EVALUATING PRODUCER DECISION MAKING SURROUNDING CALVING DATE IN THE U.S. SOUTHERN PLAINS

By

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EVALUATING PRODUCER DECISION MAKING

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Abstract: Calving date directly impacts cow-calf producers' profits, and indirectly effects the entire beef cow industry. January and February calving puts calves at risk for severe cold exposure. A calf exposed to winter weather can experience challenges related with growth and is more susceptible to diseases and lung problems. Frost damaged ears, tails, and legs may result in discounts at the sale barn.

This study evaluates cow-calf profit under varying calving dates using information from the perspective of producers, veterinarians, and feedlot operators. Researchers found March and April calving was more economically profitable than January and February calving. However, discounts for frost related issues were low in general. Though frost morbidity is not currently a major concern for Oklahoma producers, it may be more prevalent in the future with fluctuating weather patterns.

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CHAPTER I

INTRODUCTION

A cow-calf producer's calving date decision has many economically relevant implications for the operation. Calving date affects feed costs, calf weaning weights, calf health, and marketing objectives. Calving date also directly affects the value of both the cow and the calf, influencing profits (Grings et al., 2003). This study evaluates cow-calf profit under varying calving dates using information from the perspective of producers, veterinarians, and feedlot operators. Cattle producers, large animal veterinarians, and feedlot operators were asked questions such as: why a specific calving date is preferred, what discounts are expected at the sale barn for frozen extremities (ears, feet, and tails), and the potential health and economic ramifications for a cold-exposed calf in the feedlot. In this study, researchers hypothesize calves born in January or February have a higher probability of health problems, calves with cold exposure face discounts at the sale barn, calves with cold exposure perform poorly at the feedlot, and producers choose earlier calving dates because they desire a specific weight by a specific date.

Calving dates chosen by cow-calf producers impact the rest of the industry. Typically, producers calve in either a fall or spring season. In Oklahoma, spring calving is historically February through April (Selk, 2013). An early window, January or February, carries risk of low temperatures when calves are younger and vulnerable. Historically, Oklahoma experiences between 140 to 160 nights of freezing temperatures each year (Yu Media Group, 2020).

Oklahomans can experience freezing temperatures as early as October and as late as April with January being the coldest month (Yu Media Group, 2020). Calves born in January and February can experience snow and rain in addition to freezing temperatures (Oklahoma Climatological Survey, 2021).

Freezing temperatures are potentially detrimental to the health of younger calves. A cow in poor body condition can increase the likelihood and severity of calf cold stress (Smith Thomas, 2018). If newborn calves do not nurse within four hours, they can experience adverse effects that are heightened in colder weather (Hall, 2001, Smith Thomas, 2018). Olson et al. (1980) found that cold stress in calves does not substantially affect the quantity of colostrum absorbed, but the rate of absorption is greatly decreased. Newborn calves require the antibodies in colostrum to protect against diseases. If they do not get sufficient and timely colostrum, the possibility of morbidity increases (Olson et al., 1980). Cold-stressed calves can be more susceptible to diseases and lung problems (Olson et al., 1980; Jaja et al., 2016). A calf exposed to winter weather can also experience some challenges associated with growth (Young, 1981). It has been shown that when calves are kept healthy while nursing, they are healthier during the later stages of the production chain (New et al., 2020). Therefore, profit varies with calving date due to calf weaning weight and the possibility of cold weather driven morbidity.

Beyond the potential health of the calf, calving date also impacts the alignment of the cow's nutritional needs versus available forage at different stages in her production cycle (Funston et al., 2016). Spring born calves are customarily weaned late summer or early fall (Curry and Beirmacher, 2016). However, calves born in January or February can be weaned and sold mid-summer. Oklahoma native grasses, like little bluestem, are grazed into September (Tober and Jensen, 2013). By selling calves early, some producers do not take full advantage of their forage resources. Also, cow-calf producers may have to supplement cows toward the end of gestation when the nutritional needs of the cow are high, and the availability and quality of the native range is low. A 1,000-pound cow in the last third of pregnancy needs 21 pounds of dry

matter intake (DMI) each day (Lalman and Richards, 2017). However, a 1,000-pound cow in the first 90 days postpartum needs 26-27 pounds of DMI per day (Lalman and Richards, 2017). These DMI values assume an unstressed cow, meaning one not experiencing heat or cold stress. A cold-stressed cow requires additional nutrients to maintain body condition. Therefore, there are economic benefits to aligning calving date with peak forage production, including reducing feed costs. On the other hand, cow-calf producers could have an advantage of selling weaned calves at seasonal high prices. For producers who sold calves in Oklahoma City over the last five years, July and December have resulted in the highest revenues (USDA Livestock & Grain Market News, 2019).

The desire to sell a heavier calf by a set date may result in producers calving earlier, when the risk of bad winter weather is still high. The probability of adverse health outcomes, which can result in issues for the cow-calf producer, is considered against the monetary upside of selling heavier calves. Laudert (2011) reported calves exhibiting illness received major discounts at the sale barn. Williams et al. (2012) quantified these discounts at $32.79 per cwt, and Mallory et al. (2016) quantified them at $27.06 per cwt. The average discount for unhealthy calves based on these two studies was $29.93 per cwt. Calves with visible injuries, like frost bitten extremities, were deemed “unhealthy.” Health had the greatest influence on prices (Mallory et al., 2016; Williams et al., 2012).

The impact of calving date on health and final weight is economically important to the cow-calf producer. Such problems affect the profitability of the animal for other segments of the industry as well. For example, Fulton et al. (2002) found that calves entering the feed yard healthy are more likely to have higher average daily gains than calves that enter the feed yard unhealthy (Fulton et al., 2002). McNeill et al. (2001) found that sick calves gained 0.32 lb per head per day less than healthy calves. Furthermore, the net return was almost $90 per head less for sick calves than calves that never required medical care while in the feed yard (McNeill et al., 2001). Calves that require medical care also have less desirable carcass grades (Fulton et al.,

2002; McNeill et al., 2001). Additionally, sick calves perform poorly at the feedlot in terms of mortality, morbidity, and rate of gain (Fulton et al., 2002).

1.1 Problem Statement and Objectives

There is a need to determine the impact of winter calving on Oklahoma producers, as calving date affects profits. The objectives of the research detailed here are:

1) Assess producers', veterinarians', and feedlot operators' perceptions of the likelihood of frost-induced health issues in beef calves born on various dates in Oklahoma. Three surveys were created to target producers, veterinarians, and feedlot operators. Each group was asked about their perceptions of frost related issues.

2) Analyze the economic impact of calving date on producer profitability. The annualized net returns will be compared across a series of calving weeks to determine the most profitable calving period.

CHAPTER II

METHODOLOGY

2.1 Survey Instruments

Three surveys were created using Qualtrics, an online survey design tool, with the intention of targeting Oklahoma beef cattle producers, veterinarians, and feedlot operators. The data was collected to inform the economic model, and to add context to modeled results. This research was approved by Oklahoma State IRB number IRB-20-330 (Appendix 1c). Data were collected from July 27, 2020, to September 30, 2020. Researchers relied on snowball sampling to obtain survey respondents. The launch of the surveys was announced in an OSU press release, which was housed on all OSU Agriculture websites. This press release was also picked up by several local newspapers and other agriculture related online publications. The information on how to participate in the surveys was featured in various OSU agricultural newsletters and email blasts. Additionally, Facebook and Twitter posts were made on OSU agriculture related accounts[1]. The veterinarian survey was sent to large animal accredited veterinarians in Oklahoma through a list provided by the Oklahoma State University College of Veterinary Medicine. The feedlot survey was sent to a list of feedlots provided by the American Angus Association (Angus, 2020).

