BEEF PRODUCERS' MOTIVATIONS, PERCEPTIONS AND WILLINGNESS TO ADOPT ADAPTIVE MULTI-PADDOCK GRAZING

By

McKenna Elizabeth Clifford

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Agricultural, Food and Resource Economics–Master of Science

2020

ABSTRACT

BEEF PRODUCERS' MOTIVATIONS, PERCEPTIONS AND WILLINGNESS TO ADOPT ADAPTIVE MULTI-PADDOCK GRAZING

By

McKenna Elizabeth Clifford

A newer, more environmentally friendly best management practice (BMP) adaptive multi-paddock (AMP) grazing focuses on grazing cattle in a way that improves animal and forage productivity while potentially sequestering more soil organic carbon than other grazing methods (Stanley et al., 2018). AMP is an intense grazing style in which lightweight, portable fencing systems are used to move animals strategically around a large pasture, allowing for dense grazing interspersed by long periods of recovery for the land. Current AMP research is limited and focused on the environmental and production benefits of the practice. It is unknown what producers know or think about AMP or their willingness to adopt (WTA). The purpose of this thesis is to better understand current utilization, knowledge, perceptions, and WTA AMP. We find most producers (78%) already know of AMP (78%) or are familiar with the concept (17%). Additionally, one-third of our sample self-identifies as AMP grazers and 62% would frame AMP as a BMP. Using a single bounded dichotomous choice question, we find producers are willing to adopt AMP for a $12.96 per hundredweight premium (or cost reduction). Recognizing BMP adoption among beef producers remains lower than anticipated (Prokopy et al., 2008), current findings focus on the effect of socioeconomic factors on adoption and reasons for adopting or not. In effort to lead more effective adoption of AMP, and BMPs broadly, we step back to analyze why beef producers have implemented their current management practices. Using latent class models, we find heterogeneity in producer motivations. "Passing on the land," "enjoying life," "maximize profit," and "caring for the land" all surfaced as the most important motivation for at least one producer class.

ACKNOWLEDGEMENTS

I would like to thank my committee members, Dr. Melissa G.S. McKendree, Dr. Jennifer Hodbod, Dr. Christopher A. Wolf and Dr. Robert Myers for their contribution to my thesis and overall positive experience at Michigan State University.

Melissa, thank you for your constant support and encouragement. I appreciate you always being there for me, believing in me and investing in me as a researcher and a person. Amelia is very blessed to have someone as loving and encouraging raising her!

To my family, thank you for your unconditional love and support through every endeavor I set my eyes on. You all mean the absolutely world to me and I am so blessed to call you family. I couldn’t imagine starting the next chapter of my life anywhere other than back home with each and every one of you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

Agricultural producers, much like every American, make decisions daily that have lasting impacts on the world we live in. Unlike most Americans however, agricultural producers rely on the utilization of natural resources and the environment to provide for themselves and their families while supplying food, fuel, and fiber needs around the world. As stewards of the land, it is important producers manage their operations and make management decisions with potential environmental consequences in mind. Luckily, through the adoption of best management practices (BMPs) producers can mitigate negative environmental impacts while increasing enterprise productivity and profitability. Producers see themselves as caretakers and stewards of the land, hoping to leave the land better than when they found it (Quinn and Halfacre, 2014). However, adoption of BMPs remains low across agricultural sectors including the beef industry where adoption rates are relatively lower than other agricultural enterprises (Kim et al., 2005).

This trend in BMP adoption is problematic for the beef industry as agriculture accounts for 10% of total U.S. greenhouse gas (GHG) emissions with a significant portion, roughly 24%, coming from beef production alone (USEPA, 2018; Li et al., 2016). Changes in beef cattle production however, specifically grazing management, can reduce U.S. agricultural GHG emissions (Li et al., 2016). Grazing managers and scientists have implemented various forms of grazing management for sustainability and regeneration, with mixed results. "The [grazing] approach with the most promise (and debate about its effectiveness) is one that combines complexity or systems thinking with creative, adaptive management to manage the distribution of grazing over time, across landscapes, and plant communities, using planned movement of livestock through a series of paddocks: strategic or adaptive multi-paddock (AMP) grazing management." (Teague and Barnes, 2017).

AMP grazing, a regenerative grazing strategy emerging from Holistic Management (HM), is a values-based approach to decision making developed in the 1960s by Allan Savory (Savory 1998). HM can be thought of as a "triple bottom line" approach to food and fiber production because it explicitly requires attention to ecological, economic, and social/personal factors (Gosnell et al., 2020). HM posits that degraded grasslands can be restored by both mimicking wild herds through strategic planned grazing of domestic livestock herds and encouraging the return of deep-rooted perennial plants that soak up carbon, create organic material, and allow soil to hold more water (Savory 1998). Within HM is the strategy of Holistic Planned Grazing, also referred to as cell grazing, intensive rotational grazing, multi-paddock adaptive grazing, strategic planned grazing, etc. Sherren and Kent (2019) and Gosnell et al. (2020) discuss how the broader literature on these strategies has yielded neutral/mixed views, at times leading to acrimonious debate. To avoid some of this debate in the positioning of AMP grazing as a BMP, in recent years researchers have begun to use the language of AMP, instead of language associated with HM (Teague et al., 2015).

In these more recent studies framed around AMP grazing and particularly it's ecological impacts, AMP has been found to improve animal and forage productivity, increase water infiltration, reduce water runoff, and potentially sequester more soil organic carbon than other grazing methods (Park et al., 2017; Stanley et al., 2018). Specifically, switching from heavy continuous grazing to AMP grazing has been found to reduce average annual surface runoff, sediment, total nitrogen and total phosphorus loads by 39%, 34%, 33%, and 31%, respectively (Park et al., 2017). AMP grazing also has the potential to offset GHG emissions through soil carbon sequestration, and therefore the finishing phase could be a net carbon sink (Stanley et al., 2018). Stanley et al. (2018) find that when accounting for soil organic carbon, finishing GHG emissions from AMP grazing reduced from 9.62 to -6.65 kg CO_{2-e} kg carcass weight $(CW)^{-1}$, compared to feedlot-finished emissions which increased slightly from 6.09 to 6.12 kg CO_{2-e} kg CW^{-1}.

These benefits are accomplished by using lightweight, portable fencing systems to move animals strategically within a large pasture, allowing for dense grazing interspersed by long periods of recovery for the land. The profound environmental and production benefits of AMP grazing have the potential to reduce the beef industry's environmental footprint and increase enterprise productivity – bettering the beef industry and producers. However, due to the relatively recent introduction of AMP grazing language (Teague et al., 2015) and the niche utilization of Holistic Planned Grazing before the introduction of AMP grazing, little is known regarding the beef industry's perceptions or willingness-to-accept (WTA) the grazing style.

A multi-disciplinary research project based out of Arizona State University is currently analyzing how AMP grazing increases farm resilience, contributes to carbon sequestration, improves soil biodiversity, impacts animal well-being and productivity, and influences farmer well-being and overall operation economics. Findings in this thesis are a part of Module 8: Farmer/Rancher well-being, including analyzing the economic benefits of AMP grazing (Figure 1.1). Exploration of AMP grazing's economic implications was two pronged. First, in-person interviews with five pairs of AMP grazers and conventional grazers in the Southeast U.S. were conducted to construct enterprise budgets for each operation. This was done in effort to determine if economic profitability differed between the two grazing styles. Unfortunately, the small sample size paired with significant differences in financial record keeping and overall operation set up and style resulted in inconclusive results. This effort did however result in a publicly available enterprise budgeting tool which allows producers of all grazing styles to calculate their economic profitability. Additionally, producers can use the tool to examine how switching grazing styles financially impacts their operation. The second component of exploring AMP grazing's economic implications includes a national online survey focused on beef producer motivations for current management practices, grazing management classification, knowledge and perceptions of AMP grazing, and willingness to adopt AMP grazing for a monetary benefit – analyses in this thesis are based on data collected from the national survey. This work was supported by the VF Foundation, Wrangler, and Timberland and any opinions, findings, and conclusions expressed in this material are those of the author(s).

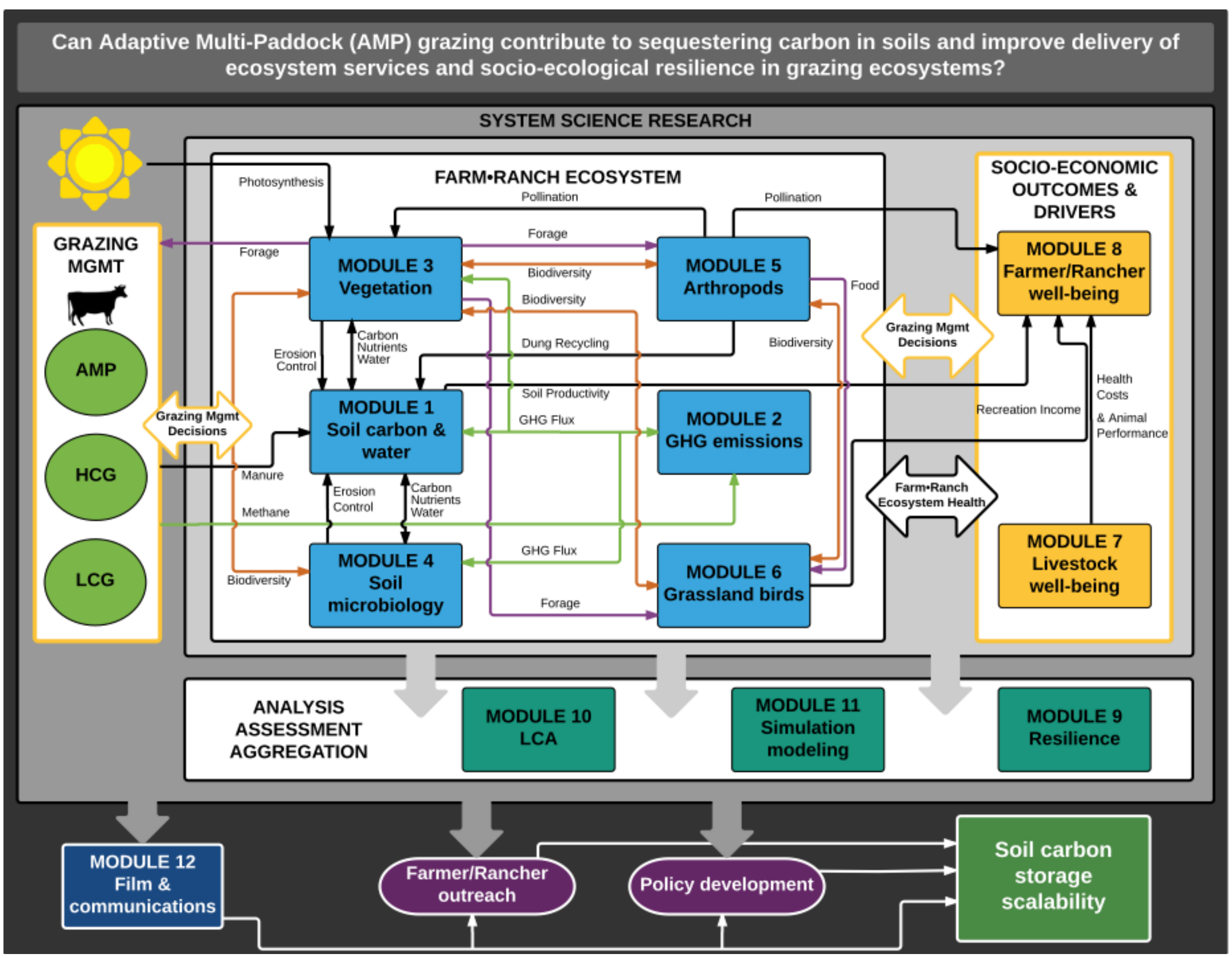

Figure 1.1 Diagram of Modules for Adaptive Multi-Paddock Grazing Research Project

The long run goal of this thesis is to increase AMP grazing adoption throughout the beef industry. In order to accomplish this long run goal, there are three specific objectives. First, to lead more effective BMP adoption broadly, we need to better understand what motivates beef producers when making management decisions. This understanding has the potential to increase BMP adoption through the industry and can also help in AMP grazing adoption specifically. Second, we seek to investigate beef producers currently identifying as AMP grazers. This objective will help identify who should be targeted for AMP grazing adoption and challenges to adopting AMP grazing. Finally, we need to understand how non-AMP grazers perceive AMP grazing including if they frame AMP grazing as a BMP, what expected challenges hinder their adoption of AMP grazing, and how a monetary benefit would impact their likeliness to adopt. These individual objectives are accomplished within this thesis' three primary essays (Chapters 2-4).

Chapter 2 outlines a summary of responses from the survey instrument along with the creation of two indexes measuring beef operations' riskiness and progressiveness. These indexes are used to gain insight on producer motivations, adoption of AMP grazing, and WTA AMP grazing. Chapter 3 explores heterogeneity in beef producer motivations for current management practices to potentially explain why BMP adoption has been lower than anticipated and lead BMP, along with AMP grazing, adoption strategies. Chapter 4 investigates beef producer utilization, knowledge, perceptions, and WTA AMP grazing. This analysis provides insight on the beef industry's understanding of the grazing style, including knowledge and perception gaps, in addition to their willingness to adopt AMP grazing. Chapter 5 provides a summary of all findings.

Chapters 2, 3 and 4 are written as standalone chapters as they are to be published independently of one another. Chapter 2, Summary Statistics, will be published as a staff paper to make the basic survey results widely available to key stakeholders, funders, and the general public.

Chapters 3 and 4 will be submitted for review to academic journals. Thus, repetition in data collection and sample demographics is commonly found among the three chapters.

CHAPTER 2: SUMMARY STATISTICS

2.1 Introduction

Environmental impacts of agricultural production can be intense and widespread. Uniquely, agriculture has the potential to impact surrounding environments, communities, and people both positively and negatively. Implementation of best management practices (BMPs) can increase positive impacts while mitigating the negative ones. BMPs are intended to minimize environmental consequences of agricultural production while increasing operation profitability (Paudel et al., 2008). They are also backed by research to be the most effective, environmentally sustainable, and long-term economically efficient way to manage an agricultural enterprise (Gillespie et al., 2007; Paudel et al., 2008).

A newer BMP within the beef industry focuses on grazing cattle in a way that improves animal and forage productivity, increases water infiltration and reduces water runoff while potentially sequestering more soil organic carbon than other grazing methods (Park et al., 2017; Stanley et al., 2018). This BMP, adaptive multi-paddock (AMP) grazing, is an intensive grazing style in which lightweight, portable fencing systems are used to move animals strategically around a large pasture, allowing for dense grazing interspersed by long periods of recovery for the land. AMP grazing is commonly grouped with other adaptive grazing methods such as Holistic Management, High-Intensity Short Duration Grazing, and Management-Intensive Grazing (Mann and Sherren, 2018). However, AMP grazing is the grazing approach with the most promise for sustainability and regeneration (Teague and Barnes, 2017). While investment in grazing systems research has been substantial, few detailed studies have gathered broad understandings of rancher perspectives regarding the efficacy or social, cultural, and economic dimensions of alternative grazing systems (Becker et al., 2016; Gosnell et al., 2020). Current AMP grazing research is limited and focused on the environmental and production benefits of the practice (Park et al., 2017; Stanley et al., 2018; Teague and Barnes, 2017). However, little is known regarding the wider beef industry's knowledge and perceptions of AMP grazing or their willingness-to-adopt the grazing style.

The purpose of this survey is to better understand current utilization, knowledge, perceptions, and willingness-to-accept (WTA) AMP. To understand current utilization, we analyze grazing management with questions crafted to allow for both researcher-identification and producer-identification of AMP grazing. WTA is analyzed via a double bounded dichotomous choice question offering a premium or cost reduction for adoption (see Chapter #4). This will help identify how a premium or cost saving would impact adoption rates. Additional sections of our survey analyze expected and experienced barriers to AMP adoption, desired improvements within the operation broadly, current BMP adoption, and marketing claims; all of which we anticipate to help explain and motivate AMP adoption.

Additionally, we recognize BMP adoption among beef producers remain lower than anticipated (Prokopy et al., 2008).[1] In effort to lead more effective adoption of AMP, and BMPs broadly, we step back to analyze producer motivations for current management practices (see Chapter #3). Current findings surrounding BMP adoption focus on producers most likely to adopt and reasons for adopting or not. BMP adoption is higher among cow-calf producers who continue training in management practices, have attained higher education, and operate larger herds (Williams et al., 2012). Producers are also more likely to adopt a BMP if they expect the practice to help them achieve their economic, social and environmental goals (Greiner et al., 2009).

[1] Investigators received approval from the Michigan State University's Institutional Review Board to administer this survey (STUDY00003111).

However, often reasons for non-adoption include unfamiliarity, non-applicability, and high cost (Gillespie et al., 2007). These insights provide great information and understanding of BMP adoption, or lack thereof. However, in order to effectively create change, we must first understand why producers have adopted their current management practices. This gap in understanding could potentially explain why BMP adoption has been lower than anticipated and lead BMP, along with AMP, adoption strategies.

This in-depth analysis of beef producers' utilization, knowledge, perceptions, and WTA AMP, along with motivations for current management practices, was conducted from a national online survey of 459 producers.

2.2 Research Design

A national online survey disseminated in September 2019 focused on current grazing management classification, producer motivations for current management methods, perceptions and willingness to adopt AMP grazing, and demographic characteristics. BEEF Magazine administered the survey in two iterations to their email listserv of cow-calf producers who owned at least 25 head. The first email was delivered to 52,202 emails and opened by 2,160 individuals. A follow up email was delivered three weeks later to 50,036 emails and opened by 1,582 individuals. The two emails received 351 responses providing a 0.3% response rate from total delivered emails and a 9.4% response rate from opened emails. [2]

In effort to increase sample size, the survey was then sent through select cattlemen's associations. Cattlemen's associations for the 11 states holding the most beef cows that calved January 1, 2019 and the Michigan Cattlemen's Association were contacted for collaboration

[2] Emails came from a newly created email by BEEF Magazine special for this survey rather than their daily newsletter email. Thus, we expect many emails went to spam.

(LMIC, 2019). The survey was sent through the Kansas Livestock Association, Michigan Cattlemen's Association, Oklahoma Cattlemen's Association, Arkansas Cattlemen's Association, South Dakota Cattlemen's Association, and Pharo Cattle Company, a listserv of regenerative grazers, receiving 108 responses. Response rate on this effort is unknown since we did not have access to email listservs for the associations.

From the combined 459 responses, 40 responses were dismissed from the survey for answering no to at least one of the three qualifying question – 'Do you voluntarily agree to participate in this research study?', 'Are you a primary operator on a beef cattle operation?' and 'Does your operation graze beef cattle?' – leaving 419 usable responses. An additional outlier response was dismissed for indicating they had 450,250 cows. The 'Request Response' option was selected for the remaining questions in the survey. Therefore, not every question was answered by all 418 respondents.

