selected strongly disagree, 419 (75.36%) selected in the middle, and 23 (4.14%) selected unsure. Of the 561 producers that answered, "With respect to my conduct of business, I dislike risk," 103 (18.36%) selected they

strongly agree, 29 (5.17%) indicated they strongly disagree and 419 (74.69%) selected a rating in the middle. Additionally, 10 producers (1.78%) selected unsure.

Figure 24 Playing it Safe

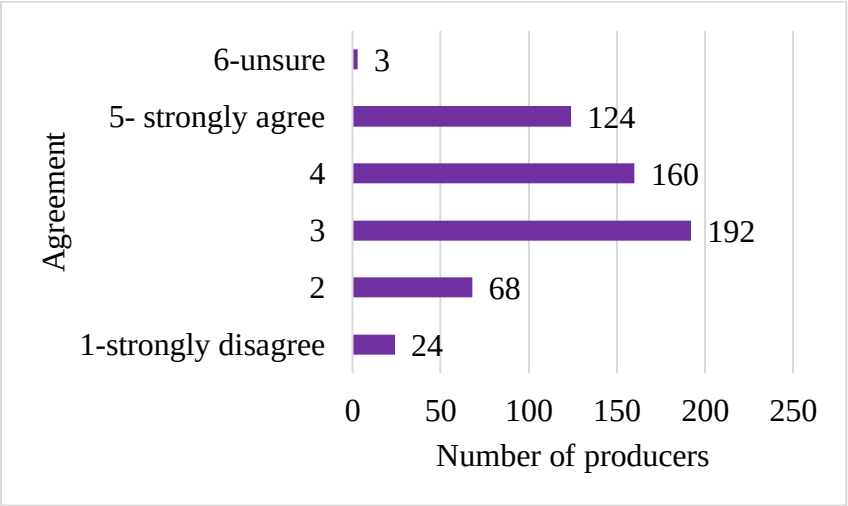


Figure 25 Tried New Technology

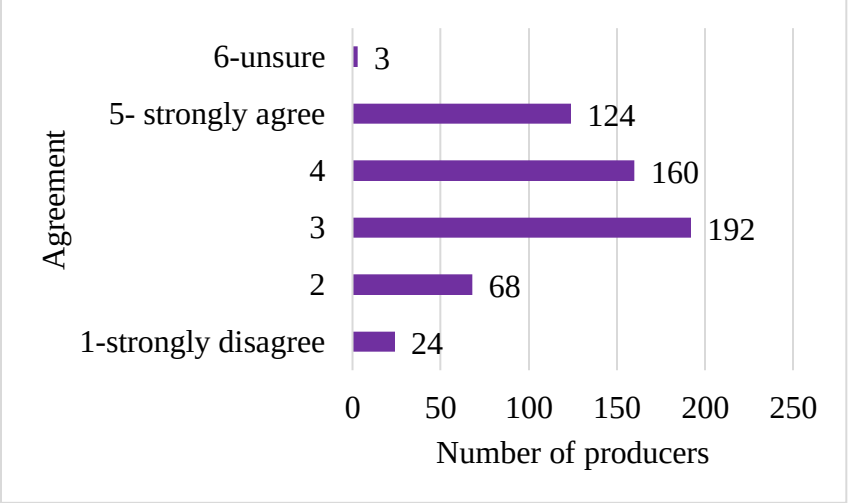


Figure 26 First to Implement a New Practice

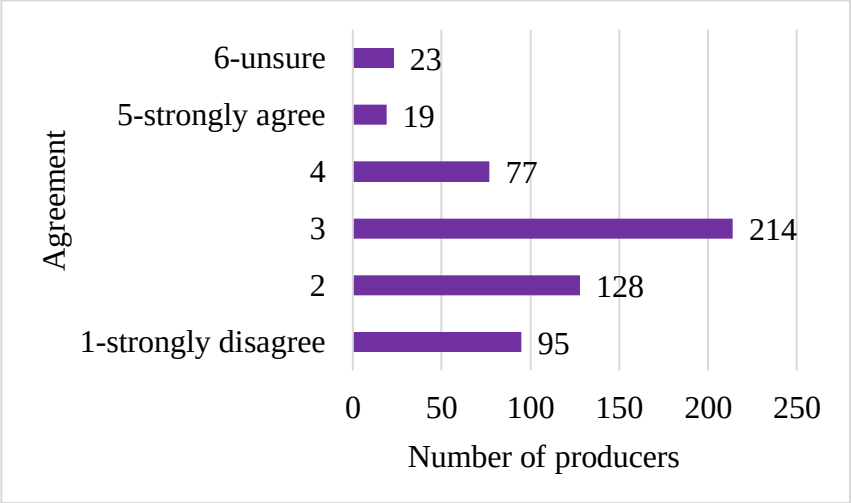
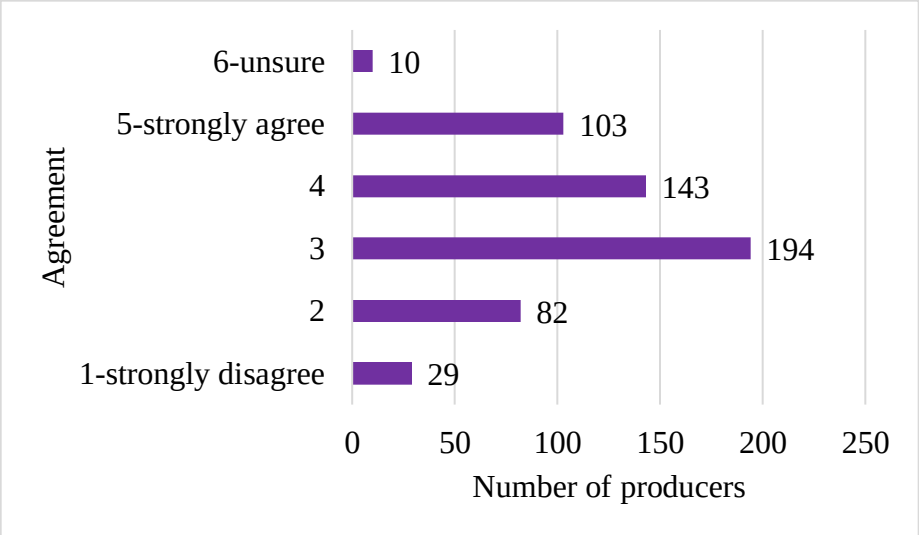


Figure 27 I Dislike Risk



The remainder of this document includes tables presenting additional response statistics which augment figures and in- text discussion that appeared earlier in the document.

Age	*What is your age?*				
	Mean	**SD**	**Min**	**Max**	**N**
	63.68	12.40	25	90	626

Education	*The best description of your education is:*	**Frequency %**	**N**
	Did not obtain a High School Diploma	2.52	16
	High School Diploma	39.94	254
	Technical training (certification or associates degree)	19.18	122
	Bachelor's Degree	27.67	176
	Graduate or Professional Degree (M.S., Ph.D., D.V.M., Law Degree)	8.81	56
	Other	1.89	12
	Total Responses		**636**

Gender	*I am:*	**Frequency %**	**N**
	Male	94.13	593
	Female	4.92	31
	Wish not to disclose	.95	6
	Total Responses		**630**

Experience	*How many years have you been raising cattle?*	**Frequency %**	**N**
	Less than 10 years	1.41	9
	11-20 years	6.25	40