For each survey, there was a screening question to ensure respondents were completing

[1]Specific features: OSU Farm Management, OSU Extension, Master Cattlemen Newsletter, Oklahoma Cattlemen's Newsletter, Oklahoma Cattlemen's Association, DASNR press prelease, Cow/calf corner newsletter

the correct survey. If an individual indicated they were not part of the target group, they were unable to continue. For example, individuals who accessed the veterinarian survey were first asked if they were a veterinarian before continuing the survey. Demographic questions such as gender, age, household income, and education were included in all surveys. Any individual who expressed they were under 18 years old were not allowed to continue past the demographics section of the survey. A test of proportions was completed in Stata (2021) to determine if there were statistically significant differences between the producer demographics and the U.S. Census of Agriculture (USDA-NASS[7], 2017). Each survey offered the opportunity for the respondent to provide additional comments at the end.

In the producer survey, researchers asked the number of years on their present farm or ranch or operating any farm or ranch, the number of years the producer owned cattle, and the number of head of cattle the producer owned. Response options were designed to match the U.S. Census of Agriculture for ease of comparison (USDA-NASS[6], 2017; USDA-NASS[7], 2017). Respondents who did not calve heifers or cows within their operation, or who did not calve primarily in Oklahoma were prevented from continuing the survey. Producers were then asked when their calving season was and why they chose it. The survey included a series of questions related to frozen ears, tails, and legs. Questions included visual identification of frozen extremities on their own cattle, perception of frozen extremities, perception of discounts at the sale barn, and expectation of health problems in the future. Final questions included what actions respondents took if their calves were born in colder months and cold exposure was an issue.

The veterinarian survey included questions such as where the veterinarian completed their degree and their practice mix between small and large animal clients. It was assumed all veterinarians have an advanced degree, so they were not asked their education level. Veterinarians were asked the percentage of their business dedicated to cattle in terms of total patients or clients and the number of cattle they worked with annually. If the veterinarian indicated they did not practice on cattle, they did not continue the survey. Veterinarians that

worked with cattle were asked the percentage of calves they saw with frozen ears, tails, or legs. Questions regarding the average cost of a farm visit to examine and assess the veterinary needs of an animal, and the average cost of treating a cold exposed calf including medication, treatment, or procedure were included.

Respondents of the feedlot survey were asked the capacity of their feedlot in terms of number of cattle and how many years they had been in the business. They were also asked a series of questions related to frozen ears, tails, and legs. Questions included whether frozen extremities could be seen in their feedlot, if frozen extremities were a problem, and if cattle with frozen extremities performed poorly in the feedlot. Economic considerations included, if the feedlot paid less for calves with frozen extremities, and if they avoided purchasing calves with freeze damage. If discounts for cold exposure were routine, the feedlot operator provided the amount and why a discount was given.

Researchers used Stata, a statistical software, to analyze the percentage of respondents who selected responses for each question within the three surveys (Stata, 2021). The percentages of respondents from the producer survey were statistically compared to the U.S. Census of Agriculture for certain demographics using the test of proportions (Acock, 2018). Additional calculations such as mean responses were calculated as needed.

2.2 Economic Analysis

To determine the profit maximizing calving date, the following equation was used:

$$\max_{Date} \epsilon[\pi|Date] = \sum_{Age=2}^{10}[0.5 \times steerWgt(age) \times (steerPrice(wgt) - probDisc(date) \times disc(date)) + 0.5 \times heiferWgt(age) \times (heiferPrice(wgt) - probDisc(date) \times disc(date)) \times (1 - retention\ \%) + cull\ heifer\ revenue \times \#\ cull\ heifers + cull\ cow\ revenue \times \#\ cull\ cows(age) - bull\ cost - feed\ cost(age) - veterinary\ cost - medication\ cost] \times cows(age) \quad (1)$$

$$s.t. Date\ \epsilon \{Jan.15, Jan.22, Jan.29, Feb.5, Feb.12, Feb.15, Feb.19, Feb.26, Mar.5,$$

$Mar.12, Mar.15, Mar.19, Mar.26, Apr.2, Apr.9, Apr.15, Apr.16, Apr.23, Apr.30\}$

Calving date *D* is defined as January 15, January 22, January 29, February 5, February 12, February 15, February 19, February 26, March 5, March 12, March 15, March 19, March 26, April 2, April 9, April 15, April 16, April 23, or April 30. The expected profit with respect to calving date *D* is a sum across cow age 2 to cow age 10. $steerWgt(age)$ is the weight of a steer with respect to cow age, $steerPrice(wgt)$ is the sale barn price of the steer with respect to weaning weight, $probDisc(D)$ is the percentage of the calf crop that has frost damage at calving date D, $disc(D)$ is the actual discount at calving date D, $heiferWgt(age)$ is the weight of a heifer with respect to cow age, $heiferPrice(wgt)$ is the sale barn price of the heifer with respect to weaning weight. $(1 - retention\ \%)$ is the percent of heifers retained for breeding purposes, $cull\ heifer\ revenue$ is the revenue from selling cull heifers, $\#\ cull\ heifers$ is the amount of heifers culled, $cull\ cow\ revenue$ is the revenue from selling cull cows, $\#\ cull\ cows(age)$ is the number of cows culled with respect to cow age, $bull\ cost$ is the amount of bull cost on a per-cow basis, $feed\ cost(age)$ is the feed cost incurred with respect to cow age, $veterinary\ cost$ is the price per hour for veterinarian assistance, $medication\ cost$ is the price per unit of medication required, and $cows(age)$ is the number of cows in each cow age group.

Researchers used GAMS, an algebraic modeling system, to complete the economic analysis (GAMS, 2020). Calving date was informed by the producer survey. Researchers analyzed calving dates of January 15 to April 30 in one week increments. The weaning weight model from Westbrook et al. (2019) derived from Bir et al. (2018) was used to create weaning weights for steers and heifers from 1999 to 2017 based on cows aged 2-10. A mature cow weight of 1,300 pounds and a calf crop comprised of 50% steers and 50% heifers were assumed (Bir et al., 2018). LMIC (2020) data was used to determine prices for feeder steers and heifers. Prices were used from the weight classes 300-350 to 850-900 assuming a midpoint for each range. Forage availability from Westbrook et al. (2019) was used. Raper (2020b) survey data determined

the average age at weaning for January, February, March, and April born calves. It was assumed the weaning ages were 9.04 months for January born calves, 7.80 months for February born calves, 7.70 months for March born calves, and 7.50 months for April born calves (Raper, 2020b). Weaning age was then used to determine sell date assuming no preweaning. Weaning percentage per cow exposed was assumed to be 89.8% (Raper, 2020a). Calf revenue was determined based on the weight of the calf and the sale price for each year, cow age, sex of the calf, calving date, and weaning percentage. Discounts for frost exposure were included based on producer and feedlot operator perceptions, informed by the producer and feedlot surveys. Researchers assumed a heifer retention rate of 20% (Bir et al., 2018).