2.3 Operation Demographics

Respondents were first asked questions about their operation demographics (Table 2.1). Ninety percent of operators indicated a portion of their cattle operation was devoted to the cow-calf segment of the beef cattle industry while backgrounding/stocker, seedstock, grass finisher, and feedlot segments represented 27%, 19%, 18%, and 12% of the operations respectively.

The average number of beef cows, including lactating and gestating, and replacement heifers on operations as of January 1, 2019 was 223 head with a median of 100. Operations with 100 or more beef cows compose 51% of operations and 90% of the beef cow inventory in our sample. On average, operations in our sample are larger than those across the nation. According to the 2017 Census of Agriculture, the average beef cow herd is 43.5 head and operations with 100 or more beef cows make up 9.9% of beef operations and 56% of the beef cow inventory (USDA, 2019).

In 2018, operations in our sample sold on average 78 calves (median 33), 50 yearlings (median 8), and 56 finished cattle (median 0). These distributions, along with our herd size, are skewed by a handful of larger producers. Additionally, operations in our sample sold more calves on average than the industry average of 23 calves (USDA, 2017).

Eight percent of operations did not sell market steers while 30% sold market steers between 500 and 599 pounds, 20% between 600 and 699 pounds, 18% over 800 pounds, and 12% sold market steers between 700 and 799 pounds. Operators received on average $146.97 per hundredweight (cwt) on steers in the last year with minimum of $80.00 per cwt and maximum of $250.00 per cwt. This average aligns with the average feeder futures price for the same time period of $144.87 per cwt (LMIC, 2020). Sixty nine percent of operators did not know their average cost of production per head of steer. Of the 31% who did, they indicated the average cost of production to be $515.84 per head on average. This value is marginally higher than the USDA estimated gross value of production of $465.75 per calf (t-test value=2.75; p-value=0.08;USDA, 2019).

The largest portion of our sample, 52%, reside in the Midwest holding 52.8% of the beef cow inventory in our sample, followed by 27% in the South holding 19.1% of inventory, 19% in the West holding 28.7% of inventory and 2% in the Northeast holding 0.4% of cows as of January 1, 2019. [3] According to the Livestock Marketing Information Center, the January 1, 2019 cattle inventory breakup among regions consisted of 34.5% in the Midwest, 44.7% in the South, 19.6% in the West and 2.2% in the Northeast.

[3] Regions assigned following the U.S. census (U.S. Census Bureau, 2020). West included WA, OR, ID, MT, WY, CO, UT, NV, CA, AZ, and NM. Midwest included ND, SD, NE, KS, MN, IA, MO, WI, IL, IN, MI, and OH. South included TX, OK, AR, LA, MS, AL, TN, KY, GA, FL, SC, NC, VA, WV, MD, DC, and DE. Northeast included PA, NJ, NY, RI, CT, MA, VT, NH, and ME.

Table 2.1 Operation Summary Statistics

Demographic Variable	
Operation Region (n=409)	
Midwest	52%
South	27%
West	19%
Northeast	2%
Inventory in Region (n=385)	
Midwest	52%
South	19%
West	29%
Northeast	<1%
Years Established (n=411)	
Less than 5	4%
5 to 10	11%
11 to 20	17%
21 to 30	18%
31 to 40	13%
41 to 50	10%
More than 50	27%
Years as Primary Operator (n=411)	
Less than 5	8%
5 to 10	15%
11 to 20	21%
21 to 30	24%
31 to 40	16%
41 to 50	11%
More than 50	4%
Average Herd Size (n=386)	223
Median	100
Average Acres Operated (n=356)	3,022
Median	724
Average Acres Grazed (n=356)	2,560
Median	390
Averages Grazed Acres Owned (n=356)	1,221
Median	220

Inventory in our sample is more concentrated in the Midwest and West than that nationally. The larger portion of Midwest inventory is likely due to targeting South Dakota, Kansas, and Michigan producers via their cattlemen's and livestock associations. Additionally, Midwest producers, especially those in Michigan, may have been more likely to respond to the survey due to Michigan State University's name recognition. Our West inventory is likely higher than that nationally due to receiving responses from larger producers within the region; herd average in the West was 334 cows.

More than a quarter, 27%, of operations have been established more than 50 years, 18% have been established 21 to 30 years, and 17% have been established 11 to 20 years while only 4% have been established less than five years. Primary operators in our sample tended to be more experienced than those nationally as 4% have been a primary operator more than 50 years, 16% between 31 and 40 years, 24% 21 to 30 years, 21% 11 to 20 years, 12% five to 10 years and 8% less than five years. Nationally, 73% of beef operators have been operating a farm 11 or more years, 13% have been operating between six and ten years and 15% five or fewer years (USDA, 2017).

Our sample operates on average 3,022 acres (median 724). Of the total acres operated, an average of 2,560 are allocated to grazing cattle (median 390). From the acres allocated to grazing cattle, on average 1,220 are owned (median 220) which is less than 50%. Meanwhile, the average size of beef cattle farms in the U.S. is 565 acres with 407 acres being owned (USDA, 2017). Again, we see a handful of larger producers skewing the dataset.

2.4 Primary Operator Demographics

The average respondent age was 58 years old aligning closely with that of principle beef cattle producers nationally which are on average 57.4 years old (Table 2.2; NCBA, 2019). All respondents have attained a high school diploma and 64% hold a bachelor's degree or higher, making our sample more educated than the U.S. population (U.S. Census Bureau, 2017). Past studies of agricultural producers have also found responding producers to be more educated than the general public (McKendree et al., 2018; Thompson et al., 2019; Ward et al., 2008). Annual pre-tax household incomes for producers in our sample also align with those found in other studies (McKendree et al., 2018). Sixteen percent of respondents' annual pre-tax household income was less than $50,000, 67% was more than $50,000 and 18% did not provide that information. Most respondents (70%) indicated the beef operation contributes 50% or less of the annual household income. More than half, 54%, of our sample do not have off-farm jobs while 32% have full time and 14% have part time off-farm jobs. Nationally, 40% of primary beef operators identified the beef operation to be their primary occupation while 60% had other primary occupations (USDA, 2017) Thirty-eight percent of operations do not have other employees or on-farm help; meanwhile 29% have full time help, 38% part time, and 5% have both. We did not ask whether the full time and part time help were paid or not. Nationally, only 20% of beef operations have hired labor and 50% have unpaid workers (USDA, 2017). Most of our respondents, 58%, identified as Republican followed by Independent, 19%, and Democrat, 8%.

Table 2.2 Primary Operator Summary Statistics

Demographic Variable	
Average Age (n=317)	58
Education Level (n = 320)	
No High School Diploma	0%
High School Graduate	13%
Some College	13%
Technical Training	8%
Bachelor's Degree	43%
Grad. Or Professional Degree	23%
Annual Pre-Tax Household Income (n=321)	
Less than $25,000	4%
$25,000-$49,999	12%
$50,000-$74,999	18%
$75,000-$99,999	15%
$100,000-$124,999	13%
$125,000 or more	21%
Household Income from Beef Operation (n=320)	
0%	6%
Less than 25%	45%
26%-50%	19%
51%-75%	12%
Over 75%	18%

2.5 Adaptive Multi-Paddock Grazing: Utilization, Knowledge, and Perceptions

In order to identify AMP grazers along with gain insight on perceptions and knowledge of AMP, a series of questions regarding current grazing management methods were asked. These questions were crafted with the help of AMP grazing experts to allow for researcher-identification of AMP grazers along with producer self-identification as an AMP grazer.

Producers were first asked about their grazing style and frequency of moving cattle. Nine percent of operations allow cattle to move freely among all available pasture(s) during the entire year (Figure 2.1). Meanwhile, cattle are moved between different pastures throughout the grazing season based on time by 11% of our sample and based on forage health and recovery by 80% of our sample. Operators indicated a variety of frequencies for moving cattle to different paddocks or pastures. Most producers, 19%, move cattle once a month, 16% move twice a month, 16% move once a week, 13% move two to three times a week, 11% move daily and 2% move multiple times a day (Figure 2.2).

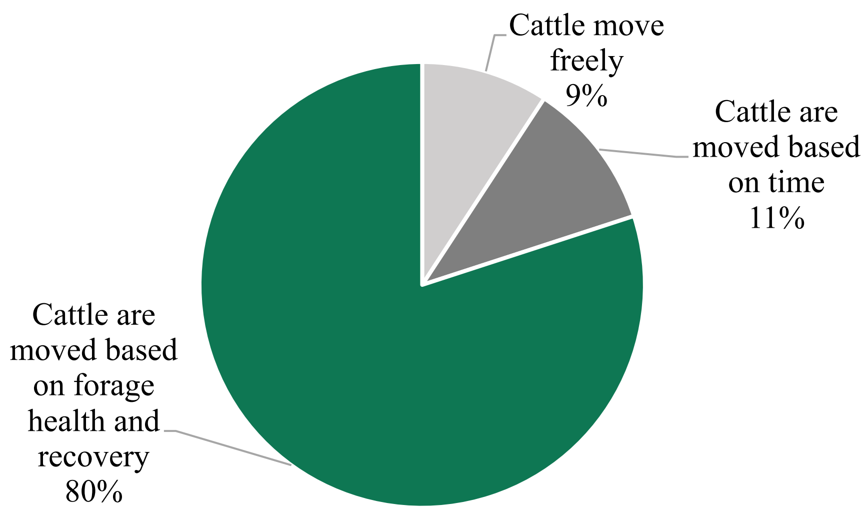

Figure 2.1 Grazing Style Most Similar to How Beef Operators Graze Cattle (n=325)

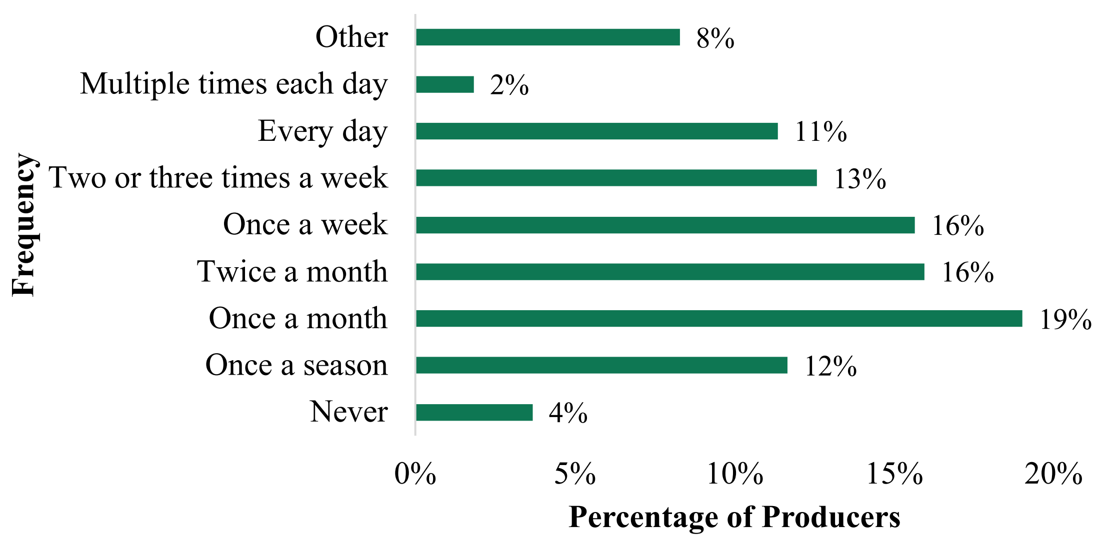

Figure 2.2 Frequency Cattle are Moved to a Different Paddock or Pasture (n=326)

From these questions, we identified operators as AMP if they said cattle are moved based on forage health and recovery and cattle are moved two or three times a week or more frequently. This classification resulted in 77 researcher-identified AMP grazers or 18% of our total sample (Table 2.3). Producer self-identification as an AMP grazer followed questions regarding perceptions and knowledge of the management practice.

Table 2.3 Percentage of Adaptive Multi-Paddock (AMP) Grazers from Researcher-Identification and Producer-Identification

AMP Grazers	Number of Producers	Percentage of Producers
Researcher-Identified (n=418)		
Yes	75	18%
No	343	82%
Producer-Identified (n=308)		
Yes	102	33%
No	129	42%
A similar adaptive style but not AMP	77	25%

After motivations for current management practices and current grazing management methods were established, respondents were introduced to AMP grazing.[4] Following this introduction they were asked about their knowledge and perceptions of the grazing management style. Knowledge of AMP was higher than anticipated as 78% had heard of AMP, 17% were familiar with the concept but not the name and only 5% had not heard of the management practice (Figure 2.3).

[4] Definition provided: "Adaptive multi-paddock (AMP) grazing is an intensive grazing method in which lightweight, portable fencing systems are used to move animals strategically around a large pasture, allowing for dense grazing interspersed by long periods of recovery for the land. This grazing method may be known by other names including holistic management or high intensity-short duration grazing."

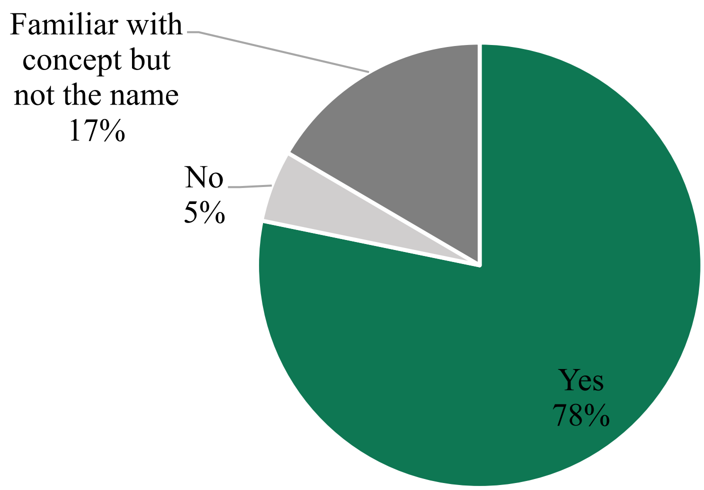

Figure 2.3 Producer Response to “Have you heard of adaptive multi-paddock grazing?” (n=326)

The 309 respondents that indicated they had heard of AMP or were familiar with the concept received follow up questions regarding the practice. From this group, 62% indicated from what they know of AMP, they would frame it as a best-management practice (BMP) while 30% did not know or were mixed (Figure 2.4). Even though they had heard of AMP or were familiar with the concept, 31% did not know any AMP grazers while 40% knew two to five AMP grazers and 11% knew more than ten (Figure 2.5). This group was directly asked if they used AMP grazing (producer self-identification) – 33% said yes, 42% no, and 25% indicated they use a similar adaptive style but not AMP (Table 2.3).

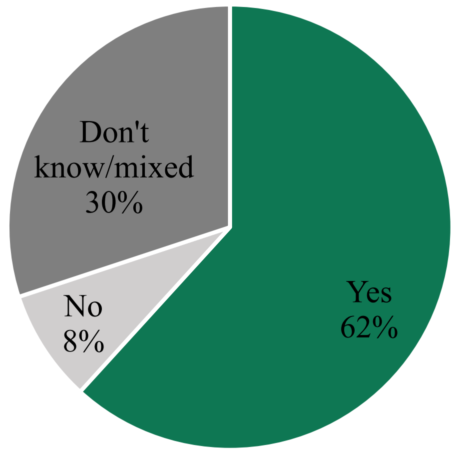

Figure 2.4 Producer Response to "Given what you know of adaptive multi-paddock grazing, would you frame it as a best-management practice?" (n=306)

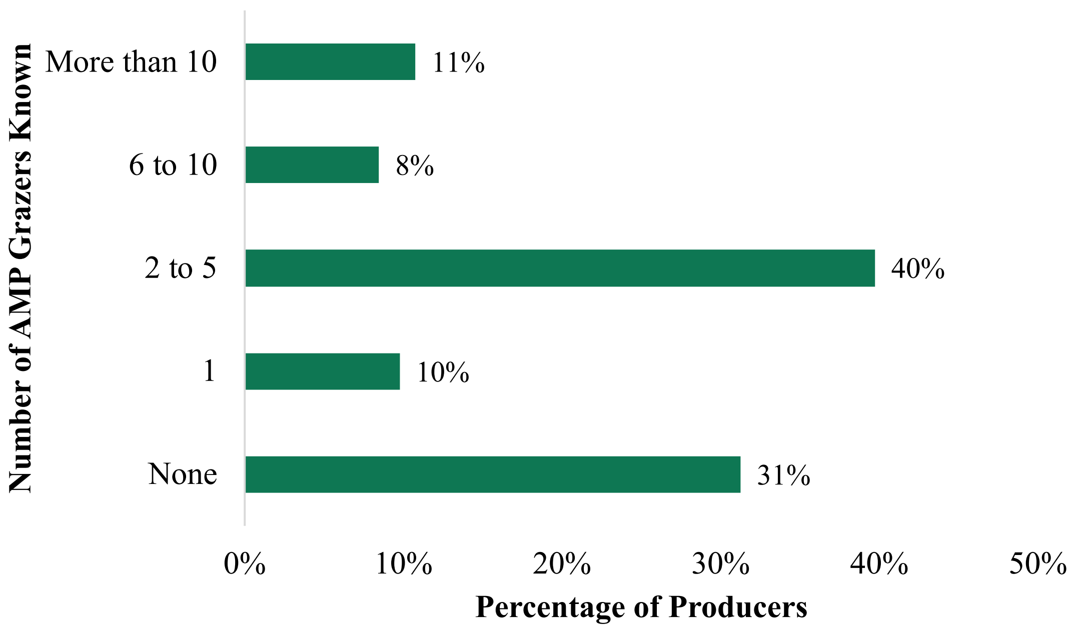

Figure 2.5 Producer Response to "How many adaptive multi-paddock grazers do you know?" (n=307)

When including those unaware of AMP, 24% of our total sample self-identified as an AMP grazer compared to the researcher-identified 18%. This difference may indicate a knowledge gap between producers and academics in terms of what AMP grazing truly is and the specifications of the grazing style.

Interested in examining expected versus experienced challenges to adoption, we asked producer-identified non-AMP and producer-identified AMP grazers a question regarding barriers to adoption. If operators had not heard of AMP, do not already use AMP, or use a similar adaptive style but not AMP, they were asked to indicate which challenges would hinder their adoption of the AMP grazing management method. Forty-five percent indicated that their operation is not set up for this kind of grazing, 36% do not have enough help on the farm, 35% say it is too time consuming, and 18% fear the financial requirement for set up is too high (Figure 2.6).