	21-29 years	9.53	61
	30 years or more	82.81	530
	Total Responses		**640**

Income	*Please estimate your annual pre-tax household income:*	**Frequency %**	**N**
	Less than $25,000	5.10	28
	$25,000-$49,999	13.84	76
	$50,000-$74,999	16.03	88
	$75,000-$99,999	21.31	117
	$100,000-$124,999	14.21	78
	$125,000 or more	29.51	162
	Total Responses		549

Income from Cattle Operation	*Approximately what proportion of your household income is from the beef cattle operation?*	**Frequency %**	**N**
	Less than 25%	25.04	147
	26%-50%	29.47	173
	51%-75%	22.83	134
	76%-99%	13.97	82
	100%	8.69	51
	Total Reponses		565

Description of Operation	*How would you describe your operation?*	**Frequency %**	**N**
	100% stocker/ backgrounder	6.30	40
	Stocker/ backgrounder with cow-calf	44.41	282
	Stocker/ backgrounder with feedlot	8.19	52
	Stocker/ backgrounder with both cow-calf and feedlot	25.20	160
	Other	15.91	101
	Total Responses		635

State	*What is the primary state in which you operate?*	**Frequency %**	**N**
	Alabama	1.74	11
	Arkansas	2.05	13
	California	1.74	11
	Colorado	2.37	15
	Florida	1.10	7
	Georgia	1.58	10
	Iowa	8.04	51
	Idaho	1.26	8
	Illinois	3.63	23
	Indiana	1.26	8
	Kansas	8.83	56
	Kentucky	2.21	14
	Louisiana	0.63	4
	Michigan	0.95	6
	Minnesota	4.57	29
	Missouri	8.68	55
	Mississippi	0.95	6
	Montana	3.00	19
	North Carolina	0.63	4
	North Dakota	5.05	32
	Nebraska	9.94	63
	New Mexico	0.63	4
	New York	0.16	1
	Ohio	2.21	14
	Oklahoma	4.42	28
	Oregon	0.79	5
	Pennsylvania	0.63	4
	South Carolina	0.32	2
	South Dakota	7.10	45
	Tennessee	2.37	15