Cull heifer revenue was informed by LMIC data (2020). Cull heifers were assumed to be first calf heifers that did not breed with a weight of 845 pounds (Bir et al., 2018). The LMIC data expressed heifer revenue in groupings of 50-pound increments, with weights ranging from 300 pounds to 850 pounds. For example, heifers from 800-850 pounds were in one bracket. To determine the cull price for heifers weighing 845 pounds, researchers used the midpoint of each bracket to calculate a one-pound increase equivalent. The highest weight class price available was divided by the second highest weight class price available, producing a "slide." The slide was added to the price of an 825 pound heifer for each year to determine the price of a cull heifer at the target weight of 845 pounds for each year. Missing values were calculated by assuming a discount from steers to heifers and then adding that discount to the missing years.

The herd distribution was informed by Bir et al. (2018) modeled from Azzam et al. (1990) and the cull rate at each age was adapted from Munson et al. (2020). Cull cow price was informed by LMIC (2020) at each calving date assuming cull cows were sold when calves were sold. Cull cow revenue was determined given cow weight, cull price, cull rate, and herd percentage for each year, cow age, and calving date. Producer Price Index (PPI) for agriculture was informed by the U.S. Bureau of Labor Statistics (2021). PPI was used to convert historical

data to current values. Thus, years prior to 2017 were updated to match 2017 values. Total revenue was determined from calf revenue, cull cow revenue, cull heifer revenue, and PPI.

The feed cost of a cow-calf operation at calving date D is given as:

$$FeedCost_{it}|Date = \left(Cubes_{it} \times CubePrice_t + Hay_{it} \times 1.20 \times HayPrice_t + \frac{Forage_{it}}{ForageYield} \times \frac{1}{.25} \times Rental\ Rate\right) \quad (2)$$

Where the feed cost is the cost of feed for cow-calf pair *i* in year *t* with respect to calving date D, $Cubes_{it}$ expresses the quantity of cubes for pair *i* in year *t*, $CubePrice_t$ is the price of cubes in year *t*, Hay_{it} is the quantity of hay given pair *i* and year *t*, the number 1.20 expresses hay loss, $HayPrice_t$ expresses the price of hay in year *t*, $Forage_{it}$ expresses the amount of available forage for pair *i* in year *t*, $ForageYield$ expresses the amount of forage produced in pounds per acre, .25 expresses the forage utilization, and $Rental\ Rate$ expresses the cost of renting land.

USDA data was used for the price of hay (USDA-NASS[1], 2020), wheat (USDA-NASS[2], 2021), cottonseed (USDA-AMS, 2021), and corn (USDA-NASS[3], 2021). The National Agricultural Statistics Service was also used for forage yield in Payne County (USDA-NASS[5], 2021), and rental rate assuming cash rent on pastureland (USDA-NASS[4], 2021). USDA-ERS (2020) was used for the price of molasses, which contributed to the price of the range cube using Kansas City data. The molasses data (USDA-ERS, 2020) was missing values between 1999-2007 and 2014-2017. Researchers determined the correlation between molasses and corn (USDA-NASS[3], 2021) and applied the value to the missing years. A 20% protein cube was assumed with 65% wheat midds (USDA-NASS[2], 2021), 30% cottonseed (USDA-AMS, 2021), and 3% molasses (USDA-ERS. 2020) based on Bir et al. (2018).

Using the ration determination tool, CowCulator (Lalman et al., 2020), annual forage, hay, and cube requirements were found assuming a January, February, March, and April calving month. It was assumed no forage was consumed in December, January, and February. Cube price (USDA-NASS[2], 2020; USDA-AMS, 2020; USDA-ERS, 2020) was multiplied by the cube

requirement for each age to determine the total cube cost. The 1.20 hay loss factor assumed a round bale with a rack (Angus Beef Bulletin, 2012). Hay price (USDA-NASS[1], 2020) was multiplied by the hay requirement (Lalman et al., 2020) for each age. Hay cost was found by multiplying hay fed, hay loss, and hay price. Forage requirement was divided by forage yield for Payne County Oklahoma (USDA-NASS[5], 2021) and then divided by the utilization rate (25%) to determine forage amount needed in acres. Forage cost was determined by the number of acres required based on year, age of the cow, and calving date multiplied by the rental rate. Feed cost was determined given cube cost, hay cost, and forage cost for each year, cow age, and calving date. Total cost for each calving date was determined based on feed cost, forage cost, the percentage of the herd at each age, and PPI. Researchers assumed an annual veterinary cost of $25 per cow, and an annual bull cost of $50 per cow (Munson et al., 2020). No fixed costs were assumed.

Percentage of frost damage observed in calves by producers was informed by the producer survey. Answer choices “0-10” and “11-20” for each month were analyzed. Researchers assumed most producers were indicating on the lower side of both bounds based on the distribution of answers. Therefore, the data used in the analysis was skewed left to 2.5% and 12.5%. For veterinary costs, veterinarian survey responses were used. The average for a veterinary call was approximately $70, and $5.70 for medication costs. Per the veterinarian survey, 48% of producers do not typically seek veterinary assistance with frost related issues. Researchers assumed producers not seeking frost assistance were those experiencing 2.5% calf crop frost exposure and those needing veterinary assistance (52%) were experiencing 12.5% calf crop frost exposure. Therefore, the veterinary costs were multiplied by the probability that a producer saw frost damage in their cattle as indicated in the producer survey with respect to each calving month. The cost of a veterinary call and medication costs were then added together. The probabilities of producers who saw frost damage in their cattle were weighted by calving month based on answers choices indicated in the producer survey. Veterinary costs were multiplied by

the frequency of frost injured calves for each month assuming again, that producers who selected "11-20" were the ones requesting veterinary assistance. An expected veterinary cost per cow for each of the four calving months was then determined.

Researchers calculated expected damages for each calving month using the producer's anticipated discount rate and the feedlot operators' anticipated discount rate. Expected cow-calf producer damages and expected feedlot damages were both determined based on their respective perceived risk of a sale barn discount, the amount of the discount, percent of frost damage seen, and the percent of producers who saw frost damage for each calving month. The annualized returns per head to the producers using both the feedlot operators' and producers' anticipated discount rates were calculated and compared.

2.2.1 Frost Exposure Sensitivity Analysis

Researchers performed a sensitivity analysis on the percentage of frost damage seen by producers from the producer survey. Answer choices "0-10" and "11-20" were originally assumed to be skewed left to 2.5% and 12.5%. This is interpreted as assuming 48% of the time 2.5% of the herd experienced frost damage and 52% of the time 12.5% of the herd experienced frost damage. Researchers re-estimated the analysis a second time assuming 48% of the time 1.5% of the herd experienced frost damage and 52% of the time 11.5% of the herd experienced frost damage in order to compare annualized return per head. The probabilities of producers who saw frost damage in their cattle were weighted by calving month based on answer choices indicated in the producer survey. The analysis was performed a third time assuming 48% of the time 1.0% of the herd experienced frost damage and 52% of the time 11.0% of the herd experienced frost damage. The probability of producers who saw frost damage in their cattle were weighted by calving month based on answers choices indicated in the producer survey. These analyses were based on the assumption that producers were potentially indicating a lower value within the answer choice than researchers originally hypothesized.

2.2.2 Cube Price Sensitivity Analysis

A sensitivity analysis was then performed on cube price. The cube price per pound used was significantly less than industry standards (Tractor Supply Co, 2021). For example, the cube price used in the analysis for 2017 resulted in $4.15 for a 50-pound bag of feed. However, that cost is roughly three times less than the feed store price. Because prices in this study were simulated, some variability was lost. Therefore, a sensitivity analysis increasing cube price was necessary. Cube price was increased in five cent increments to $0.12, $0.17, and $0.22 in 2017. PPI was then used to deflate the prices to use for previous years.