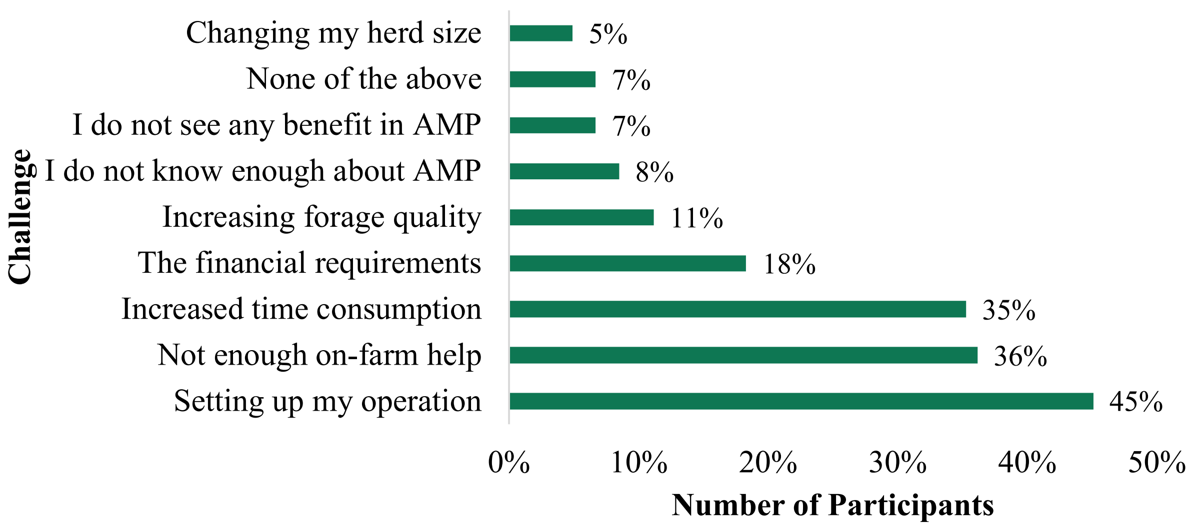

Figure 2.6 Expected Challenges that Hinder Adaptive Multi-Paddock Grazing Adoption (n=224)

Operators who self-identified as AMP grazers were asked the biggest challenge they faced when adopting AMP grazing (Figure 2.7). Forty-nine percent said setting up their operation for the grazing style was the biggest challenge which aligns with the perceived challenges of adoption. However, contrary to perceived challenges only 7% indicated it is much more time consuming and 4% identified the financial requirements to be the biggest challenge. Perhaps an overlooked expected challenge for adoption is increasing forage quality as 16% of AMP grazers determined this to be the biggest challenge while only 11% expected it. There were no challenges experienced among 10% of our AMP grazers.

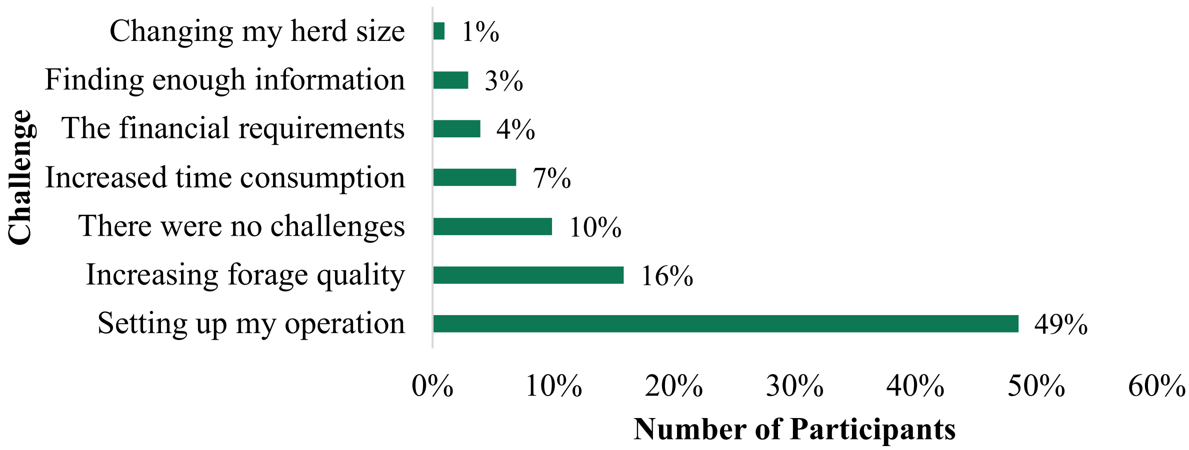

Figure 2.7 Biggest Experienced Challenge when Adopting Adaptive Multi-Paddock Grazing (n=101)

2.6 Marketing

Producers were asked to select the claims most frequently used when marketing their cattle (Figure 2.8). Pre-conditioned (weaning or vaccination) claims were the most frequently used with 57% of our respondents utilizing them. Other commonly used claims include natural (no hormones/no antibiotics), age and source verified (ASV/SAV), grass-fed, and humanely raised with 35%, 24%, 24%, and 23% utilization, respectively. The option of none, or conventional production, remained common among a fifth of our sample. Interestingly, the organic claim was only utilized by 3% of our respondents. Understanding producer use of claims when marketing cattle can help us better understand their WTA AMP grazing for a premium. Additionally, this insight may help explain differences among producers and their motivations for current management methods. Those who market as grass-fed may place more importance on caring for the land than those that market as conventional.

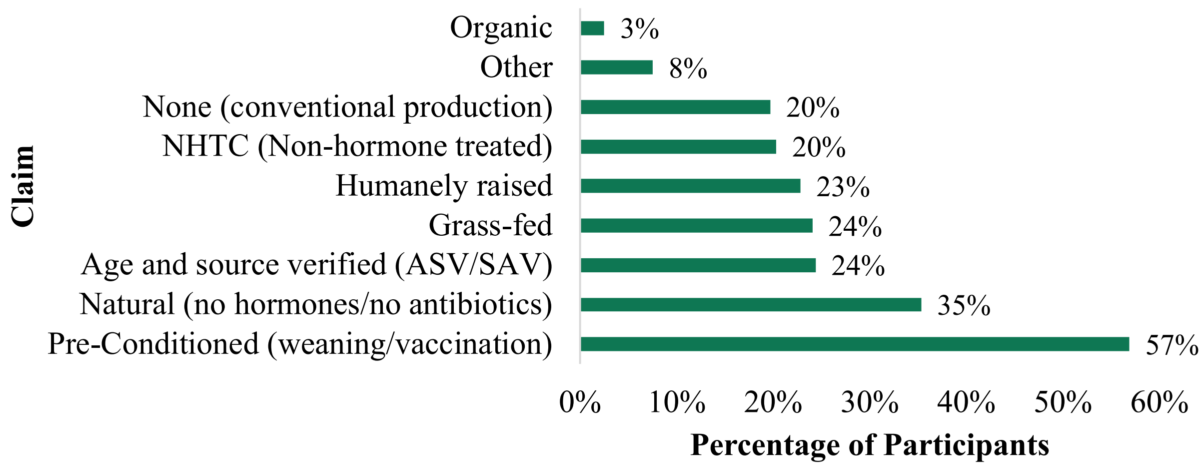

Figure 2.8 Beef Operation Marketing Claims (n=320)

Additionally, we asked respondents to indicate which method or outlet they use most often when marketing cattle (Figure 2.9). Local auctions captured 47% of respondents trailed by direct to consumers with 15% and direct to feedlot operation with 10%.

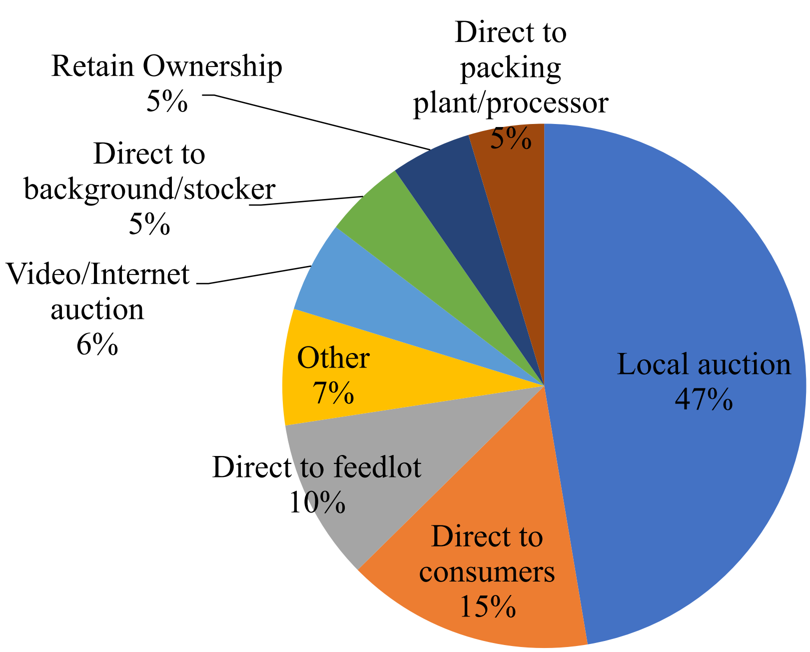

Figure 2.9 Beef Operation Marketing Methods/Outlets (n=321)

2.7 Animal Best Management Practices

Respondents were given a list of best management practices (BMP) and asked if they utilize this practice on their operation (Table 2.4). This list was based on a 2016 study of 30 cattle ranches in California examining management practices (Simon et al., 2016). Simon et al. (2016) found that even though some management and facility characteristics, such as castration and vaccination programs, were shared by most operations, other aspects like weaning age, cattle balking, and electric prod use varied. From Simon et al.'s (2016) 41 question questionnaire, the project team, including animal scientists, derived a list of 13 BMPs representing practices that put operations at higher risk if not implemented. While there are no federal standards or regulations, there are recommended BMPs within the beef industry based on scientific research (BQA, 2020). These practices were asked in effort to measure practice adoption and operation risk.

Ninety-six percent of respondents indicated they use a method of animal identification and are able to safely restrain cattle while 93% have an established relationship with a veterinarian. Between 84% and 89% of respondents maintain a herd health program that includes vaccinations for cows and calves, have written or computer financial records, perform visual health checks on their herd at least twice a week, and have a planned breeding and calving season. Fewer producers, between 68% and 75%, castrate bull calves within the first three months of age, regularly body condition score their cattle, train employees on low stress cattle handing and care, have written or computer health records, and use a low stress weaning program. Only 54% are Beef Quality Assurance certified while 6% indicated that BMP was not applicable. Thirty-five percent of producers quarantine new cattle at least 30 days after arriving onto the ranch, 34% do not and 32% indicated this was not applicable to their operation.

Table 2.4 Beef Operations' Utilization of Best Management Practices (BMP)

BMP	**n**	**Yes**	**No**	**N/A**
A method of animal identification (e.g., ear tags, brands, etc.)	321	96%	4%	1%
Ability to safely restrain cattle (e.g., squeeze chute) for procedures	322	96%	3%	0%
Have an established client relationship with a veterinarian	321	93%	7%	0%
Perform a visual health check of your herd at least twice per week	322	88%	11%	1%
Planned breeding and calving season	321	89%	9%	2%
Maintain a herd health program that includes vaccinations for cows and calves	320	84%	14%	2%
Written or computer financial records	320	85%	13%	2%
Use a low stress weaning program (fence line, etc.)	321	75%	20%	5%
Written or computer health records for the herd	320	71%	28%	2%
Train your employees on low stress cattle handling and care (includes family workers)	320	72%	8%	19%
Body condition score your cattle to gauge their nutritional state during the production cycle	319	70%	26%	3%
Castrate bull calves within the first three months of age	318	68%	28%	4%
Beef Quality Assurance Certified	316	54%	40%	6%
Quarantine new cattle at least 30 days after arriving onto ranch	320	35%	34%	32%

2.7.1 Riskiness Index

BMP responses were used to create two operation indexes, one to measure operation riskiness and one for progressiveness. These indexes were established with the help of an animal welfare expert, Dr. Janice Swanson.

The riskiness index was established by grouping BMP's into high-level, mid-level, and low-level categories (Table 2.5). Practices within the high-level category received a weight of five as they were perceived to be the practices most essential for maintaining a low-risk operation. Mid-level practices received a weight of three and were viewed as practices still important for maintaining a low-risk operation but not as important as those in the high-level category. Practices within the low-level category received a weight of one and were viewed as the least essential practices for maintaining a low-risk operation.

Table 2.5 Classes and Weights of Best Management Practices for Operation Riskiness Index

BMP	**Weight**
High-level	
Maintain a herd health program that includes vaccinations for cows and calves	5
Written or computer health records for the herd	5
Method of animal identification (e.g. ear tag….)	5
Quarantine new cattle at least 30 days after arriving onto ranch	5
Mid-level	
Perform a visual health check of your herd at least twice per week	3
Have an established client relationship with vet	3
Ability to safely restrain cattle	3
Training your employees on low stress cattle handling and care	3
Planned breeding and calving season	3
Body condition score cattle to gauge nutritional state during production cycle	3
Low-level	
Use a low stress weaning program	1
Castrate bull calves within the first three months of age	1
BQA Certified	1
Written or computer financial records	1

If operators indicated the production practice was being used in their beef operation they received the respected weight for that practice towards their overall riskiness measure. If they indicated the practice was not being used or was not applicable to their operation they did not receive the respected weight towards their overall index value. The riskiness index ranges from 0 to 42 where lower index values indicate higher risk operations and higher index values indicate lower risk operations.

We classified index values of 37 or higher to be lower-risk operations. An index value of 37 or higher required an operation to practice nearly all of the production practices analyzed. It does provide lenience for not practicing one high-level practice or a combination of mid and low level practices. Operations with index values between 29 and 36 were classified as mid-risk operations. Here more lenience was provided for operations to not practice a combination of the practices analyzed but still required utilization of most practices. Index values below 29 classified operations as high-risk. Following these classifications, 25% of our sample are lower risk operations, 53% are mid risk and 22% are high risk operations.

2.7.2 Progressiveness Index

An index measuring operation progressiveness was established similarly to the riskiness index. BMP's were grouped into high, mid, and low-level categories (Table 2.6). High-level practices received a weight of five as they reflect more advanced practices within the beef cattle industry. Practices within the mid-level category received a weight of three and were perceived to be progressive practices but not as advanced as those in the high-level category. Meanwhile, low-level practices received a weight of one, were seen as mainstream or industry standard.

Table 2.6 Classes and Weights of Best Management Practices for Operation Progressiveness Index

BMP	**Weight**
High-level	
Planned breeding and calving season	5
Training your employees on low stress cattle handling and care	5
Body condition score cattle to gauge nutritional state during production cycle	5
Castrate bull calves within the first three months of age	5
BQA Certified	5
Use a low stress weaning program	5
Mid-level	
Perform a visual health check of your herd at least twice per week	3
Ability to safely restrain cattle	3
Have an established client relationship with vet	3
Written or computer financial records	3
Low-level	
Maintain a herd health program that includes vaccinations for cows and calves	1
Written or computer health records for the herd	1
Method of animal identification (e.g. ear tag….)	1
Quarantine new cattle at least 30 days after arriving onto ranch	1

Operations received the respective weight for each BMP if they indicated utilization of the practice. However, if the practice was not used or not applicable to their operation they did not receive the respective weight for that practice towards their overall progressive index value. The progressiveness index ranges from 0 to 46 where higher index values represent more progressive operations.

We separated the progressive index into four operation classifications: more progressive, mid-level progressive, industry standard, and below industry standard. More progressive operations required an index value of 40 or higher. This classification provides lenience for not utilizing one high-level and one low-level practice or a combination of mid and low-level practices while maintaining utilization of most practices studied. Index values between 35 and 39 classified operations as mid-level progressive. Here, lenience for not practicing at most two high-level practices and one low-level, one high-level and several mid or low level practices, or a combination of several mid and low-level practices was provided. Operations classified as industry standard scored index values between 30 and 34 which provided more variation in practice adoption. These operations were seen to be doing the bare minimum in terms of industry recommended practice adoption. While there are no federal standards, certain BMPs within the beef industry are recommended based on scientific research (BQA, 2020). Below industry standard operations received less than 30 points on the progressive index. Following these classifications, 34% of our sample are more progressive operations, 27% are mid-level progressive, 19% are industry standard, and 20% are below industry standard.

2.8 Desired Improvements within Beef Operation

Producers were asked to indicate what they would like to improve within their beef operation (Figure 2.10). Profitability, forage quality, and minimize costs were the most popular desired improvements being selected 84%, 69%, and 69% of the time, respectively. Forty-three percent of producers indicated they would like to improve their quality of life. Environmental improvements were less common but remained important to many producers. Environmental factors included improve water infiltration (31%), wildlife habitat/habitation (30%), reduce water runoff (30%), and reduce greenhouse gas (GHG) emissions (14%). A quarter of our sample want to improve animal welfare and 14% want to improve community involvement. Only 2% indicated they did not want to improve any of the options provided. Understanding what producers are interested in improving within their operation can help us identify producer motivations and reasons behind WTA BMPs.

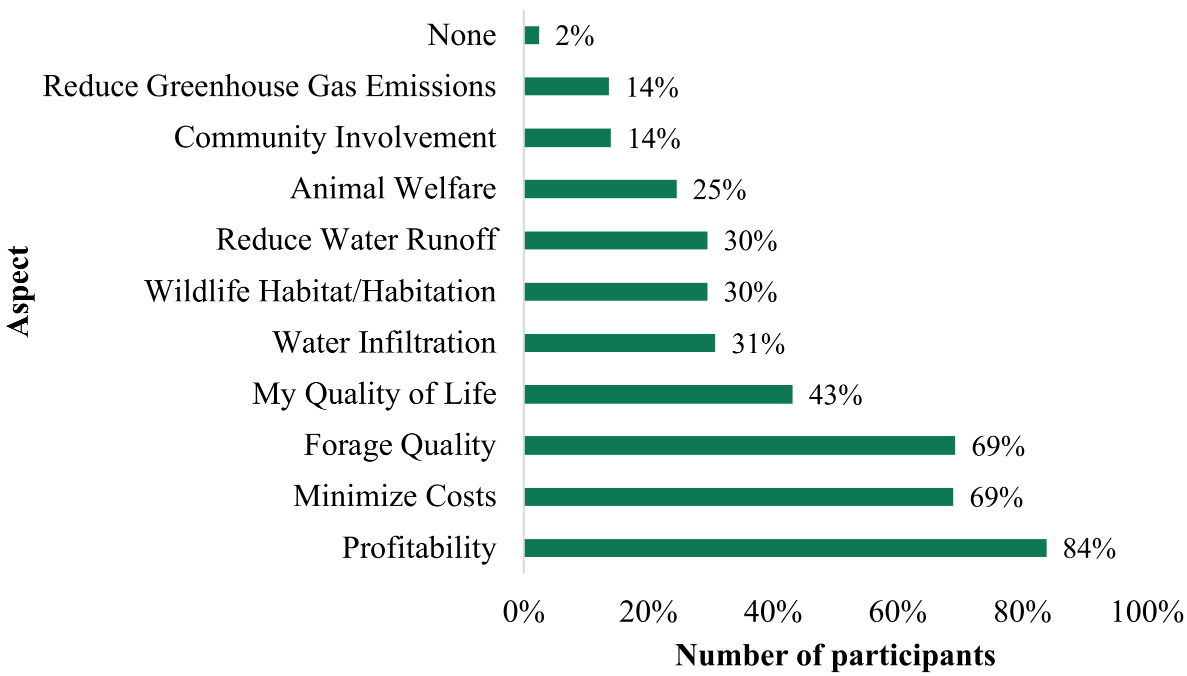

Figure 2.10 Aspects of Beef Operation Primary Operators Would like to Improve (n=322)

2.9 Conclusions and Implications

Mitigating environmental impacts of agricultural production while increasing profitability is essential for providing consumers sustainable food while maintaining operation economic efficiency. Through the adoption of BMPs this is attainable. Within the beef industry specifically, AMP grazing can improve animal and forage productivity while potentially sequestering more soil organic carbon than continuous grazing (Stanley et al., 2018). Although 33% of our sample already self-identify as AMP grazers, this BMP has the potential for significant increases in adoption.