	Texas	4.89	31	
	Utah	0.79	5	
	Virginia	1.58	10	
	Vermont	0.32	2	
	Washington	0.63	4	
	Wisconsin	1.42	9	
	West Virginia	0.32	2	
	Wyoming	1.26	8	
	Total Responses			634

Head of Cattle	*How many cattle (# head) did your operation have in inventory at the following production stages on January 1st 2020?*	**Mean**	**SD**	**Min**	**Max**	**N**
	Cows	266.65	377.37	0	4010	506
	Calves	232.25	571.55	0	7000	416
	Yearlings	355.21	1225.40	0	20000	378
	Finished Cattle	451.10	1432.21	0	14000	168

Employees	*How many employees does your operation employ?*	**Frequency %**	**N**
	Less than 5	92.57	523
	5-14	6.02	434
	15-24	0.71	4
	25 or more	0.71	4
	Total Responses		**565**

Labor Wage	*What is your current average labor wage paid to employees (wage/ hour)?*	**Frequency %**	**N**
	Under $7.25	2.32	13
	$7.25-$11.99	17.29	97
	$12.00-$14.99	23.17	130
	$15.00-$17.99	15.51	87
	$18.00-$20.99	7.84	44
	$21.00 or more	1.96	11
	Non-applicable, I do not have paid employees	31.91	179
	Total Responses		**561**

Land Ownership	*Who owns the land or lot in which you raise the majority of your cattle? (select all that apply)*	**Frequency %**	**N**
	I lease the land from the government, school sections, etc.	2.55	18
	I lease the land from a private individual or other operation	18.81	133
	My family and/ or I own the land	77.93	551
	Other	0.71	5
	Total Responses		**707**

Cattle Source	*Referring to 2019, what percentage of cattle placed in your background/ stocker operation were sourced from each of the following sources:*	**Mean**	**SD**	**Min**	**Max**	**N**
	Retained from my own cow-calf operation	82.28	29.93	0	100	414
	Purchased from auction market without knowledge of source ranches	56.1	33.09	0	100	125
	Purchased from auction with knowledge of source ranches	40.77	31.85	0	100	93
	Purchased direct from individual cow-calf ranches	36.33	31.58	1	100	95
	Purchased from internet/video auctions	40.91	29.36	0	100	22
	Other	80	32.05	15	100	14
	Total Responses					**763**

Purchase Month	*What month do you typically purchase your cattle?*	***Frequency %***	*N*
	January	5.71	14
	February	2.45	6
	March	6.53	16
	April	6.53	16
	May	2.45	6
	June	2.04	5
	July	0.82	2
	August	2.86	7
	September	9.39	23
	October	17.96	44

	November	13.88	34
	December	13.47	33
	All year	15.92	39
	Total Responses		**245**

Buy Weight	*What weight do you typically buy your cattle?*				
	Mean	**SD**	**Min**	**Max**	**N**
	531.5	130.35	100	900	259

Sell Month	*What month do you typically sell your cattle?*	**Frequency %**	**N**
	January	10.67	43
	February	8.68	35
	March	10.42	42
	April	9.43	38
	May	5.96	24
	June	5.71	23
	July	2.98	12
	August	5.96	24
	September	7.44	30
	October	8.44	34
	November	9.18	37
	December	6.70	27
	All year	8.19	33

Sell Weight	*What weight do you typically sell your cattle?*				
	Mean	**SD**	**Min**	**Max**	**N**
	828.45	252.67	250	1650	412

Placement	*Once you place your cattle on grass or in a lot, do you usually:*	**Frequency %**	**N**
	Take them all out at the same time	42.57	232
	Take some out, and then the rest out at a later date	54.13	295
	Other	3.3	18
	Total Responses		**545**

Cattle Description	How would you describe the cattle you typically purchase? *(select all that apply)*	**Number of Responses**
	Black hided	334
	Colored	135
	Eared or some Brahman influence	31
	Purebred	71
	Crossbred	179

Management Time	*What is the total length of time you typically own/ manage most stocker/ backgrounders?*	**Frequency %**	**N**
	30 days or fewer	1.02	5
	31-60 days	4.29	21
	61-90 days	14.31	70
	91-120 days	15.13	74
	121-180 days	26.18	128
	More than 180 days	39.06	191
	Total Responses		**489**