CHAPTER III

RESULTS

3.1 Survey Results

3.1.1 Demographics

Of the 205 respondents who accessed the producer survey, 175 completed the survey. Ninety-seven percent of producers said a majority of their bred cows and heifers were located primarily in Oklahoma during their calving season. Respondents who selected "Oklahoma" were the only ones allowed to proceed with the survey. Seven hundred twenty-one veterinarians were contacted via the list provided by the Oklahoma State University College of Veterinary Medicine. Of those, 20 individuals were unreachable, or indicated they were not large animal veterinarians. Ninety-eight people accessed the veterinarian survey and 68 completed the survey. Eleven percent of respondents acknowledged they worked with 0% cattle each year and were not allowed to proceed with the survey. The feedlot list from the American Angus Association provided 21 contacts. Researchers were not able to contact six operations. Seven feedlot operators accessed the feedlot survey and six completed it.

In the producer survey, 73% of the respondents were male and 27% were female (Table 1). Both were statistically significantly different from the U.S. Census of Agriculture at 62% and 38%, respectively as indicated in Table 1 (USDA-NASS[7], 2017). Sixty-seven percent were male and 33% were female in the veterinarian survey (Table 1). All respondents in the feedlot survey were male (Table 1). The percentage of total respondents in the producer survey (n=205) deviated slightly from the U.S. Census of Agriculture in regards to age (USDA-NASS[7], 2017). The survey

had slightly higher percentages of people aged 18-24 and 25-34 and slightly lower percentages of people aged 55-64 and 65-74 compared to the U.S. Census of Agriculture (USDA-NASS[7], 2017) (Table 1). The percentage of total respondents in the veterinarian survey (n=78) indicated a large percentage of people aged 25-34, 45-54, and 55-64 (Table 1).

Annual pre-tax, household income for respondents of the producer, veterinarian, and feedlot surveys were primarily $100,000+ (40%, 56%, 67%, respectively) (Table 1). Many producer and feedlot survey respondents attended college and graduated with a bachelors, associates, or trade degree earned (49%, 67%, respectively) (Table 1). The secondary response for each survey was a graduate or advanced degree (31%, 33%, respectively) (Table 1). Sixty-seven percent of producers have been on their present farm or ranch for 10+ years and 77% have been operating any farm or ranch for 11+ years. Neither result was statistically significantly different from the U.S. Census of Agriculture (68%, 70%, respectively) (USDA-NASS[7], 2017) (Table 1).

Table 1. Cattle producers, large animal veterinarians, and feedlot operators, reported demographics. Percentage of total respondents.

Demographics	Survey Type			
	Census	Producer n=205	Veterinarian n=78	Feedlot n=6
Gender				
Male	62	73†	67	100
Female	38	27†	33	0
Age				
18-24	2	5†	0	0
25-34	8	13†	29	0
35-44	13	17	14	0
45-54	18	20	19	50
55-64	26	20†	15	17
65-74	21	16†	14	33
75+	12	9	8	0
Annual pre-tax, household income				
$0-$25,000		3	5	0
$25,001-$50,000		10	5	17
$50,001-$75,000		19	13	0
$75,001-$100,000		28	21	17
$100,001+		40	56	67

Table 1 Continued. Cattle producers, large animal veterinarians, and feedlot operators, reported demographics. Percentage of total respondents.

Demographics	Survey Type			
	Census	Producer n=205	Veterinarian n=78	Feedlot n=6
Education				
Did not graduate from high school		1		0
Graduated from high school, did not attend college		7		0
Attended college, no degree earned		12		0
Attended college, bachelor's (B.S. or B.A.), associates, or trade degree earned		49		67
Graduate or advanced degree (M.S., Ph. D, Law school).		31		33
Years on present farm/ranch				
2 or less	7	6		
3-4	9	7		
5-9	16	19		
10+	68	67		
Years operating any farm/ranch				
5 or less	16	10†		
6-10	14	13		
11+	70	77		
I own ___ head of cattle				
1-9	19	5†		
10-19	18	7†		
20-49	27	19†		
50-99	15	28†		
100-199	11	18†		
200-499	8	16†		
500-999	2	4		
1,000-2,499	1	3		
2,500-4,999	0	0		
5,000+	0	0		

†Indicates the percentage of producers is statistically different than the U.S. Census of Agriculture at the 0.05 level

Many of the responses for the number of head of cattle producers owned were significantly different than the U.S. Census of Agriculture (USDA-NASS[6], 2017). The percentage of producers owning 1-9, 10-19, and 20-49 head of cattle was lower in this survey than the U.S. Census of Agriculture (USDA-NASS[6], 2017) (Table 1). The percentage of producers owning 50-99, 100-199, and 200-499 head of cattle was higher in this survey than the U.S. Census of Agriculture (USDA-NASS[6], 2017) (Table 1). When veterinarians indicated how many cattle they worked with each year, the top answers were 500-1,000, 2,501-5,000, and 5,001-10,000 (Table 2). The capacity of feedlots varied (Table 2).

Table 2. Size of operation for cattle producers, large animal veterinarians, and feedlot operators. Percentage of total respondents.

I own ___ head of cattle. Percentage of producers n=202		I work with ___ cattle each year. Percentage of veterinarians n=74		The capacity of my feedlot is___ head of cattle. Percentage of feedlots n=6	
1-9	5	100 or less	7	500 or less	17
10-19	7	101-250	12	501-1,000	0
20-49	19	251-500	7	1,001-2,500	0
50-99	28	501-1,000	15	2,501-5,000	0
100-199	18	1,001-2,500	8	5,001-10,000	17
200-499	16	2,501-5,000	15	10,001-25,000	17
500-999	4	5,001-10,000	14	25,001-50,000	17
1,000-2,499	3	10,001-25,000	9	50,001-75,000	17
2,500-4,999	0	25,001-50,000	3	75,001-100,000	0
5,000+	0	50,001-75,000	1	100,001+	17
		75,001-100,000	3		
		100,001+	7		

Respondents to the producer survey were primarily from Payne, Noble, and Kay counties in Oklahoma (8%, 8%, 5%, respectively) (Table a1). A high number of Payne County respondents was expected as Oklahoma State University is in Payne County. Of the veterinarians who completed the survey, 83% received their veterinarian degree from Oklahoma State University. This was also expected, as the contact list was obtained from the Oklahoma State University College of Veterinary Medicine and veterinarians were restricted to those actively practicing in Oklahoma.

3.1.2 Cattle

When producers indicated their calving season, 81% chose March, 59% chose April, and 55% chose February (Table 3). Reasoning included their grazing management strategy, marketing strategy, and convenience (58%, 52%, 29%, respectively) (Table 3). Producers chose their calving season based on convenience primarily due to the timing with their other farm enterprises and the timing with their off-farm job (34%, 30%, respectively) (Table 3).

Table 3. Producer calving season and rationale. Multiple selections allowed. Percentage of respondents.