Largely, producers already know of AMP (78%) or are familiar with the concept (17%) indicating familiarity has already been established within the industry. Now, less focus is required on informing producers what the practice is and instead should be on marketing benefits and targeting producer motivations to support adoption. Even though most producers are familiar with AMP, not everyone is sold on it being a BMP. This provides room for industry professionals to convey environmental and productivity research findings to help producers better understand the benefits of the practice.

When leading AMP adoption, industry professionals can directly address expected challenges that hinder adoption like operation set up (45%), having enough help (36%), increased time (35%) and financial requirements (18%). Not only can challenges be addressed, they can be mitigated by comparing to experienced challenges. Increased time consumption and financial requirements were only experienced by 7% and 4% of self-identified AMP grazers, respectively. Meanwhile, industry professionals can prepare new adopters for the overlooked challenge of increasing forage quality.

Understanding what producers wish to improve within their operation can help in matching BMP benefits with desired improvements. Beef producers largely wish to improve profitability (84%) and forage quality (69%) while minimizing costs (69%). Fewer producers wish to reduce GHG emissions (14%). Thus, when discussing the benefits of AMP grazing, more focus should be placed on how the practice increases forage quality and animal productivity, which can increase profitability or minimize costs, and less focus on how it reduces GHG emissions. However, if policy instruments can be designed to pay producers for GHG emission reductions this becomes an environmental and financial benefit and should be highlighted. Specialized adoption discussion strategies should be established for other BMPs based on matching benefits with desired improvements.

Overall, beef producers are already familiar with AMP grazing. There is ample room however for increasing AMP adoption by informing producers of AMP benefits and matching those benefits to producer desires. Additionally, expected challenges are different than experienced challenges and thus should be discussed in order to ease producers' minds and increase adoption.

Not only can understandings from this survey support AMP adoption, they can support BMP adoption throughout the entire beef industry.

CHAPTER 3: BEEF PRODUCERS' MOTIVATIONS FOR CURRENT MANAGEMENT PRACTICES

3.1 Introduction

Negative public perceptions of agricultural producers and their environmental impact continues to grow and place pressure on agricultural production and bottom lines. Most Americans feel that agricultural production has generated "significant environmental problems" with farmers having the most direct role (Harris and Bailey, 2002; McGuire et al., 2013). Even though farmers are viewed as essential for food production they are also perceived to be business people likely to put personal profit before public and environmental welfare (McGuire et al., 2013). Nevertheless, farmers see themselves as caretakers and stewards of the land, providing it security by leaving it better than when they found it (Quinn and Halfacre, 2014).

As this perception distance grows, so does society's expectation that farmers will adopt management practices that significantly reduce or eliminate agriculture's negative environmental impacts (Herrero and Thornton, 2013). Agriculturalists have the opportunity to mitigate negative impacts on surrounding environments, communities and people by implementing best management practices (BMPs). Not only can implementation of BMPs minimize environmental consequences, they can increase enterprise productivity and profitability. BMPs are backed by research as the most effective, environmentally sustainable, and long-term economically efficient way to manage agricultural production (Gillespie et al., 2007; Paudel et al., 2008). Despite found benefits and increased demand, low levels of BMP adoption continue to frustrate researchers and policy makers (Pannell et al., 2006). The trend of low BMP adoption spans across agricultural sectors including the beef industry where adoption rates are relatively lower than other agricultural enterprises (Kim et al., 2005; Prokopy et al., 2008).

The main purpose of this article is to determine what is important to beef producers when making management decisions. Further, we analyze heterogeneity in beef producer motivations. Taking a step back to understand what motivates current management practices is important to effectively lead the adoption of new management practices. Increased adoption of BMPs can increase productivity and profitability while helping to mitigate the publics' environmental concerns. Further, by communicating to the public what is important to producers we can help the public understand why producers make the decisions they do and perhaps lessen scrutiny in all facets. Through best-worst scaling (BWS), we analyze nine beef producer motivations for current management practices (Table 3.1; Mathison and Hodbod, 2020).

Table 3.1 Beef Producers' Motivations for Current Management Practices Examined

Article Wording	**Survey Description**
Caring for the land	it is important to me that I manage my land in a way that does not negatively affect, or even improves, the environment.
Enjoying life	it is important to me that I get pleasure out of my life on the farm/ranch.
Trying new things	it is important to me that I experiment with new management practices, breeds, and/or technologies on the farm/ranch.
Teaching others	it is important to me that I teach others (family, farmers, school children, and/or community members) about what I do on my farm/ranch.
Passing on the land to future generations	it is important to me that I can pass on my land and farm/ranch to my children and/or grandchildren.
Feeling proud	it is important to me that I get pride from my farm/ranch (the animals, my equipment, my land etc.).
Feeling like I belong	it is important to me that I am a part of my community and/or feel like I belong in this place.
Maximize profit	it is important to me that I make the most profit each year given my available resources.
Minimize risk	it is important to me that I minimize risk and financial losses so that I am not forced out of business.

Current findings reveal little about beef producer motivations for current management practices and instead focus on the effect of socioeconomic factors on adoption and reasons for adopting or not. BMP adoption is higher among purebred cattle producers, cattle producers who own rather than rent their land, and those with greater financial resources (Kim et al., 2005). Higher education levels, larger operations, and continued training in management practices have also been found to positively impact BMP adoption among cow-calf producers (Williams et al., 2013). In the adoption of forage BMPs, herd size, dependency on income from cattle, goals of reducing labor and generating additional income, age and education were positive indicators (Ward et al., 2008). Among stocker cattle producers, operation size and dependency upon income from the stocker operation increased the adoption of recommended management practices while older producers and those producing year round lagged in adoption (Johnson et al., 2010). Additionally, beef producers adopt an innovation if they expect that the practice will help them achieve their goals, which may include economic, social and environmental goals (Greiner et al., 2009). The most common reasons for beef producers not to adopt are unfamiliarity, non-applicability, and high costs (Gillespie et al., 2007). Barriers to adopting BMPs in beef grazing systems include water availability and quality, leasing and renting land, and skilled labor (King et al., 2017). However, a gap in this literature is understanding why beef producers have implemented their current management practices. This gap in understanding could potentially explain why BMP adoption has been lower than anticipated and guide BMP adoption strategies.

The literature concerning what motivates agricultural producers to adopt BMP and conservation practices exists with a wide array of themes. Often, financial-economic concerns are stated or implied to be the most important motives for practice adoption (Chouinard et al., 2008). Cary and Wilkinson (1997) find the best way to increase the use of a practice is to ensure it is economically profitable. One of the main criticisms of the financial motivations approach is that it fails to include heterogeneity of producer preferences (Nowak, 1987). If all producers are self-interested profit maximizers, everyone would make the same decision when faced with the same situation. Heterogenous motivations for farm practice selection has been found implying some producers are entirely motivated by profitability and wealth, some entirely by their own needs and some by obligations to others, future generations, God, or spirit of the land (Chouinard et al., 2008). It is possible though for producers to maximize profit and still be stewardly (Klonsky et al., 2004). As heterogeneity exists among agricultural producer preferences broadly it is likely heterogeneity also exists among producers of different enterprise types. In other words, grain producers' motivations could be different than livestock producers. Accordingly, analyzing beef producer motivations specifically is important yet literature is limited.

Greiner et al. (2009) and Basarir and Gillespie (2006) analyze producer motivations and goals for current management practices. Greiner et al. (2009) ask Australian cattle grazers to rate the importance of 32 motivation items/goals for being a grazer on a ten-point Likert-scale. The five most highly rated goals were not financially related but instead included "pass on land in good condition," "produce high quality food," "enjoy farm work," "feel independent," and "look after the environment." Greiner et al.'s (2009) analysis is specific to the Burdekin River catchment where farms have different environmental impacts than the average American farm as the catchment drains into the Great Barrier Reef lagoon. Basarir and Gillespie (2006) use fuzzy pair-wise comparison to analyze the importance of seven goals, with respect to the farming operation, for Louisiana beef producers. The two most important goals were "maintain and conserve land" and "avoid years of loss/low profit" with "maximize profit" and "have time for other activities" tied for third (Basarir and Gillespie, 2006). Our analysis uses a national survey of U.S. cattle producers, providing more direct implications for leading BMP adoption within the United States and lessening public scrutiny and concern.

We improve upon Greiner et al. (2009) and Basarir et al.'s (2006) empirical methods through the utilization of BWS. Likert-scale questions make it challenging to differentiate the actual importance of motivations. For example, Greiner et al.'s (2009) motivations "produce high quality food", "enjoy farm work", and "feel independent" all have the same mean level of importance. Another issue with Likert-scale questions is scale subjectivity – what is considered a "4" on one individual's scale may be a "5" on another (Lusk and Briggeman, 2009; Lusk and Parker, 2009; Wolf and Tonsor, 2013). Fuzzy pair-wise comparisons improve upon these limitations through the assumption of cardinality of preferences; respondents not only know which goal they prefer but also by how much they prefer that goal (Basarir and Gillespie, 2006). A limitation of the fuzzy pair-wise comparison method is the number of required questions which can lead to respondent fatigue. The number of pair-wise comparisons of goals, Q, is determined by $Q = (g \times (g - 1))/2$, where g is the number of goals. Thus, Basarir and Gillespie's (2006) seven goals required 21 questions and our nine motivations would require 36 questions. Instead, through BWS we are able to analyze nine motivations in 12 questions. Additionally, by using BWS, a tradeoff method, we achieve shares of importance that can be directly interpreted from a ratio scale such that if motivations j and k have importance shares of 0.3 and 0.1, respectively, motivation j is three times as important as k. BWS also provides five to 10 times more differentiation than most scaling methods, such as Likert scales (Horne, 2012). Directly interpretable shares and more differentiation provides further insight to the exact importance of each motivation.

We explore heterogeneity in beef producer motivations through LCM to identify if different classes of beef producers have different motivations for current management practices. Greiner et al. (2009) assume homogenous preferences among beef producers while Basarir and Gillespie (2006) begin to investigate heterogenous preferences among beef operators of different herd sizes. Grouping beef producers into herd size categories of 1-19, 20-49, 50-99, and 100+, Basarir and Gillespie (2006) find the four categories rank goals differently. It is likely however that more characteristics than just herd size impact how beef producers make decisions, and therefore we do not predetermine producers classes using herd size, but let those differences emerge through the analysis. Additionally, Basarir and Gillespie's (2006) investigation of heterogenous preferences is based on the categorization of producers using a demographic characteristic followed by analyzing goals. We reverse this process as LCM first categorizes producers based on how they answered the BWS questions. From these categories we identify statistical difference among producers in each class that emerge solely because of their difference in motivations – we do not pre-determine the analysis (category). This process establishes first that producers have heterogenous preferences then allows us to investigate why these difference exist.

Furthermore, there is no specification on how the motivations Greiner et al. (2009) and Basarir and Gillespie (2006) studied were constructed. The nine motivations in our analysis were created inductively from qualitative research – i.e. result directly from the language of beef producers rather than being created by researchers. Utilizing motivations from qualitative research provides further internal validity than if the motivations were randomly established from researchers' assumptions.

3.2 Methodology

Producers allocate their limited resources, human and nonhuman, to where those resources maximize expected utility (Ward et al., 2008). Since producers make decisions based on personal identity and motivations we must account for these factors in their utility function. Using general utility theory, beef producers make management decisions that maximize their utility, or happiness, while remaining profitable for continued existence. To determine the motivations most and least important in maximizing beef cattle producers' utility function and explaining current management practices we used BWS. BWS, also known as maximum difference scaling or most-least scaling, was originally introduced by Finn and Louviere (1992) with the theoretical properties of probabilistic, best-worst choice models more recently explained by Marley and Louviere (2005).

BWS is rooted in Random Utility Theory (RUT). RUT, which also underlies discrete choice experiments used in marketing research and economics, assumes that the relative preference for object A over object B is a function of the relative frequency with which A is chosen as better than B for an individual (Louviere et al., 2013). Individuals make choices stochastically, with some error involved, in such a way to maximize utility. The best-worst method presents each individual multiple answer options (in our analysis motivations) and asks them to select one as "best" (or most important) and one as "worst" (or least important) (Figure 3.1). In practice, the BWS method consists of a series of several questions, each comprised of different mixes of motivations per question.

Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important	Motivation	Least Important
	Teaching others - it is important to me that I teach others (family, farmers, school children, and/or community members) about what I do on my farm/ranch.	
	Enjoying life - it is important to me that I get pleasure out of my life on the farm/ranch.	
	Feeling proud - it is important to me that I get pride from my farm/ranch (the animals, my equipment, my land, etc.).	

Figure 3.1 Example of Best Worst Scaling Question in the Survey

According to RUT, the utility for respondent *n* in selecting alternative *i* in choice set *t*, is:

$$U_{nit} = V_{nit} + \varepsilon_{nit}$$

where V_{nit} is the deterministic portion of utility dependent upon the attributes of the alternative and ε_{nit} is the stochastic component of utility, which is independently and identically distributed over all alternatives and choice scenarios.

Generally, when respondents are presented with a choice set, they make choices on the basis of maximizing the utility they can receive from each alternative in the choice set. For example, in making a choice between alternative *j* and alternative *k,* respondent *n* will pick alternative *j* over alternative *k* when:

$$U_{njt} > U_{nkt} \text{ for all } j \neq k$$

Given that each choice set has *J* motivations (3 in our case), the pair of motivations chosen represents a choice from all *J(J-1)* possible pairs (6 in this study), which maximizes the difference in importance. Following Lusk and Briggeman (2009) and McKendree et al. (2018), let the true or latent unobservable level of importance for individual *n* be represented by $I_{nj} = \lambda_j + \varepsilon_{nj}$, where λ_j represent *j*'s location on the scale of importance and ε_{ij} is the random error term.

The probability that pair j, k is chosen, where j represents the most important motivation and k represents the least important motivation, out of a choice set with J motivations, is the probability that the difference between j and k is larger than all the $J(J-1)-1$ other possible differences in the choice set. When the error terms are independent and identically distributed type I extreme value the multinomial logit (MNL) form of this probability is:

$$\text{Prob}_n\,(j \text{ is chosen as most and k as least}) = \frac{e^{\lambda_j-\lambda_k}}{\sum_{l=1}^{J}\sum_{m=1}^{J} e^{\lambda_l-\lambda_m}-J}$$

From this probability statement, by maximizing the log-likelihood function, λ_j parameters can be estimated. When doing this, the dependent variable is 1 for the chosen most-least motivation pair and 0 for the remaining $J(J-1)-1$ pairs.

The MNL assumes respondents have homogenous views of the motivations analyzed. However, past studies have found heterogenous preferences among beef producers (McKendree et al., 2018; Schulz and Tonsor, 2010). Not only do beef producers manage their cattle differently, it is likely they also have different motivations behind these decisions. Accordingly, to account for response heterogeneity, latent class models (LCMs) are estimated (Boxall and Adamowicz, 2002). LCMs assume homogenous preferences within a class while allowing heterogenous preferences across classes. Akaike information criterion (AIC; Boxall and Adamowicz, 2002) and adjusted Bayesian information criterion (BIC; Dziak et al., 2019) tests were used to identify the preferred LCM model.

MNL and LCM coefficient estimates cannot be directly interpreted. However, a “share of importance” estimate based on a ratio scale can be calculated for each motivation:

$$\text{Share of importance for motivation } j = \frac{e^{\widehat{\lambda_J}}}{\sum_{k=1}^{J} e^{\widehat{\lambda_k}}}$$

The sum of shares among all nine motivations analyzed must equal one. If motivation *j* has an importance share of 0.3 and motivation *k* has an importance share of 0.1, then *j* is three times as important as *k*.

Krinsky-Robb confidence intervals (Krinsky and Robb, 1986) were calculated to compare importance shares both within and across classes. Statistically differences within a class and across the LCMs can be determined by using overlapping confidence intervals. The full combinatorial method (Poe, Giraud, and Loomis, 2005) was used to test if shares of importance were different across the classes identified in LCM.

In LCMs, class membership probabilities are calculated for each respondent. Respondents are then sorted into a single class based on their largest class membership probability (greater than 0.30).[5] To better understand the characteristics of primary operators and operations most likely to sort into each class, demographic characteristics and marketing claims across classes are compared using *F*-tests and pairwise *t*-tests. If the *F*-test is significant, revealing differences in means across all classes, pairwise *t*-tests are used to identify differences between two classes at a time.

This study, along with Mathison and Hodbod (2020), is part of a larger multi-disciplinary study analyzing the BMP of adaptive multi-paddock (AMP) grazing within the Southeast U.S. AMP grazing is an intensive grazing style that allows for dense grazing interspersed by long periods of recovery for the land by moving animals strategically within a large pasture. AMP is not the focus of this study but has implications for producer motivations which are discussed later. The nine motivations investigated (Table 3.1) were gathered from qualitative research conducted within the larger multi-disciplinary study of AMP grazing within the Southeast U.S. Mathison and Hodbod (2020) qualitatively analyzed beef producer motives behind decision making, using photo

[5] Most respondents' highest class probability was much larger than 0.30.

elicitation (Harper, 2002; Beilin, 2005; Sherren et al., 2010) with ten ranchers from Kentucky, Tennessee, Alabama, and Mississippi. Each rancher was asked to take 12-16 photographs, with each photograph focused on something from their operation that was of importance to them. In-depth in-person interviews were conducted to discuss why each picture was taken and what the picture meant to the rancher. From these interviews, eight common motivations surfaced from inductive coding efforts (Mathison and Hodbod, 2020). Collaborating with Mathison and Hodbod, and using previously studied motivations (Greiner et al. (2009)), we expanded "generating income" to "maximize profit" and "minimize risk to avoid financial loss," providing nine motivations for this analysis. This expansion captures the two ways businesses make optimization decisions according to economic theory – either maximizing profits or minimizing costs.