Frequency and Seasonality	*What best describes the frequency and seasonality of your background/ stocker operation?*	**Frequency %**	**N**
	Typically place one set of feeder cattle in the Spring	17.07	85
	Typically place one set of feeder cattle in the Fall	38.76	193
	Typically place multiple	44.18	220
	Total Responses		**498**

Forage	*Referring to 2019, what percentage or your total stocker/backgrounder cattle were on each of the following and for how long?*					
		Mean	**SD**	**Min**	**Max**	**N**
	Cool season grass pasture *(brome, fescue, perennial, ryegrass, etc.)*					
	Average % of cattle	68.09	33.83	0	100	97
	Days	134.72	71.38	30	365	81
	Warm season grass pasture *(switchgrass, big bluestem, etc.)*					
	Average % of cattle	53.33	32.54	0	100	58
	Days	141.67	66.42	20	360	57
	Warm season annual *(annual planted specifically for cattle grazing, i.e. Sudan)*					
	Average % of cattle	48.73	37.17	6	100	11
	Days	110	42.43	30	180	9
	Fall cereal pasture *(cereal grain pastures such as winter wheat, oats or ryegrass)*					
	Average % of cattle	62.82	32.68	9	1000	28
	Days	127.14	44.81	30	180	28
	Dormant Winter feed *(stockpiled dormant forage and crop residue)*					
	Average % of cattle	63.08	30.43	10	100	26
	Days	114.81	72.50	30	365	27
	Dry lot *(bunk fed forage, confined management of harvested feed)*					
	Average % of cattle	88.10	23.63	10	100	189
	Days	176.09	100.30	30	460	140
	Other					

	Average % of cattle	93.62	15.97	50	100	13
	Days	208.3	151.28	60	540	10

ADG	*When placing cattle in your stocker/ backgrounder operation, what average daily gain (lbs./day) do you typically manage for?*	**Frequency %**	**N**
	Less than 1.26	2.53	12
	1.26-1.5	11.16	53
	1.51-1.75	15.79	75
	1.76 to 2.0	20.63	98
	2.01-2.25	28.21	134
	More than 2.25	21.68	103
	Total Responses		**475**

Stocking Rate Change	*Has your stocking rate changed in the last 5 years?*	**Frequency %**	**N**
	No	76.73	343
	Yes	23.27	104
	Total Responses		**447**

Stocking Rate	*What is your current stocking rate? (head/acre)*				
	Mean	**SD**	**Min**	**Max**	**N**
	19.14	59.94	0.03	500	279

Risk Management	*Which practices do you typically use to manage market or price risk? (select all that apply)*	**Number of Responses**
	Paying a premium to buy high quality cattle	108
	Focus on low cost production	246
	Buying lower priced cattle	68
	Retained ownership to the feed yard	127
	Forward contracting inputs/ outputs	48
	Futures market contracts	71
	Options on future market contracts	41
	Livestock Risk Protection (LRP) Insurance	12
	Livestock Gross Margin (LGM) Insurance	2
	Other	27

Marketing	*Referring to 2019, what percentage of cattle do you market using the following options:*	**Mean**	**SD**	**Min**	**Max**	**N**
	Retain ownership at the feedlot	79.63	31.13	0	100	147
	Sell directly to the feedlot	71.37	29.96	0	100	73
	Sell through a traditional auction market	84.28	29.10	2	100	274
	Sell through internet/ video auction	71.23	27.89	10	100	35
	Other	63.06	38.50	8	100	32
	Total Responses					**561**

Agreement	*Please rate your agreement with these statements (1-strongly disagree, 5- strongly agree, 6- unsure*	***Frequency %***	*N*
	I usually like playing it safe by doing what I have done for many years		
	1- strongly disagree	4.2	24
	2	11.91	68
	3	33.63	192
	4	28.02	160
	5- strongly agree	21.72	124
	6- unsure	0.53	3
	Total Responses		**571**
	During my time as a cattle producer, I have tried new technology		
	1- strongly disagree	3.87	22
	2	10.02	57
	3	25.83	147
	4	37.96	216
	5- strongly agree	21.09	120
	6- unsure	1.23	7
	Total Responses		**569**
	If there is a new practice, I want to be the first one to implement it in my operation		
	1- strongly disagree	17.09	95
	2	23.03	128
	3	38.49	214
	4	13.85	77
	5- strongly agree	3.42	19
	6- unsure	4.14	23
	Total Responses		**556**
	With respect to my conduct of business, I dislike risk		
	1- strongly disagree	5.17	29
	2	14.62	82
	3	34.58	194
	4	25.49	143
	5- strongly agree	18.36	103
	6- unsure	1.78	10
	Total Responses		**561**