My calving season is: Average of total respondents n=185		I chose this calving season because: Average of total respondents n=185		Please select the answer choices that best describe why your chosen calving date is most convenient for you. Average of total respondents n=70	
January	22	I want a certain weight at an earlier date	12	The timing works best with my off-farm job	30
February	55	It is convenient for me	29	The timing works best with my other farm enterprises	34
March	81	There is no planning involved in my decision	5	The timing coincides with when I have seasonal labor	9
April	59	It is what my family has always done	17	Other (please specify)	27
May	31	I view this as the norm in the business	14		
June	11	The date is part of my grazing management strategy	58		
July	5	The date is part of my marketing strategy	52		
August	12	The date is part of my risk management strategy	25		
September	38	Other (please specify)	14		
October	39				
November	24				
December	11				

Of the producers who calved in January (n=40), the majority said it was because of their marketing strategy, secondarily because of their grazing management strategy, and lastly because it is what their family has always done (58%, 45%, 28%, respectively) (Table 4). Producers who calved in February (n=101), March (n=149), and April (n=110) had similar reasoning. Each producer, regardless of calving date, ranked grazing management strategy first (58%, 57%, 56%, respectively), marketing strategy second (55%, 54%, 44%, respectively), and convenience third (29%, 29%, 33%, respectively) (Table 4). It should be noted that some producers indicated they calved in all twelve months.

Thirty-eight percent of veterinarians said they defined their practice as large animal, while 49% selected mixed practice. Only 13% indicated their practice was small animal[2]. Forty-six percent indicated cattle made up less than half of their practice in terms of total patients or clients and 43% answered cattle made up more than half of their practice in terms of total patients or clients.

3.1.3 Frost Exposure

When asked about producers own experience with cold exposure, 97% selected they saw "0%-10%" of their calf crop with frozen ears, tail, and legs. This indicates that while cold exposure is a problem, many Oklahoma producers do not experience it. Of the 174 producers who were asked what they did if they saw cold exposure in their calves, 15% reported they retained ownership until the calf reached a heavier weight, and 1% got a certificate from their veterinarian ensuring future buyers their calves were healthy. Seventy-four percent said they did not see problems with cold exposure.

When producers were asked what they did if they calved in the colder months, producers who calve in January (n=40) and February (n=101) had similar strategies. Each group answered they provided windbreaks for their cows (63%, 50%, respectively), they provided bedding for

[2]Although these veterinarians indicated their practice was small animal, they also indicated they saw at least some cattle as part of their regular practice.

Table 4. Producer rationale by month. Multiple selections allowed. Average of respondents.

	Month producer calves												
	Jan. n=40	Feb. n=101	Mar. n=149	Apr. n=110	May n=58	Jun. n=20	Jul. n=9	Aug. n=22	Sep. n=71	Oct. n=73	Nov. n=44	Dec. n=21	Total n=185
I choose this calving season because___. Multiple selections allowed, average of total respondents n=185													
I want a certain weight at an earlier date	23	19	13	10	5	5	0	14	8	7	14	24	141
It is convenient for me	23	29	29	33	17	25	33	27	37	32	34	24	342
There is no planning involved in my decision	5	5	5	5	10	20	22	5	6	7	9	14	113
It is what my family has always done	28	23	18	18	19	10	11	9	15	21	27	38	237
I view this as the norm in the business	20	17	15	13	9	10	11	5	8	10	16	10	142
The date is part of a grazing management strategy	45	58	57	56	50	45	33	45	54	58	48	29	578
The date is part of my marketing strategy	58	55	54	44	31	20	33	68	65	59	45	24	556
The date is part of my risk management strategy	25	27	26	25	26	15	0	18	27	34	36	33	293
Other (please specify)	13	10	14	20	21	20	11	9	14	12	9	14	167
If my calving season is in the colder months, I __. Multiple selections allowed, average of total respondents n=185													
Provide windbreaks for my cows	63	50	46	41	36	25	56	59	45	45	45	57	569
Provide bedding for my cows to calve	33	26	20	15	12	5	22	32	25	29	30	24	272
Calve in a barn to limit the cold exposure	18	12	12	9	9	5	33	23	14	16	14	14	179
Put the calf in my vehicle to warm them	13	21	23	21	19	10	11	18	15	18	16	10	194
Provide the calf with warm colostrum or fluids	23	18	17	15	12	15	22	18	21	22	16	14	212
Put the calf in warm water	3	2	3	4	3	0	0	9	3	3	2	5	37
Towel dry the calf	28	26	24	18	17	15	33	32	25	26	23	19	286
I do not calve in months when cold exposure is an issue	0	10	23	35	47	40	11	14	27	22	23	10	259
I do not do any of these things	23	24	18	15	12	20	22	18	17	16	16	14	215
Other (please specify)	13	13	9	7	3	0	0	5	7	8	9	14	89

their cows (33%, 26%, respectively), and they towel dried the calf (28%, 26%, respectively) (Table 4). However, 23% of producers who calved in January and 24% of producers who calved in February said they do not do anything if they calve in cold weather (Table 4). Additionally, 10% of producers who calved in February said they do not calve in months when cold exposure is an issue.

Of the veterinarians who worked with cattle (n=67), 73% saw frozen ears, tails, and legs on 0%-2% of the calves they worked with and 21% saw frozen ears, tails, and legs on 3%-5% of the calves they worked with (Table a2). Ten percent of the veterinarians who worked with 501-1,000 cattle, saw frost exposure in 0%-2% of the cattle they worked with (Table a2). Nine percent of the veterinarians who worked with 101-250, 5,001-10,000, and 10,001-25,000 cattle saw frost exposure in 0%-2% of the cattle they worked with (Table a2). One percent of the veterinarians who worked with 501-1,000 cattle saw frost exposure in 12%-20% of the cattle they worked with (Table a2).

Producers and feedlot operators were also asked various questions regarding their perceptions about frozen ears, tails, and legs (Table 5). Respondents answered on a scale of 1-5, with 1 being they strongly disagreed with the statement and 5 being they strongly agreed with the statement. Producers had a mean of 1.6 regarding if they saw frozen ears, tails, and legs on their cattle (Table 5). Feedlot operators had a mean of 2 regarding if they see cattle with frozen ears, tails, and legs (Table 5). Producers and feedlot operators were somewhat neutral on whether frozen ears, tails, and legs are a problem. Producers had a mean score of 2.6, while feedlot operators had a mean score of 3.2 (Table 5). However, producers view the possibility of discounts at the sale barn as a greater danger than feedlot operators do. Regarding discounts at the sale barn due to frost exposure, producers had a mean of 3.6. Feedlot operators had a mean score of 2.8 on if they would pay less for cattle with frost exposure (Table 5). Producers and feedlot operators were similar in opinions about whether frost exposure would lead to potential health problems in the future; producers had a mean of 3.1, while feedlot operators had a mean of 3 (Table 5).

Feedlot operators had a mean score of 2.7 regarding if they expect cattle with frost exposure to perform poorly in the feedlot compared to their counterparts (Table 5). For the statement they avoided purchasing calves with freeze damage, feedlot operators had a mean of 2.8 (Table 5).

Table 5. On a scale of 1-5 where 1 is "I strongly DISAGREE with this statement" and 5 is "I strongly AGREE with this statement" beliefs of producers and feedlot operators. Percentage of total respondents.