3.3 Data

A national online survey disseminated in September 2019 focused on producer motivations for current management methods, current grazing management style, BMP adoption and operation and primary operator demographics. To increase response rate, $50 gift cards administered via BEEF Magazine were given to ten random responding producers. Initially, BEEF Magazine administered the survey in two iterations to cow-calf producers with herds of 25 or more cows. The first email was delivered to 52,202 emails and opened by 2,160. Three weeks later a follow up email was delivered to 50,036 emails and opened by 1,582. The two e-blasts received 351 responses providing a response rate from total delivered emails of 0.3% and a response rate from opened emails of 9.4%.[6] The email messages sent to elicit responses are provided in Appendix B.

[6] Emails came from a newly created email by BEEF Magazine special for this survey rather than their daily newsletter email. Thus, we expect many emails went to spam.

In effort to increase sample size, select beef producer associations were also contacted for collaboration. The agreeing associations included Michigan, Oklahoma, Arkansas, and South Dakota Cattlemen's Associations, Kansas Livestock Association, and two cattle grazing listservs receiving 108 responses. Response rate from this effort is unknown due to not having access to the associations' email listservs. Likelihood-ratio tests were used to determine statistical differences did not exist among respondents from different sources indicating the pooled sample could be used for analysis.

From the 459 responses, 40 responses were dismissed from the survey for answering no to one of the following qualifying questions: 'Do you voluntarily agree to participate in this research study?', 'Are you a primary operator on a beef cattle operation?' and 'Does your operation graze beef cattle?'. Additional responses were dismissed from this analysis including 109 responses for not completing the BWS questions, five responses for not completing the survey, and one outlier response.[7] The 'Request Response' option was selected for all questions in the survey, except qualifying questions where "Force Response" was used. Therefore, not every question was answered by all remaining respondents. Summary statistics for the 304 useable responses are included in Tables 3.2 and 3.3.

Respondent's averaged 58 years of age aligning closely with the national average age of principle beef cattle ranchers, 57 (Table 3.2; NCBA, 2019). All respondents have graduated high school and 66% hold a Bachelor's degree or higher making our sample's education level higher than the U.S. average (U.S. Census Bureau, 2019). Previous studies of agricultural producers have also found responding producers to be more educated than the general U.S. public (Thompson et al., 2019; McKendree et al., 2018; Ward et al., 2008). Annual pre-tax household incomes for

[7] The respondent indicted they owned 450,250 cows.

producers in our sample align with those found in other studies (McKendree et al., 2018). Sixteen percent of respondents' annual household income was less than $50,000, 69% was more than $50,000, and 15% did not disclose that information. Meanwhile, most (72%) indicated 50% or less of their household income comes from their beef cattle operation with 50% of operations contributing less than 25%. The majority of our producers identified as Republican followed by Independent and Democrat with 58%, 19%, and 7%, respectively.

Table 3.2 Primary Operator Summary Statistics

Demographic Variable	n=304
Average Age	58
Education Level	
Did not graduate from high school	0%
Graduated from high school	13%
Some college	12%
Associate's or Trade Degree	9%
Bachelor's (B.S. or B.A.) Degree	43%
Graduate or Advanced Degree	23%
Annual Pre-Tax Household Income	
Less than $25,000	4%
$25,000-$49,999	12%
$50,000-$74,999	19%
$75,000-$99,999	15%
$100,000-$124,999	13%
$125,000 or more	22%
I'd rather not say	15%
Household Income from Beef Operation	
0%	6%
Less than 25%	46%
26%-50%	20%
51%-75%	11%
Over 75%	17%
Political Affiliation	
Republican	58%
Independent	19%
Democrat	7%

Summary statistics of operation demographics are included in Table 3.3. The average number of beef cows (lactating and gestating) and replacement heifers on operations as of January 1, 2019 was 200 head with a median of 90. Operations with 100 or more beef cows account for 48% of operations and 87% of the beef cow inventory. Nationally, the average beef cow herd is 43.5 head and operations with 100 or more beef cows make up 9.9% of beef operations and house 56% of the beef cow inventory (USDA, 2017). Therefore, operations in our sample are larger than the national average (t-test value= 3.85; p-value=0.0001)

Our national survey received responses from operations in 38 states. The largest portion of our sample, 53%, is from the Midwest housing 56% of inventory, followed by 27% in the South housing 21% of inventory, 18% in the West housing 23% of inventory and 2% in the Northeast housing 0.5% of inventory.[8] According to the 2019 cattle inventory report, breakup among regions consisted of 35% in the Midwest, 45% in the South, 20% in the West and 1% in the Northeast (Livestock Marketing Information Center, 2020). On average, operations in our sample operate 3,021 acres (median 700), 2,547 of which are grazed (median 370) and 1,276 are owned (median 233). Meanwhile, the average size of beef cattle farms in the U.S. is 565 acres with 407 acres being owned (USDA, 2017).

Nearly one-third of operations in our sample have been established over 50 years while 5% have been established less than five. Meanwhile, over half of respondents have been a primary operator on their operation for more than 20 years but only 4% have been a primary operator more than 50 years showing generational changes within management. Furthermore, 24% have been primary operators less than 10 years indicating new and potentially younger management.

---

[8] Regions assigned following the U.S. census (U.S. Census Bureau, 2020). West included WA, OR, ID, MT, WY, CO, UT, NV, CA, AZ, and NM. Midwest included ND, SD, NE, KS, MN, IA, MO, WI, IL, IN, MI, and OH. South included TX, OK, AR, LA, MS, AL, TN, KY, GA, FL, SC, NC, VA, WV, MD, DC, and DE. Northeast included PA, NJ, NY, RI, CT, MA, VT, NH, and ME.

Table 3.3 Operation Summary Statistics

Demographic Variable	n=304
Average Herd Size	200
Median	90
Operation Region	
Midwest	53%
South	27%
West	18%
Northeast	2%
Inventory in Region	
Midwest	56%
South	21%
West	23%
Northeast	<1%
Average Acres Operated	3,021
Median	700
Average Acres Grazed	2,547
Median	370
Average Grazed Acres Owned	1,276
Median	233
Years Established	
Less than 5 years	5%
5 to 10 years	10%
11 to 20 years	15%
21 to 30 years	17%
31 to 40 years	12%
41 to 50 years	11%
More than 50 years	30%
Years as Primary Operator	
Less than 5 years	9%
5 to 10 years	15%
11 to 20 years	21%
21 to 30 years	23%
31 to 40 years	17%
41 to 50 years	11%
More than 50 years	4%
Risk Level	
Low Risk	25%
Mid Risk	53%
High Risk	22%
Progressiveness Level	
Below Industry Standard	20%
Industry Standard	19%
Mid-Level Progressive	27%
More Progressive	34%

BMP adoption among operations in our sample varied. The 13 BMPs analyzed in our study represented higher risk practices from Simon et al.'s (2016) 41 question questionnaire. Through collaboration with an animal welfare expert, these 13 BMPs were used to create two operation indexes, one measuring operation riskiness and one for progressiveness. If an operation indicated they use a BMP, they received the respective weight for that practice towards their index while if they did not use the practice or it was not applicable for their operation they did not receive the respective weight. The riskiness index lead to classifications of low risk, mid risk, and high risk operations while the progressiveness index lead to classifications of below industry standard, industry standard, mid-level progressive, and more progressive. A quarter of operations were classified as low risk, 53% were mid risk and 22% high risk. Meanwhile, 20% were below industry standard, 18% were industry standard, 27% were mid-level progressive, and 34% were more progressive. Further explanation of the indexes can be found in Chapter 2.

Overall, our sample consists of operations larger in herd size and acreage, more Midwest operations, and fewer operations in the South. Meanwhile, primary operator characteristics including age, education level, annual pre-tax household income and income from beef operation aligns with those nationally or found in other agricultural producer studies. Thus, our sample is not representative of all U.S. cattle operations but is representative of U.S. cattle primary operators. Coming from Michigan State University, our survey likely received more Michigan responses increasing the number of Midwest operations in our sample. Additionally, our sample likely garnered more responses from producers most interested in grazing management which may have indications as to why our sample is not representative of U.S. cattle operations. With email subject lines of "seeking your opinions on grazing management practices," "awaiting your response | grazing management practices," and "let your voice be heard on grazing management practices" our survey likely appealed especially to producers interested in grazing management styles and techniques. Although this may be a limitation, our study provides keen insights for grazing BMPs specifically.

3.4 Results and Discussion

The results of the estimated MNL and LCMs for beef producers' maximum difference responses are presented subsequently. Shares of importance have a more useful and direct interpretation than coefficient estimates thus the respected shares are shown in Table 3.4 and Table 3.5 while underlying coefficient estimates for the models are reported in Appendix C. In all models, the coefficients for each motivation are estimated relative to "trying new things."

3.4.1 Multinomial Logit Model

Assuming homogenous preferences among beef producers, the MNL shares of importance for the nine motivations are shown in Table 3.4. "Caring for the land" was largely valued as the most important motivation for current management practices with an importance share of 0.272 (Table 3.4). Managing land in a way that does not negatively affect, or even improves, the environment was nearly twice as important as "minimize risk," the second most important motivation with a share of 0.143. The relative importance of these two motivations aligns with the most important goals found for Louisiana beef producers, "maintain and conserve land" and "avoid years of loss/low profit" (Basarir and Gillespie, 2006).

The third most important motivation for current management practices, with an importance share of 0.129, is "passing on the land." It makes sense that minimizing risk and financial losses to avoid being forced out of business is marginally more important than passing on the land to future generations. If an operation is forced out of business, the opportunity to pass on land and the farm/ranch to children and/or grandchildren is not available. Nearly a third of operations in our sample have been established for more than 50 years. Thus, it is no surprise that passing on the land to future generations is important to primary operators.

Table 3.4 Multinomial Logit Model Shares of Beef Producers' Motivations for Current Management Practices

Motivation	**Share**
Caring for the Land	0.272
	[0.254, 0.291]
Minimize Risk	0.143
	[0.133, 0.151]
Passing on the Land	0.129
	[0.120, 0.137]
Enjoying Life	0.127
	[0.118, 0.135]
Maximize Profit	0.096
	[0.090, 0.103]
Teaching Others	0.075
	[0.069, 0.081]
Trying New Things	0.068
	[0.062, 0.072]
Feeling Proud	0.059
	[0.054, 0.063]
Feeling like I Belong	0.032
	[0.028, 0.035]

Note: The 95% confidence intervals in square brackets were derived following Krinsky and Robb (1986).

"Enjoying life" is the fourth most important motivation with an importance share of 0.127. Even though it remains one of the more important motivations for current management practices, it is less than half as important as "caring for the land." This relationship implies when ranchers make management decisions, practices that do not negatively affect, or even improve, the environment ("caring for the land" survey description) are twice as important as those that provide personal pleasure (portion of "enjoying life" survey description) (Table 3.1). Further, "enjoying life" remains significantly more important than the fifth most important motivation, "maximize profit." This implies that when making management decisions getting personal pleasure out of life on the farm is more important than making the most profit each year given available resources.

"Maximize profit" received a share of importance of 0.096 making it two-thirds as important as minimize risk to avoid financial loss. This may be evidence of loss aversion. Loss aversion is the tendency to prefer avoiding loss to acquiring equivalent gains. The importance, or lack thereof, of maximizing profit is interesting as 54% of our sample do not have off farm jobs and thus their contribution to the household income comes from the farm.

"Trying new things" was the third least important motivation for current management practices with a 0.068 importance share. The average age of our respondent was 58 years old with 39% being older than 60. Producers younger than 26 and older than 60 are less likely to adopt new management practices (Jelinski et al., 2019). The least two important motivations for current production practices were "feeling proud" and "feeling like I belong" with importance shares of 0.059 and 0.032, respectively.

3.4.2 Latent Class Model

Motivation heterogeneity is present across producer groups. LCMs allow for further exploration of why these differences in motivations occur and why similarities persist. Table 3.5 presents the shares of importance for each of the classes of producers identified by the LCM. AIC and adjusted BIC measures identified the five-class LCM as the preferred model over one (MNL) to four classes, confirming preference heterogeneity. The five classes had membership probabilities of 28.9%, 19.5%, 18.9%, 8.4%, and 24.4%, respectively.

Table 3.5 Latent Class Modeling Shares for Beef Producers' Motivations for Current Management Practices

Class Name	Class 1	Class 2	Class 3	Class 4	Class 5
	Larger, More Established Conventional Grazers	Average Producer	Smaller, Less Experienced, More Financially Aware	Less Experienced and Financially Aware AMP Grazers	Larger, More Established AMP Grazers
% of Sample in Class	28.9%	19.5%	18.9%	8.4%	24.4%
Motivation					
Caring for the Land	0.182	0.250	0.232	0.651	0.344
	[0.151, 0.214]	[0.200, 0.307]	[0.190, 0.280]	[0.436, 0.811]	[0.250, 0.430]
Minimize Risk	0.230	0.081	0.234	0.032	0.056
	[0.184, 0.277]	[0.064, 0.098]	[0.179, 0.295]	[0.012, 0.062]	[0.036, 0.081]
Passing on the Land	0.262	0.057	0.023	0.025	0.389
	[0.215, 0.312]	[0.044, 0.072]	[0.016, 0.033]	[0.010, 0.048]	[0.302, 0.479]
Enjoying Life	0.069	0.263	0.080	0.128	0.060
	[0.056, 0.084]	[0.213, 0.316]	[0.060, 0.102]	[0.061, 0.222]	[0.042, 0.080]
Maximize Profit	0.156	0.047	0.254	0.013	0.023
	[0.127, 0.184]	[0.036, 0.060]	[0.201, 0.309]	[0.005, 0.024]	[0.012, 0.040]
Teaching Others	0.030	0.089	0.053	0.029	0.055
	[0.021, 0.038]	[0.070, 0.109]	[0.040, 0.069]	[0.012, 0.061]	[0.036, 0.080]
Trying New Things	0.026	0.050	0.071	0.107	0.037
	[0.017, 0.037]	[0.039, 0.061]	[0.054, 0.090]	[0.053, 0.187]	[0.023, 0.054]
Feeling Proud	0.034	0.108	0.036	0.007	0.023
	[0.026, 0.042]	[0.086, 0.132]	[0.027, 0.047]	[0.002, 0.015]	[0.015, 0.033]
Feeling like I Belong	0.012	0.055	0.016	0.008	0.012
	[0.008, 0.016]	[0.044, 0.067]	[0.010, 0.022]	[0.003, 0.015]	[0.007, 0.019]

Note: Adaptive multi-paddock (AMP) is an intense grazing style that allows for dense grazing interspersed by long periods of recovery for the land by moving animals strategically within a large pasture.

Table 3.6 identifies differences in operation and operator characteristics among the five classes. Compared to other classes, class 1 consisted of operations that had on average been established longer, hold more beef cows, and were least likely to self-classify as AMP (Table 3.6). Class 1 will be called "larger, more established conventional grazers." Class 2 was most similar to the entire sample with their only significant difference being they were least likely to know their average cost of production. We will call them "average producer." Class 3 included those who had, on average, been a primary operator for a shorter amount of time, managed less beef cows, and were most likely to know their average cost of production. Class 3 will be referred to as "smaller, less experienced, more financially aware." Class 4 included, on average, less experienced primary operators who do not know their average cost of production, self-classify as AMP and own the largest percentage of grazed acres. We will call class 4 "less experienced and financially aware AMP grazers." Class 5 included, on average, operations that have been established longer, managed more beef cows and self-classify as AMP, will be referred to as "larger, more established AMP grazers". Both AMP classes, 4 and 5, were also lower risk and more progressive scoring higher values on these scales.

Table 3.7 shows statistical differences between importance shares for each motivation across the five classes. For example, class 1 and class 3 importance shares for "minimize risk" are not statistically different (p-value 0.44) but class 1's share for "passing on the land" is statistically higher than class 3's share (p-value 0.05; Table 3.7, column 3).

Larger, more established conventional grazers (class 1) and larger, more established AMP grazers (class 5) viewed "passing on the land" as the most important motivation for current management practices (Table 3.5). However, the larger, more established AMP grazers (class 5) valued it significantly more with an importance share of 0.389 (Tables 3.5 and 3.7).

Table 3.6 Descriptive Statistics Across Classes and t-Tests of Differences in Sample Average Across Classes

	Averages of Classes						*t*-Test for Differences across Classes (yes = significant at 0.10 level, blank = not significant)									
Variable	All	1	2	3	4	5	1&2	1&3	1&4	1&5	2&3	2&4	2&5	3&4	3&5	4&5
Years Established	34.4	37.2	31.9	30.4	25.8	39.1	Yes	Yes	Yes				Yes		Yes	Yes
Years as Primary Operator	23.6	24.7	23.8	19.8	18.8	26.7		Yes	Yes						Yes	Yes
Head 100+	0.5	0.6	0.4	0.3	0.4	0.5	Yes	Yes							Yes	
Do Not Know Avg. Cost of Prod.	0.7	0.7	0.8	0.6	0.8	0.6	Yes				Yes		Yes	Yes		Yes
Use AMP - Self-classified	0.3	0.2	0.3	0.3	0.5	0.4			Yes	Yes		Yes	Yes	Yes	Yes	
Market Claims - None	0.2	0.2	0.2	0.3	0.0	0.2			Yes			Yes		Yes		Yes
Riskiness Index	32.2	31.5	31.2	31.8	34.5	33.4			Yes	Yes		Yes	Yes	Yes		
Progressiveness Index	35.0	33.6	34.2	34.6	37.0	36.8			Yes	Yes		Yes	Yes			

Table 3.7 Poe Test (Poe, Giraud, and Loomis, 2005) *P* Values for Latent Class Modeling

Class Pairing / Motivation	1 & 2	1 & 3	1 & 4	1 & 5	2 & 3	2 & 4	2 & 5	3 & 4	3 & 5	4 & 5
Caring for the Land	0.01	0.05	<0.01	<0.01	0.28	<0.01	0.03	<0.01	0.01	<0.01
Minimize Risk	<0.01	0.44	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	0.05
Passing on the Land	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.50	<0.01	0.03
Enjoying Life	<0.01	0.20	0.05	0.25	<0.01	<0.01	<0.01	0.12	0.09	0.04
Maximize Profit	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Teaching Others	<0.01	<0.01	0.47	<0.01	<0.01	<0.01	0.01	0.06	0.45	<0.01
Trying New Things	<0.01	<0.01	<0.01	0.11	0.02	0.02	0.12	0.14	<0.01	0.10
Feeling Proud	<0.01	0.35	<0.01	0.07	<0.01	<0.01	<0.01	<0.01	0.03	<0.01
Feeling like I Belong	<0.01	0.14	0.21	0.38	<0.01	<0.01	<0.01	0.05	0.20	<0.01

Despite differences in management styles, operations that have been established longer and are larger in herd size largely value the opportunity to pass on their land to future generations. Further, it is not surprising two of the five classes in our sample valued “passing on the land” as the most important motivation as Greiner et al. (2009) found it to be the most important motivation among their entire sample.