Question	Score					
	1	2	3	4	5	Mean
I see frozen ears/tails/legs on my cattle/cattle coming through my feedlot						
Producer						
n=186	62	23	9	5	1	1.6
Feedlot						
n=6	17	67	17	0	0	2
Frozen ears/tails/legs are a problem						
Producer						
n=186	28	23	22	13	13	2.6
Feedlot						
n=6	17	17	17	33	17	3.2
Frozen ears/tails/legs lead to discounts at the sale barn/I pay less for cattle with frozen ears/tails/legs						
Producer						
n=186	6	10	26	30	28	3.6
Feedlot						
n=6	17	17	33	33	0	2.8
Frozen ears/tails/legs lead to potential health problems in the future						
Producer						
n=186	12	19	35	21	13	3.1
Feedlot						
n=6	0	33	50	0	17	3
I expect cattle with frozen ears/tails/legs to perform poorly in the feedlot compared to their counterparts						
Feedlot						
n=6	17	33	17	33	0	2.7
I avoid purchasing calves with freeze damage						
Feedlot						
n= 6	17	17	33	33	0	2.8

Twenty-five percent of all producers (n=186) expect to receive no discount at the sale barn for frozen ears, tails, and legs, 19% expect to receive a $0.01-$1.00/cwt discount, and 18% expect to receive a $1.01-$5.00/cwt discount (Table 6). Feedlot operators' opinions varied on the discount producers can expect to receive for cold exposure (Table 6). Feedlot owners acknowledged their reason for discounting as decreased performance, poor gains or worse feed conversion, and mobility problems (20% for each).

Table 6. The expected discount per cwt for frozen ears, tails, and legs at the sale barn. Percentage of cattle producers and feedlot operators.

I expect to receive a ___ discount per cwt at the sale barn for frozen ears/tails/legs/a producer can expect to receive a ___ discount per cwt from me for cold exposure	Producer n=186	Feedlot n=6
$0.00	25	17
$0.01-$1.00	19	17
$1.01-$5.00	18	17
$5.01-$10.00	8	0
$10.01-$15.00	11	17
$15.01-$20.00	4	0
$20.01-$25.00	1	17
$25.01-$30.00	2	17
$30.01-$35.00	1	0
$35.01-$40.00	0	0
$40.01-$45.00	1	0
$45.01-$50.00	0	0
$50.01+	1	0
I do not sell cattle at the sale barn	9	

Large animal veterinarians reported what the average producer could expect to pay for a farm call visit, examination of an animal, and the assessment not including medication. Twenty-seven percent of respondents said they charged $51-$75, 25% said $76-$100, and 21% said $101+. Additionally, large animal veterinarians reported what the average producer could expect to pay to treat a cold exposed calf including any medication, treatment, or procedure but not including the original examination fees. Thirty-nine percent of respondents indicated the cost was $6.01+ per calf. However, 48% reported producers typically did not ask for additional help regarding frozen ears, tails, and legs and 7% reported they do not prescribe medication for frozen ears, tails, and legs.

3.2 Model Results

Researchers found total revenue was highest for the calving week of April 23rd, and lowest for the calving week February 12th (Table 7). Calf revenue was also highest for the calving week of April 23rd, and lowest for the calving week of February 12th (Table 7). However, cull cow revenue was highest for the calving week of February 5th, and lowest for the calving weeks

of March 26th and April 2nd. While low in general, cull heifer revenue was highest for the calving week of April 16th, and lowest for the calving weeks of January 15th, January 22nd, February 19th, February 26th, and March 5th (Table 7). Total cost was highest throughout January and lowest throughout April (Table 7). Pasture cost was also highest throughout January, but lowest throughout March (Table 7). Feed cost was highest throughout January and lowest throughout April (Table 7). Expected damages using the producer's anticipated discount rate was highest throughout January, and lowest throughout April (Table 7). However, expected damages using the feedlot operators' anticipated discount rate was highest throughout January, and lowest throughout March (Table 7).

Annualized returns per head using the producers' and feedlot operators' anticipated discount rates were both highest for the calving week of April 23rd, and lowest for the calving week of February 12th (Table 7). There was nearly a $60 difference in annualized return per head between the two weeks. The difference in annualized return per head using the two anticipated discount rates was $0.18 throughout January, $0.17 throughout February, $0.16 throughout March, and $0.16 throughout April.

3.2.1 Frost Exposure Sensitivity Analysis

After performing the frost-based sensitivity analysis assuming 48% of the time 1.5% of the herd experienced frost exposure and 52% of the time 11.5% of the herd experienced frost exposure, the producer's and the feedlot operators' annualized returns per head were highest for the calving week of April 23rd, and lowest for the calving week of February 12th (Table 7). The average difference between the two was $0.12 throughout January, $0.11 throughout February, $0.10 throughout March, and $0.11 throughout April.

The frost-based sensitivity analysis assuming 48% of the time 1.0% of the herd experienced frost exposure and 52% of the time 11.0% of the herd experienced frost exposure using the producer's and the feedlot operators' discount rates, resulted in annualized returns per head being highest for the calving week of April 23rd, and lowest for the calving week of

February 12th (Table 7). The average difference between the two was $0.09 in January, $0.08 in February, $0.07 in March, and $0.08 in April.

3.2.2 Cube Price Sensitivity Analysis

Cube price had a considerable impact on feed costs, and as a result, annualized return per head based on the producers' anticipated discount rates. In January, annualized return per head decreased roughly $60 with a cube price of $0.12, $100 with a cube price of $0.17, and $175 with a cube price of $0.22 (Table 7). In April, annualized return per head decreased roughly $20 with a cube price of $0.12, $75 with a cube price of $0.17, and $135 with a cube price of $0.22 (Table 7).

Table 7. Model results from the economic analysis.

	J15[1]	J22	J29	F5	F12	F19	F26	M5	M12	M19	M26
Base Model-2.5% and 12.5%[2]											
Total Revenue	840.66	850.59	845.62	849.52	838.75	840.66	850.59	850.59	845.62	850.33	853.05
Calf Revenue	633.13	641.52	640.27	634.75	630.72	633.13	641.52	641.52	640.27	646.31	652.17
Cull Cow Revenue	197.92	199.47	195.72	205.13	198.38	197.92	199.47	199.47	195.72	194.18	191.22
Cull Heifer Revenue	9.61	9.61	9.64	9.64	9.65	9.61	9.61	9.61	9.64	9.84	9.66
Total Cost	509.72	509.72	509.72	504.77	504.77	504.77	504.77	493.39	493.39	493.39	493.39
Pasture Cost	165.57	165.57	165.57	169.38	169.38	169.38	169.38	183.15	183.15	183.15	183.15
Feed Cost	344.16	344.16	344.16	335.38	335.38	335.38	335.38	310.24	310.24	310.24	310.24
Annual Veterinary Cost	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Bull Cost	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Expected Veterinary Cost	0.25	0.25	0.25	0.15	0.15	0.15	0.15	0.1	0.1	0.1	0.1
Expected Damages-Producer	0.161	0.161	0.161	0.15	0.15	0.15	0.15	0.145	0.145	0.145	0.145
Expected Damages-Feedlot	0.338	0.338	0.338	0.316	0.316	0.316	0.316	0.304	0.304	0.304	0.304
Annualized Return per Head-Producer	255.53	265.46	260.49	269.45	258.68	260.60	270.53	281.96	276.99	281.66	284.38
Annualized Return per Head-Feedlot	255.35	265.28	260.31	269.29	258.52	260.43	270.36	281.80	276.83	281.50	284.22
Frost Exposure Sensitivity Analysis-1.5% and 11.5%[3]											
Annualized Return per Head-Producer	255.58	265.51	260.54	269.51	258.74	260.65	270.58	282.01	277.04	281.71	284.43
Annualized Return per Head-Feedlot	255.46	265.40	260.42	269.40	258.63	260.54	270.48	281.91	276.94	281.61	284.33
Frost Exposure Sensitivity Analysis-1.0% and 11.0%[4]											
Annualized Return per Head-Producer	255.61	265.54	260.57	269.53	258.76	260.68	270.61	282.04	277.07	281.74	284.46
Annualized Return per Head-Feedlot	255.52	265.45	260.48	269.46	258.68	260.60	270.53	281.97	277.00	281.67	284.39
Cube Price Sensitivity Analysis-0.12[5]											
Annualized Return per Head-Producer	192.19	202.13	197.16	244.81	234.03	235.95	245.88	260.18	255.21	259.88	262.60
Cube Price Sensitivity Analysis-0.17[6]											
Annualized Return per Head-Producer	155.79	165.73	160.75	170.02	159.25	161.16	171.10	194.10	189.12	193.79	196.51
Cube Price Sensitivity Analysis-0.22[7]											
Annualized Return per Head-Producer	80.78	90.71	85.74	95.24	84.47	86.38	96.32	128.01	123.04	127.71	130.43

Table 7 Continued. Model results from the economic analysis.

	A2	A9	A16	A23	A30
Base Model-2.5% and 12.5%[2]					
Total Revenue	853.05	855.31	865.75	873.90	869.95
Calf Revenue	652.17	654.25	662.86	668.43	665.11
Cull Cow Revenue	191.22	191.40	192.97	195.65	195.10
Cull Heifer Revenue	9.66	9.66	9.93	9.82	9.74
Total Cost	480.52	480.52	480.52	480.52	480.52
Pasture Cost	179.96	179.96	179.96	179.96	179.96
Feed Cost	300.56	300.56	300.56	300.56	300.56
Annual Veterinary Cost	25.00	25.00	25.00	25.00	25.00
Bull Cost	50.00	50.00	50.00	50.00	50.00
Expected Veterinary Cost	0.14	0.14	0.14	0.14	0.14
Expected Damages-Producer	0.149	0.149	0.149	0.149	0.149
Expected Damages-Feedlot	0.313	0.313	0.313	0.313	0.313
Annualized Return per Head-Producer	297.24	299.50	309.94	318.09	314.14
Annualized Return per Head-Feedlot	297.07	299.33	309.78	317.92	313.98
Frost Exposure Sensitivity Analysis-1.5% and 11.5%[3]					
Annualized Return per Head-Producer	297.29	299.55	309.99	318.14	314.20
Annualized Return per Head-Feedlot	297.19	299.45	309.89	318.04	314.09
Frost Exposure Sensitivity Analysis-1.0% and 11.0%[4]					
Annualized Return per Head-Producer	297.32	299.58	310.02	318.17	314.22
Annualized Return per Head-Feedlot	297.24	299.50	309.94	318.09	314.15
Cube Price Sensitivity Analysis-0.12[5]					
Annualized Return per Head-Producer	278.15	280.41	290.85	299.00	295.06
Cube Price Sensitivity Analysis-0.17[6]					
Annualized Return per Head-Producer	220.25	222.51	232.95	241.09	237.15
Cube Price Sensitivity Analysis-0.22[7]					
Annualized Return per Head-Producer	162.34	164.60	175.04	183.19	179.24

[1]Each calving month is abbreviated with its first letter, and calving weeks are indicated with the subsequent numbers.

[2]Researchers assumed 48% of the time 2.5% of the herd experienced frost damage, 52% of the time 12.5% of the herd experienced frost damage.
[3]Researchers assumed 48% of the time 1.5% of the herd experienced frost damage, 52% of the time 11.5% of the herd experienced frost damage.
[4]Researchers assumed 48% of the time 1.0% of the herd experienced frost damage, 52% of the time 11.0% of the herd experienced frost damage.
[5]Researchers assumed a cube price of $0.12 in 2017, and deflated prices for previous years based on PPI.
[6]Researchers assumed a cube price of $0.17 in 2017, and deflated prices for previous years based on PPI.
[7]Researchers assumed a cube price of $0.22 in 2017, and deflated prices for previous years based on PPI.

CHAPTER IV

DISCUSSION

The USDA Animal and Plant Health Inspection Service (APHIS) performed a survey in 2017 about cow-calf management practices in the United States and found similar results to the producer survey. In their survey, Oklahoma was included in the west region. They found 31.9% of the producers in their survey calved in January, 48.6% calved in February, 64.6% calved in March, and 59.1% calved in April (USDA-APHIS, 2020). Researchers also found March to be the most popular calving month, with April and February at second and third, respectively. The calving percentage for the west region was 80.2% for heifers, and 92.6% for cows (USDA-APHIS, 2020). The heifer calving percentage found by APHIS (2017) was significantly lower than the percentage researchers used in this analysis (89.8%). However, the cow calving percentage used was similar.

In the USDA-APHIS (2020) survey, the most popular reasoning behind calving date was tradition. The second most popular answer was weather, and the third most popular answer was grazing management strategy. In the producer survey, tradition was the third most popular answer for January producers, and the fifth most popular answer for February, March, and April producers. However, grazing management strategy was the second most popular answer for January producers, and the most popular answer for February, March, and April producers. In the producer survey marketing strategy was the most popular answer for January producers and the second most popular answer for February, March, and April producers. Marketing strategy was the fourth most popular answer in the USDA-APHIS (2020) survey. The differences in results

could be because the USDA-APHIS survey categorized at the regional level, not at the individual state level. Additionally, using the snowballing survey collection method, researchers found some statistical differences between the results found and the U.S. Census of Agriculture. There could be some variability lost because of the non-representative sample. However, researchers believe the sensitivity analysis conducted helps account for how production differences found in a more representative survey would impact the results found.

Based on the results, calving in March and April is more economically profitable than calving in January and February. Survey results show March and April were the most popular calving months (Table 3). Therefore, many Oklahoma producers are behaving in a profit maximizing way. However, March was the most popular calving month chosen by producers (Table 3), but the second most profitable (Table 7). April was the second most popular calving month (Table 3), but it was the most profitable (Table 7).

There are many hurdles associated with calving in the winter. Though costs associated with frost damage are low, feed costs are higher for cows calving in January and February when compared to cows calving in March and April. Feed costs, specifically cube costs, impact profitability by month. The sensitivity analysis performed on cube price increased cube price to $0.22 per pound, which was most similar to feed store prices (Tractor Supply Co, 2021). Increasing cube cost considerably impacted annualized returns per head. Profit maximizing producers must also be cost minimizing.

Another concern associated with winter calving includes cost of labor, which is a necessary consideration. As shown in table 4, providing windbreaks, bedding, and towel drying calves add to the cost of labor for January and February producers. To prevent death loss, Dewell et al. (2021) suggests windbreaks or well ventilated facilities for winter calving. They also advise placing a newborn calf in warm water or a heating box (Dewell et al., 2021). There is an increased fuel cost of driving to each pasture to care for animals. The cost of supplies is also not captured in this model. While veterinary costs are low in general, they were significantly higher

in January. Only 6% of all veterinarians practice on large animals (Radke, 2021). In 2019, 44 states had a veterinarian shortage, primarily in rural areas (Radke, 2021). In the future, the cost of service calls could increase. On the other hand, producers could be less willing to make a service call, resulting in more morbidity issues.

Survey results indicated some producers lack knowledge on the significance of winter calving. Ten percent of producers who calve in February indicated they did not calve in months when cold exposure was an issue (Table 4). Those producers are potentially either located in southern Oklahoma, or one who indicated year-round-calving. In that case, their answer choice would be applied to the February results. Researchers also acknowledge the majority of their calving may not occur in February, or it may be spread out across multiple months. In that case, winter calving would be more manageable, but still not more profitable.