Smaller, less experienced, more financially aware producers (class 3) producers viewed “maximize profit” and “minimize risk” as the most important motivations with importance shares of 0.254 and 0.234, respectively, followed closely by “caring for the land” (Table 3.5). Further, they valued “maximize profit” significantly more than any other class and “minimize risk” significantly more than everyone except larger, more established conventional grazers (class 1) with whom they valued it equally (Table 3.7). These relationships potentially indicate when more financially aware producers make management decisions within their operations, financial benefits are considered more than when producers in other classes make similar decisions. However, the direction of this relationship is unknown. It is possible these producers inherently care more about “maximizing profit” and “minimizing risk” and that is why they know their average cost of production.

Less experienced and financially aware AMP grazers (class 4) valued “caring for the land” as five times more important than any other motivation with the largest importance share of any motivation by any class of 0.651 (Tables 3.5 and 3.7). This extreme importance is likely due to a combination of grazing management style and owning the largest portion of grazed acres. AMP grazing has the potential to sequester more soil organic carbon than continuous grazing (Stanley et al., 2018). BMP adoption is higher among cattle producers who own rather than rent their land (Kim et al., 2005). Additionally, producers are likely to adopt an innovation if they expect it to help them achieve environmental goals (Greiner et al., 2009). Thus, by already adopting a BMP with the potential to improve the environment, producers are signaling this motivation is important to them. Additionally, it is no surprise producers place more value on caring for their land when they own it rather than renting or leasing.

An interesting note here is, “caring for the land” was nearly twice as important as any other motivation when treating all preferences as homogeneous in the MNL model (Table 3.4). Even though “caring for the land” is the only motivation within the top three motivations of all classes, it is only the most important motivation to 8.4% of our sample (class 4) when accounting for heterogeneity. Their strong importance share, 0.651, was statistically higher than that of any other class and thus likely skewed the MNL results.

Less experienced and financially aware AMP grazers (class 4) additionally valued “minimize risk” and “maximize profit” significantly less than any other group with importance shares of 0.032 and 0.013, respectively (Table 3.7). These exceptionally small shares are likely due to the minimal remaining importance shares available for distribution among the eight other motivations.[9]

Average producers (class 2) viewed motivations much differently than our other more defined classes. The most important motivation to them was “enjoying life” with an importance share of 0.263, significantly higher than any other group, followed by “caring for the land” with importance share of 0.250 (Tables 5 and 7). Average producers (class 2) also valued “teaching others,” “feeling proud,” and “feeling like I belong” significantly more than other classes (Table 3.7).

---

[9] Shares of importance sum to one. “Caring for the land” received importance share of 0.651, leaving 0.349 to be distributed among remaining motivations.

Even though financial-economic concerns are stated or implied to be the most important motivates for practice adoption (Chouinard et al., 2008), the importance of financial motivations, “minimize risk” and “maximize profit,” differed significantly among the five classes. No single characteristic appears to explain this difference. “Maximize profit” was the only motivation viewed statistically differently across all five classes (Table 3.7, row 7). Meanwhile, “minimize risk” was viewed statistically differently among all pairs except larger, more established conventional grazers (class 1) and smaller, less experienced, more financially aware (class 3) who both valued it as their second most important motivation. “Minimize risk” was more important than “maximize profit” for every class except smaller, less experienced, more financially aware producers (class 3) where it was only slightly less important. This relationship aligns with Smith and Capstick (1976) findings that many farmers are more concerned with minimizing the risk of going out of business than maximizing profit as well as Greiner et al. (2009) where of 32 motivations, “avoid low/negative income” was eighth and “maximize company profit” was 22nd. This relationship may additionally be evidence of loss aversion, meaning preference for avoiding loss to acquiring equivalent gains, as seen in the MNL model.

“Caring for the land” was valued differently depending on how producers classified their grazing management. Conventional grazers (class 1) valued “caring for the land” less than any other group while AMP grazers (class 4 and class 5) valued it significantly more. This implies AMP grazers care more about managing their land in a way that does not negatively affect, or even improves, the environment than conventional grazers. Less experienced and financially aware AMP grazers (class 4) and larger, more established AMP grazers (class 5) were also lower risk and more progressive than operations in other classes, signaling AMP grazing to be the common factor. It is not surprising that operations that implement progressive grazing management methods are more progressive in the adoption of other BMPs.

3.5 Conclusions and Implications

Public perceptions and expectations continue to challenge agricultural production. The beef industry remains susceptible to these challenges yet adoption of practices that mitigate these concerns, BMPs, remains low (Prokopy et al., 2008). To better understand why adoption remains low and potentially help increase BMP adoption it is important to first understand why beef producers have implemented their current management practices before trying to change their behavior. This analysis identifies motivational differences among adopters and non-adopters of one BMP, AMP grazing. Motivational differences could also exist among adopters and non-adopters of other BMPs. Exploring heterogeneity among beef producers and the differences in socioeconomical classes' motivations can further guide this understanding.

This analysis utilized best-worst scaling to determine beef producers' motivations for current management practices. Directly interpretable shares of importance for each motivation were derived from MNL and LCM coefficients. The preferred five class LCM identified heterogeneity among producers' motivations. "Passing on the land," "enjoying life," "maximize profit," and "caring for the land" all surfaced as the most important motivation for at least one producer class.

Although our sample is likely not representative of the entire beef cattle industry but rather more representative of producers with grazing management interests, these findings can guide industry professionals, extension educators, and academics in leading the discussion of BMP adoption, especially BMPs regarding grazing management. These results provide guidance for identifying target audiences as well as leading one-one-one adoption discussions. Largely, "caring for the land" is important to all beef producers as it landed within the top three motivations for every socioeconomical class. Thus, regardless of the BMP or producer, environmental benefits should be discussed with more strategized targeting and discussion to follow. For example, financially beneficial BMPs should be aimed at smaller, less experienced, more financially aware (class 3) producers. Additionally, larger, more established producers (classes 1 and 5) place more importance on passing on the land to future generations thus discussing ways in which a BMP can help them achieve this goal should be prioritized.

Furthermore, as an industry we can communicate producer motivations in effort to better inform the public and lessen scrutiny and concern. Contrary to public perceptions, beef producers care about managing their land in a way that does not negatively affect, or even improves, the environment. Smaller, less experienced, more financially aware (class 3) producers place the most importance on financial motivations yet "caring for the land" remains nearly as important (Table 3.5). Meanwhile, other producers place little to nearly no importance on financial motivations. Bridging this perception gap within the industry can lead to increased consumer trust and potentially beef demand.

Society's growing expectation that producers implement practices that significantly reduce or eliminate negative environmental impacts continues to challenge the beef industry. Technology and research innovations will continue to develop BMPs that can meet this demand. Such developments will likely arise at rates faster than practical implementation. Therefore, more specialized education strategies based on producer motivations are important for faster adoption and higher adoption rates.

CHAPTER 4: BEEF CATTLE PRODUCERS' PERCEPTIONS AND WILLINGNESS TO ADOPT ADAPTIVE MULTI-PADDOCK GRAZING

4.1 Introduction

Agricultural production often places significant pressure on the utilization of natural resources and the environment. This pressure is commonly accompanied by societal concern and scrutiny. Increased societal concern for environmental use and conservation has led to best management practice (BMP) innovations and the call for sustainable agriculture. Sustainable agriculture seeks to increase farm profitability, promote environmental stewardship, enhance farm family and community quality of life, and increase production for human food and fiber needs (NIFA, 2019).

Despite BMP innovations and increased desire for sustainable agriculture, agriculture still accounts for 10% of total U.S. greenhouse gas (GHG) emissions (USEPA, 2018). A significant portion of U.S. agricultural GHG emissions, roughly 24%, come from beef production alone (Li et al., 2016). However, changes in beef cattle production, especially changes in grazing management, can reduce U.S. agricultural GHG emissions (Li et al., 2016). Not only can changes in grazing management mitigate environmental impacts, there is also potential profit to be made as consumers are willing to pay more for beef produced using practices that mitigate GHG emissions and increase carbon sequestration (Li et al., 2016). Various forms of grazing for sustainability and regeneration have been implemented by managers and scientists with mixed results. "The [grazing] approach with the most promise (and debate about its effectiveness) is one that combines complexity or systems thinking with creative, adaptive management to manage the distribution of grazing over time, across landscapes, and plant communities, using planned movement of livestock through a series of paddocks: strategic or adaptive multi-paddock (AMP) grazing management." (Teague and Barnes, 2017:77).

AMP grazing is an intensive grazing style in which lightweight, portable fencing systems are used to strategically move animals within a large pasture, allowing for dense grazing interspersed by long periods of recovery for the land. AMP grazing is considered a BMP for its environmental benefits and improved productivity. Current research on AMP grazing is limited and focused on the methods' environmental benefits. Stanley et al. (2018) investigate the impacts of AMP grazing and related soil organic carbon (SOC) sequestration on net GHG emissions. They find that when accounting for SOC in GHG footprint estimates, finishing emissions from AMP grazing were reduced from 9.62 to -6.65 kg CO_{2-e} kg carcass weight $(CW)^{-1}$, while feedlot-finished emissions increased slightly from 6.09 to 6.12 kg CO_{2-e} kg CW^{-1} (Stanley et al., 2018). These findings indicate that AMP grazing has the potential to offset GHG emissions through soil carbon sequestration, and therefore the finishing phase could be a net carbon sink (Stanley et al., 2018). Park et al. (2017) assess hydrologic and water quality impacts of traditional continuous and AMP grazing management practices. When grazing management changed from AMP grazing to heavy continuous (HC) grazing, the simulated average (1980-2013) annual surface runoff, sediment, total nitrogen and total phosphorus losses increased by 148%, 142%, 144%, and 158%, respectively (Park et al., 2017). On the other hand, changing from HC to AMP grazing, reduced the average annual surface runoff, sediment, total nitrogen and total phosphorus loads by 39%, 34%, 33%, and 31%, respectively (Park et al., 2017).

AMP grazing is commonly associated with other adaptive grazing methods including Holistic Management (HM), High-Intensity Short Duration Grazing, and Management-Intensive Grazing (Mann and Sherren, 2018). Previous studies have analyzed perceptions of producers currently practicing adaptive grazing methods. Becker et al. (2017) find that increasing the number of paddocks improves rancher perceptions of land health sustainability on commercial ranches in North Central Texas, especially when respondents use eight or more paddocks. Stinner et al. (1997) find that HM grazers perceived increases in biodiversity, profits from land, and quality of life since implementing HM. Prior studies have also compared adaptive grazers to non-adaptive or more conventional grazers. Sherren et al. (2012) compare landscape perceptions of HM grazers with those of more conventional grazers in Australia. Such comparisons indicate HM grazers are more likely to embrace vegetative heterogeneity, appreciate a diversity of species and life stages in their pasture grass cover, and see value in protecting biodiversity than more conventional grazers (Sherren et al., 2012). HM producers were also found to be more adaptive in day-to-day farm management and long-range planning (Sherren et al., 2012). McLachlan and Yestrau (2009) find Canadian HM grazers to be more adaptive in decision making and more optimistic about the future of the Canadian livestock industry than non-HM grazers. Although previous studies have explored perceptions of adaptive grazing styles they tend to be from the perspective of adopters rather than the industry as a whole. Additionally, to our knowledge, no previous study has investigated knowledge and perceptions of AMP grazing specifically or producers' willingness-to-accept (WTA) the grazing style.

The main purpose of this article is to determine the impact of a monetary benefit, whether that be a premium at sale or cost savings during production, on AMP grazing adoption. However, it is important to first analyze where the industry stands on knowledge and perceptions of the grazing style. This understanding is essential in order to help fill the knowledge gap as well as shed light on monetary requirements. These understandings can guide extension educators and academics in leading the discussion of adopting AMP grazing in order to mitigate environmental impacts and societal pressures surrounding beef production.

Broadly, BMP adoption within the beef industry remains lower than anticipated (Prokopy et al., 2008). However, monetary benefits have the potential to increase BMP adoption especially when it comes to grazing management. Kim et al. (2008) examine the effects of cost-share levels on Louisiana cattle producers' willingness to adopt rotational grazing. They find cost-share levels positively influence willingness to adopt and their results suggest for each percentage increase in cost-share burden on a producer their probability to adopt could decline by as much as 0.85% (Kim et al., 2008). Jensen et al. (2015) estimate the effects of per acre incentive payments on prescribed grazing adoption; they find that an average annual incentive of just over $50 per acre would encourage adoption. Past studies have analyzed the impact of monetary benefits on different grazing methods but have not investigated AMP specifically.

This paper contributes to the literature by filling gaps in three ways. First, we examine current grazing management practices and AMP grazing utilization. From this we can better understand who has adopted AMP grazing and what population of producers could be targeted for future AMP grazing adoption. Second, we analyze knowledge and perceptions of AMP grazing. These findings indicate where the industry stands on AMP grazing and where knowledge or perception gaps exist. Finally, we investigate the impact of a monetary benefit on AMP grazing adoption. Using a dichotomous choice contingent valuation question with a split design we estimate mean WTA AMP grazing for a premium or cost reduction on feeder steers. Within this, we examine what producers are more or less likely to adopt AMP grazing based on requiring a lower or higher benefit for adoption. By combining these contributions AMP grazing education and adoption efforts can be more targeted and strategic.

4.2 Methodology

In September 2019, an online survey investigating knowledge, perceptions, utilization, and WTA AMP grazing was completed by 459 beef grazers. To increase response rate, $50 gift cards administered via BEEF Magazine were offered to ten randomly responding producers. Grazers were targeted through BEEF Magazine in two iterations. The first email was sent to a listserv of cow-calf producers with 25+ head with a follow up three weeks later receiving 351 responses. The first email was delivered to 52,202 emails and opened by 2,160. The second email was delivered to 50,036 emails and opened by 1,582 individuals. Response rate from delivered emails is 0.3% while response rate from opened emails is 9.4%. Emails came from a newly created email by BEEF Magazine special for this survey rather than their daily newsletter email. Thus, we expect many emails went to spam. Additionally, select beef producer associations were contacted for collaboration. The survey was sent though Michigan, Oklahoma, Arkansas, and South Dakota Cattlemen's Associations, Kansas Livestock Association, and two cattle grazing listservs, collecting 108 responses. Response rate from this effort is unknown due to not having access to each association's email listservs. Likelihood-ratio tests were used to determine statistical differences did not exist among respondents from different sources indicating the pooled sample could be used for analysis. Email messages sent to elicit responses are provided in the appendix.

From the 459 responses, 40 were dismissed for answering no to one of the following qualifying questions: 'Do you voluntarily agree to participate in this research study?', 'Are you a primary operator on a beef cattle operation?' and 'Does your operation graze beef cattle?'. An additional 96 incomplete responses were dismissed along with one outlier leaving 322 useable responses.[10]

[10] The respondent indicated they owned 450,250 cows.

4.2.1 Knowledge and Perceptions of Adaptive Multi-Paddock Grazing

Producers were introduced to AMP grazing with a definition then asked a series of questions regarding their knowledge and perceptions of the grazing style.[11] First, they were asked if they had heard of AMP grazing. If they indicated they had heard of AMP grazing or were familiar with the concept but not the name they received follow up questions asking if they would frame AMP grazing as a BMP, if they use AMP grazing, and how many AMP grazers they know. If respondents self-classified as AMP grazers by saying "yes" to using the practice, we will refer to them as AMP grazers. If respondents had not heard of AMP grazing, indicated they do not practice AMP grazing or they practice a similar adaptive style but not classified as AMP grazing, we will refer to them as non-AMP grazers. To better understand producers practicing AMP grazing, demographic characteristics, marketing claims and desired improvements of AMP and non-AMP grazers are compared using *F*-tests.

Interested in understanding how current grazing management and knowledge of AMP grazers impacts whether or not a producer frames AMP grazing as a BMP, cross-tabulations were created in SAS 9.4 software (SAS, 2002). Chi-square tests were used to test for statistical differences (Severino, n.d.).

4.2.2 Willingness to Adopt Adaptive Multi-Paddock Grazing

To determine potential impact of a monetary benefit on AMP grazing adoption, a split-sample design was utilized in which different respondents were randomly assigned to one of two different

---

[11] AMP survey definition: Adaptive multi-paddock (AMP) grazing is an intensive grazing method in which lightweight, portable fencing systems are used to move animals strategically around a large pasture, allowing for dense grazing interspersed by long periods of recovery for the land. This grazing method may be known by other names including holistic management or high intensity-short duration grazing.

treatments – half were shown dichotomous choice questions framed as a per hundredweight (cwt) premium on feeder steers sold and half as a per cwt cost reduction. The two treatments were designed to test for loss aversion. Loss aversion is the tendency to prefer avoiding loss to acquiring equivalent gains. If loss aversion exists in our sample the WTA for a cost reduction will be lower than WTA for a premium.

If respondents indicated they did not know what AMP grazing was, did not use AMP grazing or used a similar adaptive style but not AMP grazing, they were asked a double bounded dichotomous choice question (Hanemann et al., 1991): 'Would you be willing to adopt an adaptive multi-paddock grazing method for a **premium (cost reduction)** of $*X* /cwt on each 500-599 lb. steer sold? YES OR NO'. If the respondent answered YES to the initial choice question, they received a subsequent question asking if they would adopt for a premium (cost reduction) of $ (0.5**X*) /cwt. Conversely, if the respondent answered NO, they were subsequently asked if they would adopt for a premium (cost reduction) of $ (1.5**X*) /cwt.

The initial premium (cost reduction), *X,* varied randomly from $0.10 to $18.06 per cwt. This range was determined by analyzing percentage premiums received for similar value-added feeder calf programs in prior studies. Bulut and Lawrence (2006) estimated price premiums for preconditioning claims (vaccinations and minimum 30 days of weaning) with third-party certification to be $6.12/cwt. During the time period their data was collected, October 2005 to February 2006, the average monthly feeder futures price was $113.66/cwt, making the $6.12/cwt premium a 5.38% premium (6.12/113.66 = 0.0538) (LMIC, 2020). This process was conducted for value added health and certification programs analyzed by Zimmerman et al. (2012), King et al. (2006), and Schumacher et al. (2012) providing percentage premium ranges from 5.71% to 9.53%. Additionally, Blank et al.'s (2016) premiums as a percentage of sales price ranging from

0.37% to 1.64% were considered. From these prior studies, we concluded our premium percentages should at least range from 0% to 10%. Erring on the side of caution, our final range included 0% to 12.5% of the average monthly feeder futures for September 2018 to August 2019, $144.44 (LMIC, 2020).

The double bounded dichotomous choice model has been found to have improved statistical efficiency over the single bounded model (Hanemann et al., 1991). However, the double bounded model relies on the underlying assumption that individuals will respond to the follow-up bid exactly the same as if it had been the starting bid (Hanemann et al., 1991) – this is known as "response consistency." A number of empirical studies have proposed psychological explanations for response inconsistency in the double bounded model (Cameron and Quiggin, 1994; Herriges and Shogren, 1996; Alberini et al., 1997; Bateman et al., 2001; DeShazo, 2002). Respondents may use the information in the first question to inform their decision in the second question through anchoring or starting point bias (Boyle et al., 1985; Herriges and Shogren, 1996; Boyle et al., 1997). Alternatively, using prospect theory, respondents would frame the bid in question two as a gain or loss against the initial bid in question one (DeShazo, 2002). Mitchell and Carson (1989) propose a "strategic behavior model" where respondents answer the first question truthfully but the second question strategically because they feel they are now a part of a bargaining situation.

Following Cameron and Quiggin (1994) we test for response consistency by modeling the joint distribution of the two WTA values with a bivariate normal distribution model. We find response inconsistency within our double bounded model and opt to only use the single bounded model. The single bounded model remains a popular technique among practitioners of contingent valuation for its attractive features with respect to the double bounded model. The single bounded method requires less information, is easier to implement at data collection and estimation stages, and can avoid systematic bias in responses (Calia and Strazzera, 2000). Additionally, the improved efficiency of the double bounded model over the single bounded model tends to decrease as sample size increases (Calia and Strazzera, 2000). From the single bounded model we can estimate producer i's WTA for a benefit:

$$WTA_i(z_i, u_i) = z_i\beta + u_i,$$

where z_i is a vector of explanatory variables pertaining to respondent *i,* β is a vector of parameters, and u_i is an error term. It is expected that an individual will answer no when their WTA is more than the bid amount, P_i. , i.e. when $WTA_i > P_i$. Thus, the probability of observing a negative response given the values of the explanatory variables is:

$$Pr(y_i = 0|z_i) = Pr\ (WTA_i > P_i)$$

$$= Pr\ (z_i\beta + u_i > P_i)$$

$$= Pr\ (u_i > P_i - z_i\beta)$$

Assuming that $u_i \sim N(0, \sigma_2)$ we have:

$$Pr(y_i = 0|z_i) = Pr\left(v_i > \frac{P_i - z_i'\beta}{\sigma}\right)$$

$$= 1 - \Phi\left(\frac{P_i - z_i'\beta}{\sigma}\right)$$

$$Pr(y_i = 0|z_i) = \Phi\left(z_i'\frac{\beta}{\sigma} - P_i\frac{1}{\sigma}\right)$$

where $v_i \sim N(0,1)$ and $\Phi(x)$ is the standard cumulative normal distribution function. We estimate this model using the probit command in Stata. The probit model follows the form:

$$y = \alpha + \beta_1 P + \beta_k z_k + \varepsilon$$

If the model is estimated with only a constant term, mean WTA is determined by dividing the constant, α, by the bid coefficient, β_1. Additional explanatory variables of interest are included in the model to examine subject-specific characteristics. When this is done, mean WTA can be determined using sample averages for the independent variables included:

$$\overline{WTA} = -(\alpha + \sum_k (\beta_k \bar{z})) / \beta_1$$

We estimate probit models for the pooled sample along with both treatments, premium and cost reduction, to determine if the framing of the benefit as a premium or cost reduction impacted producers WTA. A likelihood ratio test was used to test the null hypothesis that WTA was the same in each treatment. We fail to reject the hypothesis of common parameters across the two treatments implying WTA did not differ depending on which treatment was shown (premium or cost reduction) implying the pooled sample can be used. Therefore, loss aversion is not supported. When adding explanatory variables of interest to the full sample probit model Akaike information criterion (AIC; Boxall and Adamowicz, 2002) and adjusted Bayesian information criterion (BIC; Dziak et al., 2019) tests were used to identify the preferred model.

4.3 Results and Discussion

Primary operator summary statistics for the full sample, along with AMP and non-AMP grazers, are found in Table 4.1. The average age of primary operators in our sample was 58 years old, aligning with the national average of 57 (NCBA, 2019). Education levels and annual pre-tax household incomes for our sample align with those found in other agricultural producer studies (Thompson et al., 2019; McKendree et al., 2018; Ward et al., 2008). Sixty-five percent of our sample have a Bachelor’s degree or higher and 17% have annual pre-tax household incomes less than \$50,000 while 71% are more than \$50,000. Most (75%) of our sample’s beef operation contributes 50% or less of the annual household income. The majority of primary operators identified as Republican trailed by Independent then Democrat with 57%, 19%, and 8%, respectively.

Table 4.1 Primary Operator Summary Statistics

Demographic Variable[12]	Full sample (n = 322)	AMP (n = 110)	Non-AMP (n = 222)
Average Age	57.9	56.5	58.4
Earned Bachelor's (B.S. or B.A.) Degree or Higher	65%	71%	62%
Annual Pre-Tax Household Income			
Less than $25,000	5%	3%	5%
$25,000-$49,999	13%	12%	12%
$50,000-$74,999	19%	27%	14%
$75,000-$99,999	16%	13%	15%
$100,000-$124,999	14%	11%	14%
$125,000 or more	23%	18%	23%
Household Income from Beef Operation			
0%	7%	8%	5%
Less than 25%	48%	41%	47%
26%-50%	20%	19%	19%
51%-75%	12%	15%	10%
Over 75%	19%	16%	18%
Political Affiliation			
Republican	57%	53%	59%
Independent	19%	22%	18%
Democrat	8%	9%	7%

Table 4.2 presents operation summary statistics for the full sample and two grazing classifications. The average number of beef cows, lactating and gestating, and replacement heifers on operations as of January 1, 2019 was 211 head with a median of 90. Our sample average is higher than the national average, 43.5 head, due to several larger producers in the sample (t-test

[12] Primary operator characteristics did not differ between AMP and non-AMP grazers.

value= 4.06; p-value= 0.0001; USDA, 2017). Fifty-four percent of our sample is from the Midwest holding 51% of our sample's inventory, followed by 27% in the South with 20% of inventory, 17% in the West with 28% of inventory, and 2% in the Northeast with 0.4% of inventory.[13] According to the 2019 cattle inventory report, inventory breakup by region consists of 35% in the Midwest, 45% in the South, 20% in the West and 1% in the Northeast (LMIC, 2020). Operations in our sample operate on average 2,982 acres (median 663) while grazing 2,516 acres (median 350) and owning 1,247 acres (median 220). Nationally, the average size of beef cattle farms in the U.S. is 565 acres with 407 acres being owned (USDA, 2017). Almost one-third of operations in our sample have been established more than 50 years while 5% have been established less than five. A quarter of respondents have been a primary operator less than 10 years indicating new and potentially younger management along with generational changes within management.

BMP adoption varied within our sample. The 13 BMPs analyzed in our study were gathered from Simon et al.'s (2016) 41 question questionnaire and represent practices placing operations at higher risk if not implemented. While the beef industry does not have federal standards for animal welfare or management practices, there are recommended BMPs for animal welfare and operation longevity based on scientific research (BQA, 2020). Through collaboration with an animal welfare expert, the 13 BMPs in our analysis were used to establish operation riskiness and operation progressiveness indexes. If an operation used a BMP, they received the respective weight for that practice towards their index value while if they did not use the practice or it was not applicable to their operation they did not receive the respective weight. Based on these indexes, a quarter of operations were classified as low risk, 53% were mid risk and 22% were

[13] Regions assigned following the U.S. census (U.S. Census Bureau, 2020). West included WA, OR, ID, MT, WY, CO, UT, NV, CA, AZ, and NM. Midwest included ND, SD, NE, KS, MN, IA, MO, WI, IL, IN, MI, and OH. South included TX, OK, AR, LA, MS, AL, TN, KY, GA, FL, SC, NC, VA, WV, MD, DC, and DE. Northeast included PA, NJ, NY, RI, CT, MA, VT, NH, and ME.

high risk for animal welfare and operation longevity concerns. Progressiveness classifications included 20% being below industry standard, 19% were industry standard, 27% were mid-level progressive and 34% were more progressive. Further explanation of the indexes can be found in Chapter 2.

One potential limitation is our sample's representativeness. Overall, operations in our sample are on average larger in herd size and acreage, more concentrated in the Midwest and less in the South than the national population. However, primary operator demographics in our sample align with those nationally or in other agricultural studies. Therefore, our sample is likely not representative of all cattle operations in the U.S. but is representative of U.S. cattle primary operators. Potentially we received more Midwest, especially Michigan, responses due to Michigan State University's name recognition and due to the follow-up sampling strategy. Additionally, with email subject lines of "seeking your opinions on grazing management practices," "awaiting your response | grazing management practices," and "let your voice be heard on grazing management practices" our survey likely receive more responses from producers most interested in grazing management. With this, our sample may have more producers self-identifying as AMP grazers than what actually exists in the industry. Producers in our sample may also be more likely to know of AMP grazing or have skewed perceptions – positive or negative – based on their prior knowledge of grazing systems. Although this may be a limitation, our study provides keen insights on who is practicing AMP grazing, an overview of industry perceptions of AMP grazing, and WTA the style.

Table 4.2 Operation Summary Statistics

Demographic Variable	Full Sample (n=322)	AMP (n=100)	Non-AMP (n=222)
Average Herd Size	211	176	227
Median	90	100	80
Operation Region			
Midwest	54%	54%	54%
South	27%	26%	27%
West	17%	18%	17%
Northeast	2%	2%	2%
Inventory in Region			
Midwest	51%	37.6%	55.9%
South	20%	29.9%	17.0%
West	28%	32.0%	26.7%
Northeast	0.4%	0.5%	0.4%
Average Acres Operated	2982	2636	3138
Median	663	500	700
Average Acres Grazed	2516	2265	2630
Median	350	350	355
Average Grazed Acres Owned	1247	1262	1241
Median	220	200	230
Years Established			
Less than 5 years	5%	6%	4%
5 to 10 years	11%	18%	7%
11 to 20 years	16%	16%	15%
21 to 30 years	18%	14%	19%
31 to 40 years	13%	11%	13%
41 to 50 years	12%	9%	12%
More than 50 years	31%	26%	31%
Years as Primary Operator			
Less than 5 years	9%	11%	7%
5 to 10 years	16%	23%	12%
11 to 20 years	22%	16%	23%
21 to 30 years	25%	19%	26%
31 to 40 years	18%	14%	18%
41 to 50 years	12%	12%	10%
More than 50 years	5%	5%	4%
Risk Level			
Low Risk	25%	29%	23%
Mid Risk	53%	50%	54%
High Risk	22%	21%	23%
Progressiveness Level			
Below Industry Standard	20%	14%	23%
Industry Standard	19%	22%	17%
Mid-Level Progressive	27%	25%	27%
More Progressive	34%	39%	32%

Note: Boldface demographic variable indicates statistical difference between AMP and non-AMP grazers at 5% level

4.3.1 Differences in Adaptive Multi-Paddock and Non-Adaptive Multi-Paddock Grazers

Table 4.3 presents summary statistics of producers' knowledge, utilization, and perceptions of AMP grazing. The majority of our sample (78%) have heard of AMP grazing while 16% are familiar with the concept but not the name and 5% have not heard of AMP grazing. Those who have heard of AMP grazing or are familiar with the concept were asked follow up questions regarding the grazing style. From this group, 33%, or 100 producers, indicated they practice AMP grazing, 25% (77 producers) practice a similar style but not AMP grazing, and 42% (128 producers) do not practice AMP grazing or a similar style. The 100 producers practicing AMP grazing are classified as AMP grazers while the 77 practicing a similar style, 128 not practicing AMP grazing, and 17 who have not heard of AMP grazing are classified as non-AMP grazers. These classifications indicate 31% of our sample are AMP grazers and 69% are non-AMP grazers. This is significantly higher than the only other estimate of AMP grazers, which estimated 5-10% (Sherren and Kent, 2018). Again, this may be a reflection of the over-representation of those interested in grazing management in our sample.

Table 4.3 Knowledge and Perceptions of Adaptive Multi-Paddock (AMP) Grazing

Heard of AMP (n = 322)	
Yes	78%
No	5%
Familiar	16%
Use AMP (n = 305)	
Yes	33%
No	42%
Similar adaptive style but not AMP	25%
Number of AMP Grazers Known (n = 305)	
1	10%
2 to 5	40%
6 to 10	9%
More than 10	10%
None	31%
Consider AMP a Best Management Practice (n = 305)	
Yes	62%
No	8%
Don't Know/Mixed	30%

Largely, demographic characteristics of AMP and non-AMP grazers do not differ (Tables 4.1 and 4.2). Statistical differences between the two groups are found in operation establishment length, years as primary operator, and progressiveness. Operations practicing AMP grazing have on average been established fewer years than those not practicing AMP grazing. Forty percent of AMP grazing operations have been established less than 20 years, 24% of which have been established less than 10 years. Meanwhile, only 26% of non-AMP grazing operations have been established less than 20 years. Notably, both groups have a significant portion of operations established more than 50 years (26% of AMP and 31% of non-AMP). Primary operators of AMP grazing operations have been in their current role for less years than non-AMP grazing primary operators. This aligns with producers practicing HM grazing who have also been found to be earlier in their career than those practicing more conventional grazing styles (Sherren et al., 2012). However, this does not indicate that AMP grazing operators are younger, as age is not statistically different across groups. Over a third of AMP grazing operators have been a primary operator less than 10 years compared to 19% of non-AMP grazing operators. Even though AMP grazing operations tend to be newer than non-AMP grazing counterparts there still exists a handful of AMP grazing operations that have been established for more than half a century. It is possible these more established operations have experienced generational changes in management which included changes in grazing style.

Operations practicing AMP grazing tend to be more progressive than those not practicing AMP. Thirty-nine percent of AMP grazing operations are classified as more progressive, 25% as mid-level progressive, 22% as industry standard, and 14% as below industry standard. Comparatively, 32% of non-AMP grazing operations classified as more progressive, 27% as mid-level progressive, 17% as industry standard, and 23% as below industry standard. AMP grazing is a newer, adaptive grazing style thus it is no surprise operations who have already implemented the BMP are more progressive in other BMP adoption. Interestingly, AMP grazers and non-AMP grazers did not differ in operational riskiness. Even though non-AMP grazers are not implementing as many progressive BMPs they are still implementing practices that put them at high risk of animal welfare and operation longevity concerns, if not adopted.

More differences among the two grazers arise in their marketing claims and desired operational improvements (Table 4.4). AMP grazers more frequently market their cattle with natural (no hormones/no antibiotics) and grass-fed claims with 51% and 37%, respectively. Meanwhile, 28% of non-AMP grazers market as natural and 18% market as grass-fed. On the other hand, non-AMP grazers (61%) market their cattle as pre-conditioned (weaning or vaccination claims) significantly more than AMP grazers (46%). These marketing differences may be due to differences in operational set up and what segments of the beef industry AMP grazers and non-AMP grazers are a part of. AMP grazers were more likely to indicate a portion of their operation was dedicated to the backgrounder/stocker sector along with the grass finisher sector, 34% and 37% respectively, compared to non-AMP grazers with 24% and 9%, respectively. Meanwhile, non-AMP grazers were more likely to have a portion of their operation dedicated to the feedlot sector, 16%, compared to AMP grazers, 7%.

AMP grazers indicated more desired improvements within their beef operations than non-AMP grazers selecting on average 4.75 of 11 improvements compared to 3.85. Significant differences exist in AMP grazers' desire to improve water infiltration, wildlife habitat/habitation, community involvement, reduce GHG emissions, and reduce water runoff. AMP grazing has been found to increase water infiltration and reduce runoff while reducing the overall beef GHG footprint (Park et al., 2017; Stanley et al., 2018). By implementing AMP grazing and by being more progressive, AMP grazers have already signaled the importance of improving their operation through BMP adoption. It is interesting that despite steps already taken to improve their operation they still want to improve it further.

Table 4.4 Market Claims and Desired Improvement of Adaptive Multi-Paddock (AMP) Grazers and Non-AMP Grazers

	Full Sample (n = 322)	AMP (n = 100)	Non-AMP (n = 222)
Market Claim			
None (conventional production)	20%	15%	22%
Age and source verified (ASV/SAV)	24%	24%	24%
Natural (no hormones/no antibiotics)	35%	51%	28%
Organic	2%	3%	2%
Humanely raised	23%	24%	22%
NHTC (Non-hormone treated)	20%	21%	20%
Pre-Conditioned (weaning/vaccination claim)	57%	46%	61%
Grass-fed	24%	37%	18%
Other	7%	10%	6%
Desired Improvement			
Profitability	84%	85%	83%
Minimize Costs	69%	64%	71%
Forage Quality	69%	74%	67%
My Quality of Life	43%	47%	41%
Water Infiltration	31%	47%	23%
Wildlife Habitat/Habitation	30%	39%	25%
Reduce Water Runoff	30%	44%	23%
Animal Welfare	25%	28%	23%
Community Involvement	14%	23%	10%
Reduce Greenhouse Gas Emissions	14%	20%	11%
None	2%	1%	3%

Note: Boldface indicates statistical difference between AMP and non-AMP grazers at 5% level

The two grazing groups on average received different prices per cwt for steers in the last year. Operators in the full sample received on average $146.44 per cwt for steers in the last year with minimum of $80.00 per cwt and maximum of $250.00 per cwt. This is comparable with the average feeder futures prices for the same time period of $144.87 per cwt (LMIC, 2020). On average, AMP grazers received $149.64 per cwt while non-AMP grazers received $145.10 per cwt. This $4.54 difference may be from AMP grazers' utilization of natural and grass-fed marketing claims. Although these differences are not statistically different, this difference may indicate a small, indirect, premium already exists for the grazing management method. Another interesting note is AMP grazers were more likely to know their average cost of production per head for steers as 38% stated they knew it compared to only 27% of non-AMP grazers. Additionally, the AMP grazers are more likely to keep financial records, 93% compared to 80% of non-AMP grazers. These relationships indicate AMP grazers may be more financially aware than non-AMP grazers.

4.3.2 Knowledge and Perceptions of Adaptive Multi-Paddock Grazing

Even though most of our sample had heard of AMP grazing or were familiar with the concept, producers had mixed opinions on framing it as a BMP and indicated several perceived challenges hindering adoption. Sixty-two percent of producers considered AMP grazing a BMP while 8% did not and 30% did not know or were mixed. Utilization of AMP grazing and the number of AMP grazers known impacted producers' framing of AMP grazing as a BMP (Table 4.5). Nearly all (95%) AMP grazers identified AMP grazing as a BMP yet 3% were still mixed and 2% did not classify it as a BMP. Producers who practice a grazing style similar to AMP grazing but not AMP grazing were also most likely to classify AMP grazing as a BMP (62%) while 34% remained mixed and 4% said no. The most uncertainty came from producers who said they do not practice AMP grazing as 49% were mixed on framing it as a BMP, 34% said yes and 16% no.

The more AMP grazers a respondent knew, the more likely they were to frame AMP grazing as a BMP. Producers who knew none or only one AMP grazer were more distributed on how they framed the practice. Of those who knew no AMP grazers, 43% framed AMP grazing as a BMP, 11% did not, and 45% were mixed. Of those who knew one AMP grazer, 40% framed

AMP grazing as a BMP, 17% did not, and 43% were mixed. Of those who knew two to five, six to ten, and more than ten, 70%, 73%, and 97%, respectively, framed AMP grazing as a BMP. It is not surprising as the number of AMP grazers known increased so did perceptions that it is a BMP.