Producers and feedlot operators were somewhat neutral on whether frozen ears, tails, and legs are a problem (Table 5). The similarity between the annualized return per head based on producer and feedlot operator discount perceptions indicates both groups have access to the same market data, and it is good data. However, cold stress should be taken seriously. Cold stress may lead to pneumonia, which can cause lung damage (Jaja et al., 2016). Damaged lungs are condemned at the slaughterhouse resulting in a significant monetary loss (Jaja et al., 2016).

Producers do not ask for veterinarian assistance for healthy calves. Therefore, veterinarians disproportionately hear about the consequences of winter calving due to the nature of their work. However, this study proves cold stress is not a major concern for most Oklahoma producers. Nevertheless, shifting weather patterns (Sommer et al., 2020) could change decision making in the future. Weather directly effects the beef cattle industry, because it influences production (Patalee and Tonsor, 2021). There was a significant increase to labor costs in February 2021 in Oklahoma due to an unprecedented snowstorm (Stotts, 2021). Many producers worked long days to provide constant food, water, and shelter for their cattle. There was an increase in feed cost associated with the colder weather (Stotts, 2021). Furthermore, the death loss was

speculated to be 15-20%, a dramatic increase from the number assumed in the model of 10.2% (Stotts, 2021).

The producers who choose to calve in January and February are not profit maximizing. However, many non-economic factors may drive decision making. For example, producers may find a certain calving season works best with their off-farm job, despite potential increased labor associated with winter calving. Other producers may base their calving decisions around other farm operations such as crops, or seasonal activities. Such considerations were not included in the model. Additionally, Oklahoma has a somewhat diverse climate and producers have varying risk preferences regarding weather. Different areas of the state experience a mix of weather during the first few months of the year. Producers also have personal, off-farm factors that relate to on farm decision making. Winter weather should be considered when making calving decisions, especially as weather patterns shift and cold winters increase in intensity. Ultimately, each producer must choose the calving season that works best for their operation while trying to maximize profits.

CHAPTER V

CONCLUSIONS

Few studies have addressed the economic impact of winter calving. Considering recent winter weather affecting the U.S. Southern Plains in 2021, this research is timely. This research builds on previous work regarding calving date as an important economic decision. This study included three surveys, one each of beef cattle producers, large animal veterinarians, and feedlot operators. Each group was asked their perception on cold related issues in beef calves, such as frozen ears, tails, and legs. Questions on the producer survey included percentage of calf crop with morbidity issues and the expected discount at the sale barn. Questions on the veterinarian survey included typical service call and medication costs and the frequency of seeing morbidity issues. Questions on the feedlot survey included perceived discounts and reasoning behind the discounts.

Survey results were used to inform a GAMS model. The model computed annualized returns per head per calving month, using producer and feedlot operator perceptions on frost discounts. Results indicated that March and April calving was a better option than January and February calving. Feed costs are significantly higher in January and February compared to March and April. Given the assumption of our analysis, producers calving in the late spring months are behaving in the most economically profitable way. Producers calving in January and February should consider changing their calving season to capture more profits. However, researchers acknowledge many non-economic factors influence calving decisions.

Extension educators should continue informing producers on the dangers of winter

calving. They should also educate producers on best practices to use if they choose to calve in the winter including providing shelter and additional care. Further research could include a follow up survey following the February 2021 snowstorm. Recency bias may change results on perceived economic losses associated with early calving in Oklahoma.

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APPENDICES

Table a1. Cattle producers reported county of residence. Percentage of total respondents.

Which county in Oklahoma do you live in?					
Adair	0	Grant	1	Nowata	2
Alfalfa	0	Greer	0	Okfuskee	0
Atoka	2	Harmon	1	Oklahoma	2
Beaver	0	Harper	0	Okmulgee	2
Beckham	1	Haskell	1	Osage	1
Blaine	0	Hughes	1	Ottawa	0
Bryan	2	Jackson	0	Pawnee	3
Caddo	0	Jefferson	3	Payne	8
Canadian	0	Johnston	0	Pittsburg	1
Carter	3	Kay	5	Pontotoc	0
Cherokee	0	Kingfisher	2	Pottawatomie	0
Choctaw	0	Kiowa	1	Pushmataha	0
Cimarron	0	Latimer	0	Roger Mills	3
Cleveland	1	Le Flore	1	Rogers	0
Coal	0	Lincoln	2	Seminole	0
Comanche	1	Logan	2	Sequoyah	0
Cotton	0	Love	0	Stephens	1
Craig	0	McClain	0	Texas	0
Creek	1	McCurtain	0	Tillman	1
Custer	1	McIntosh	1	Tulsa	2
Delaware	0	Major	2	Wagoner	1
Dewey	0	Marshall	0	Washington	0
Ellis	1	Mayes	1	Washita	0
Garfield	0	Murray	1	Woods	1
Garvin	4	Muskogee	2	Woodward	1
Grady	4	Noble	8		

Table a2. Reported percentage of frost exposure seen by veterinarians. Percentage of total respondents n=67.

I work with ___ cattle a year	0%-2%	3%-5%	6%-8%	9%-11%	12%-20%	21%+
100 or less	6	0	0	0	0	0
101-250	9	0	0	0	0	0
251-500	7	0	0	0	0	0
501-1,000	10	3	0	0	1	0
1,001-2,500	6	1	1	0	0	0
2,501-5,000	6	9	0	0	0	0
5,001-10,000	9	3	0	1	0	0
10,001-25,000	9	0	0	1	0	0
25,001-50,000	3	0	0	0	0	0
50,001-75,000	0	1	0	0	0	0
75,001-100,000	1	1	0	0	0	0
100,001+	6	1	0	0	0	0

Appendix 1c. IRB Approval

Oklahoma State University Institutional Review Board

Date:	07/16/2020
Application Number:	IRB-20-330
Proposal Title:	Understanding the decisions and implications of beef cattle producer calving date
Principal Investigator:	Courtney Bir
Co-Investigator(s):	Amanda Upton, ERIC DEVUYST
Faculty Adviser:	
Project Coordinator:	
Research Assistant(s):	
Processed as:	Exempt
Exempt Category:	

Status Recommended by Reviewer(s): Approved

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in 45CFR46.

This study meets criteria in the Revised Common Rule, as well as, one or more of the circumstances for which continuing review is not required. As Principal Investigator of this research, you will be required to submit a status report to the IRB triennially.

The final versions of any recruitment, consent and assent documents bearing the IRB approval stamp are available for download from IRBManager. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be approved by the IRB. Protocol modifications requiring approval may include changes to the title, PI, adviser, other research personnel, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms.
2. Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3. Report any unanticipated and/or adverse events to the IRB Office promptly.
4. Notify the IRB office when your research project is complete or when you are no longer affiliated with Oklahoma State University.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact the IRB Office at 405-744-3377 or irb@okstate.edu.

Sincerely,
Oklahoma State University IRB

VITA

Amanda Jo Upton

Candidate for the Degree of

Master of Science

Thesis: EVALUATING PRODUCER DECISION MAKING SURROUNDING CALVING DATE IN THE U.S. SOUTHERN PLAINS

Major Field: Agricultural Economics

Biographical:

Education:

Completed the requirements for the Master of Science in Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma in July, 2021.

Completed the requirements for the Bachelor of Science in Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma in 2019.

Experience:

Graduate Research Assistant
Department of Agricultural Economics, Oklahoma State University, 2020-2021

Undergraduate Teaching Assistant
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Undergraduate Teaching Assistant
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Professional Memberships:

Phi Kappa Phi