Non-AMP grazers were asked to select challenges that would hinder their adoption of AMP grazing, we call these expected challenges (Table 4.6). Forty-five percent of non-AMP grazing operations indicated their operation was not set up for the grazing style, 36% said AMP grazing is too time consuming, and another 36% indicated they do not have enough help on the farm. Other expected challenges included financial requirements by 18% of non-AMP grazers, other by 17%, and forage quality by 11%. Notably, 7% of non-AMP grazers indicated none of the challenges presented would hinder their adoption.

In a parallel fashion, AMP grazers were asked to select the biggest challenge when adopting AMP grazing, we call these experienced challenges (Table 4.7). The largest portion (49%) of AMP grazers indicated setting up their operation to be the biggest challenge while 16% indicated getting forage quality high enough to be the biggest challenge. Additional time and financial requirements were only the biggest challenge to 7% and 4% of AMP grazers, respectively, indicating these additional requirements are not as intense as expected by non-adopters. Ten percent of AMP grazers experienced no challenges when adopting AMP grazing.

Table 4.5 Crosstabulation of Framing Adaptive Multi-Paddock (AMP) Grazing as a Best Management Practice with Using AMP Grazing and Number of AMP Grazers Known

	Use AMP			Number of AMP Grazers Known				
AMP is BMP	Yes	No	Similar	One	Two to Five	Six to Ten	Ten+	None
Yes	95	44	48	12	85	19	30	41
	95%	34%	62%	40%	70%	73%	97%	43%
No	2	20	3	5	7	2	0	11
	2%	16%	4%	17%	6%	8%	0%	11%
Don't Know/Mixed	3	63	26	13	30	5	1	43
	3%	49%	34%	43%	25%	19%	3%	45%
$\chi 2$-value	397.06			347.14				
P-value	<0.01			<0.01				

Note: Number of responses, column percent

Table 4.6 Expected Challenges that Hinder Adoption of Adaptive Multi-Paddock Grazing

Challenge	n=222
My operation is not set up for this kind of grazing	45%
I do not have enough help on the farm	36%
It is too time consuming	36%
The financial requirement for set up is too high	18%
Other	17%
My forage quality is not good enough	11%
I do not know enough about the management style	9%
I do not see any benefit in the management practice	7%
None of the above	7%
I would have to change my herd size	5%

Table 4.7 Biggest Experienced Challenge When Adopting Adaptive Multi-Paddock Grazing

Challenge	n=100
Setting up my operation for this grazing management style	49%
Getting my forage quality high enough	16%
There were no challenges	10%
Other	10%
It is much more time consuming	7%
The financial requirements	4%
Finding enough information about the management style	3%
The financial requirements	4%
Changing my herd size	1%

Setting up an operation for AMP grazing is both an expected and experienced challenge. Thus, when encouraging AMP grazing adoption it is important to focus on ways this transition can be done as easily as possible. Other expected challenges however are not as commonly experienced. This provides the opportunity to lessen producer concern when considering adoption. Additionally, improving forage quality may be an overlooked challenge by those considering adoption. When leading AMP grazing adoption it is important producers understand the forage requirements and are prepared to meet them in order to maximize benefits from the grazing style.

4.3.3 Willingness to Adopt Adaptive Multi-Paddock Grazing

Non-AMP grazers were asked their WTA AMP grazing for a premium (or cost reduction) per cwt for each 500-599 lb. steer sold. An estimated supply curve based on the portion of positive responses for bids by $2 per cwt increments is shown in Figure 4.1. The estimated supply cure is not as smooth or upward sloping as anticipated, based on the law of supply. However, overall the portion of positive responses did increase as the benefit offered increased indicating a premium (cost reduction) would increase AMP grazing adoption.

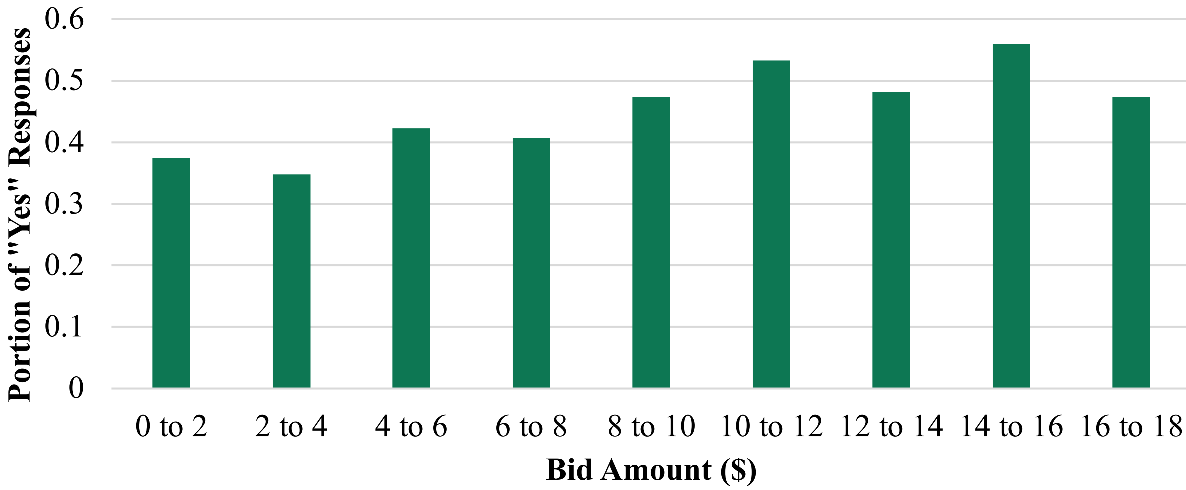

Figure 4.1 Dichotomous Choice Question Portion of Positive Responses to Bids by Category

A base model, including only a constant and the bid, is estimated in Table 4.8. From this model we derive a mean WTA of $12.96/cwt for each 500-599 lb. steer sold. This value is a 9% premium based on average monthly feeder futures for September 2018 to August 2019. This percentage premium is similar to that found by Schumacher et al. (2012) of 9.53% for calves sold vaccinated against respiratory (viral and bacterial) and clostridial/blackleg, treated for internal and external parasites and weaned for at least 45 days.

To determine the impact of demographics and perceptions of AMP grazing on WTA, model two was estimated (Table 4.8). Several demographic characteristics influenced WTA. If an operation is a part of the grass finisher sector of the beef industry, they would adopt AMP grazing at a lower benefit than those that are not. It is possible grass finishers anticipate lower start-up costs since they are already pasture based. Additionally, they may be more familiar with pasture care techniques that increase forage quality more efficiently thus offsetting start-up costs.

Meanwhile, other demographic variables had the opposite effect. If an operation was located in the Midwest, had a more experienced primary operator, or owned more than 50% of the acres grazed, the producer required a higher benefit to be willing to adopt AMP grazing. It is possible Midwest producers have different perceptions of AMP grazing, anticipate more or different challenges to adopting the grazing style, or have operations that would require higher switching costs. More experienced primary operators are likely more set in their ways with current management practices and thus less likely to adopt new practices. It is surprising operators who own more than 50% of the acres grazed require a higher benefit for adoption. We would expect operators who own their land to be more willing to invest in sustainable practices. Additionally, BMP adoption has been found to be higher among cattle producers who own rather than rent their land (Kim et al., 2005).

Perceptions of AMP grazing and expected challenges that hinder AMP grazing adoption also influenced WTA. WTA benefits required are higher for producers who do not frame AMP grazing as a BMP compared to those who do or are unsure. If producers indicated they do not have enough help on the farm to adopt AMP grazing, their operation is not set up for AMP grazing, or they do not see a benefit in AMP grazing, they required a higher WTA benefit. Meanwhile, producers who have no expected challenges that hinder AMP grazing adoption require a lower WTA benefit. When accounting for these explanatory variables mean WTA is $17.41/cwt.

Lower benefits indicate a producer is more willing to adopt AMP grazing. This lower required benefit is potentially due to lower anticipated switching costs or high valuations of AMP grazing's environmental and productivity benefits. Higher benefits imply a producer is less willing to adopt AMP grazing. This is likely due to higher anticipated switching costs or not seeing any benefit to the practice. By understanding what producers are more or less likely to adopt AMP grazing we can target adoption strategies towards specific producer groups. For example, grass finishers, producers who own less than 50% of the land they graze, and newer primary operators will adopt for lower benefits; thus, they should be targeted. Meanwhile, less focus should be placed on producers in the Midwest as they require higher benefits and are less likely to adopt.

While we cannot influence demographic characteristics of beef producers we can potentially shape their perceptions of AMP grazing. It is not surprising that producers who anticipate challenges when adopting AMP grazing require a higher benefit in order to adopt. However, the differences in expected challenges and experienced challenges provides room to lessen these concerns and potentially lower the required benefit. Producers who expect a lack of on-farm help to hinder their adoption of AMP grazing likely require a higher benefit in order to hire additional help. This expectation however may not be as big of an issue as anticipated. Few AMP grazers experienced added time to be the biggest challenge when adopting AMP grazing indicating extra hands on the farm may not be necessary (Table 4.7). These differences in expected and experienced challenges provides room to educate non-AMP grazers of actual experienced challenges and directly address expected challenges. Additional room for education includes informing non-AMP grazers of the practices' found benefits. By doing this, non-AMP grazers may change their perceptions of the grazing style, see benefits in the practice, and frame it as a BMP. These education efforts may not only lessen the required benefit for producers with concerns but also increase AMP grazing adoption.

Table 4.8. Dichotomous Choice Probit Models

Parameter	Model 1	Model 2
Premium (Cost Reduction)	0.028*	0.014
	(0.017)	(0.019)
Constant	-0.364**	1.083***
	(0.173)	(0.346)
Grass Finisher[14]		0.935**
		(0.382)
Midwest[15]		-0.324*
		(0.189)
Primary Operator Years		-0.016**
		(0.007)
Own 50% of Grazed Acres[16]		-0.554**
		(0.227)
AMP is not BMP[17]		-0.531*
		(0.329)
Hinder: Help[18]		-0.407**
		(0.201)
Hinder: Operation Set Up[19]		-0.555***
		(0.195)
Hinder: No Benefit[20]		-0.713*
		(0.429)
Hinder: None[21]		1.021**
		(0.452)
n	220	220
LL	-150.20	-121.46
Akaike information criterion/ Bayesian information criterion	304.40/ 311.19	264.92/ 302.25

Note: Numbers in parentheses are standard errors; *, **, *** denote 10%, 5%, and 1% significance levels, respectively.

[14] 1 = portion of beef operation is dedicated to grass finisher sector; 0 otherwise
[15] Operation is located in ND, SD, NE, KS, MN, IA, MO, WI, IL, IN, MI, or OH
[16] 1 = own 50% or more of acres grazed; 0 otherwise
[17] 1 = would not frame adaptive multi-paddock (AMP) grazing as a best management practice (BMP); 0 otherwise
[18] 1 = expected challenge to hinder AMP adoption is not enough on farm help; 0 otherwise
[19] 1 = expected challenge to hinder AMP adoption is operation set up; 0 otherwise
[20] 1 = expected challenge to hinder AMP adoption is not seeing a benefit in AMP; 0 otherwise
[21] 1 = no expected challenges to hinder AMP adoption; 0 otherwise

4.4 Conclusions and Implications

Agricultural production continues to face societal concern and scrutiny for its environmental impacts. This increased concern has led to higher demands for agricultural products produced via environmentally friendly and sustainable methods. Through the adoption of BMPs, beef producers can significantly lower their GHG emissions and environmental footprint to meet this demand. The BMP, AMP grazing, can improve animal and forage productivity, increase water infiltration and reduce water runoff while sequestering more soil organic carbon than continuous grazing (Park et al., 2017; Stanley et al., 2018).

Broadly, BMP adoption within the beef industry remains lower than anticipated (Prokopy et al., 2008). Additionally, current AMP grazing studies have focused on the practices' environmental benefits leaving a gap in knowledge of the industry's adoption, knowledge, perceptions, or WTA AMP grazing. We investigate current understandings and perceptions of the grazing style in addition to the impact of a monetary benefit on adoption. Although our sample is likely not representative of the entire beef cattle industry but rather more representative of produces with grazing management interests, these findings fill the literature gap and can be used to guide AMP grazing education and adoption strategies.

We find most producers have heard of AMP grazing (78%) or are familiar with the concept (16%) indicating the knowledge of the practice is already relatively established. We can build upon this knowledge base with strategized adoption efforts. Nearly a third of producers identify as AMP grazers leaving adequate room to increase adoption. Despite the practices' familiarity, there remains uncertainty among producers when framing the practice as a BMP. Sixty-two percent of producers consider AMP grazing a BMP yet 8% do not and 30% are unsure. Non-AMP grazers were the most uncertain when framing the practice as a BMP. This uncertainty provides educational opportunities when leading AMP grazing adoption. Environmental and productivity benefits should be highlighted in effort to ease this uncertainty and help producers perceive AMP grazing as a BMP.

When leading AMP grazing adoption it is also essential to address expected challenges that hinder adoption. Findings on experienced challenges will be helpful in mitigating adoption concerns as well as adequately preparing producers for the switch. Increased financial and time requirements are expected to hinder adoption by many non-AMP grazers. However, few AMP grazers stated they experienced these challenges, indicating a large perceptions gap. Setting up the operation for AMP grazing is both an expected and experienced challenge. In order to make this transition as effortless as possible guidance should be established with readily available information and how-tos. This information should include insight on financial and time requirements when adopting AMP grazing in order to mitigate uncertainty. This guidance can easily be established by talking with AMP grazing researchers and grazers.

Even though AMP grazers already receive on average $4.54 per cwt on steers more than non-AMP grazers a larger monetary benefit is necessary to increase adoption. We find no difference in this monetary benefit being a premium at sale or cost reduction during production. Without accounting for demographics and perceptions of AMP grazing, the needed monetary benefit is estimated to be $12.96/cwt for each 500-599 lb. steer sold. Producers in the Midwest, those who have been primary operators longer, and operations who own more than 50% of the acres they graze require a higher benefit to adopt AMP grazing. Grass finishers on the other hand require a lower benefit. Producers who expect on farm help and operation set up to hinder their adoption require a higher benefit. Additionally, if they do not frame AMP grazing as a BMP or see no benefit in the practice they require a higher benefit. If a producer expects no challenges to adoption they require a lower benefit. Those who require a lower benefit to adopt AMP grazing should be targeted as they are more willing to adopt the practice. It is important to educate those who doubt AMP grazing's environmental and production benefits in order to not only change their perception of AMP grazing but also lessen required benefits and increase adoption.

There is significant potential to increase AMP grazing adoption through targeted education efforts. By emphasizing the grazing style's environmental and productivity benefits we can help beef producers better understand what AMP grazing is and why it is a BMP. We now have the insights to directly address and mitigate adoption concerns in effort to increase uptake. Future research analyzing consumer willingness-to-pay (WTP) for beef produced via AMP grazing can help establish market demand for the practice. Consumers are willing to pay more for beef produced by practices that mitigate GHG emissions and increase carbon sequestration (Li et al., 2016) but there may be room in the market for a specific AMP grazing label. This kind of premium however requires the supply chain to pass the premium back to the grazer. With this, the potential for a more direct premium when selling beef calves to finishers should be examined. If calves born and raised in AMP grazing systems are preferred to those from other grazing systems finishers may be willing to pay more for them. Additionally, economic benefits to AMP grazing should be further explored with emphasis on the potential for cost reduction in production and improved profitability from increased production. These findings would determine if an adequate premium, cost reduction, or combination of the two exists to support and encourage producer adoption.

CHAPTER 5: THESIS SUMMARY

The U.S. beef industry plays an essential role in meeting food, fuel, and fiber needs around the world. However, the industry's environmental impact does not go unnoticed and continues to place pressure on beef producers and their decision making. Producers have the opportunity to lessen their operation's environmental footprint while improving enterprise productivity and profitability through the adoption of best management practices (BMPs). One BMP specifically, adaptive multi-paddock (AMP) grazing, has been found to increase water infiltration, reduce water runoff, and potentially sequester more soil organic carbon than other grazing methods while improving animal and forage productivity (Park et al., 2017; Stanley et al., 2018). AMP grazing is relatively new with current research focused on the grazing styles' environmental benefits. Until now, little was known regarding utilization, perceptions, or willingness to adopt AMP grazing within the beef industry. With these understandings we can lead more strategized AMP grazing education and adoption efforts. Additionally, we recognize BMP adoption throughout the beef industry remains lower than anticipated (Prokopy et al., 2008). In effort to lead more effective adoption of AMP grazing, and BMPs broadly, we analyze producer motivations for current management practices.

We find 33% of producers in our sample already self-identify as AMP grazers. These producers are newer to their role as primary operator and operate operations that have been established fewer years than non-AMP grazers. Further, AMP grazing operations are more progressive in their adoption of BMPs which is not surprising considering their adoption of AMP grazing. AMP grazers are more likely to market cattle as natural (no hormones/no antibiotics) and grass-fed and less likely to market as pre-conditioned (weaning or vaccination claims) compared to non-AMP grazers. Additionally, AMP grazers indicated a stronger desire to improve environmental aspects of their beef operations. Such improvements include improving water infiltration, wildlife habitat/habitation, reduce GHG emissions, and reduce water runoff. From these understandings of AMP grazers we can target similar producers who have not already implemented AMP grazing within their operations. These findings indicate demographic characteristics may not be the best way to identify non-AMP grazers and targeting efforts should focus on marketing claims and desired improvements.

With two-thirds of beef producers not self-identifying as AMP grazers, this BMP has the potential for significant adoption within the industry. Largely, producers are aware of AMP grazing as 78% have heard of it and 17% are familiar with it. Regardless of established familiarity, perceived benefits of the grazing style remain uncertain indicating the need of more communication surrounding found environmental and productivity benefits. Other perception gaps include expected challenges to adopting AMP grazing. Non-AMP grazers expect financial and time challenges to hinder their adoption yet few AMP grazers experienced these as the biggest challenge when adopting AMP grazing. By communicating experienced challenges we can mitigate adoption uncertainty and help producers make the switch as effortless as possible.

While environmental benefits of AMP grazing may be enough to encourage some producers to adopt the grazing style, others require monetary motivation. Even though AMP grazers in our sample receive on average $4.54 per hundred weight (cwt) on steers more than non-AMP grazers, we find a larger monetary benefit is necessary to increase adoption. Without accounting for demographic characteristics and perceptions of AMP grazing, this monetary benefit is estimated to be $12.96/cwt for each 500-599 lb. steer sold. This monetary benefit can either be in the form of a premium at sale or cost reduction during production and is likely required to offset switching costs acquired from adopting AMP grazing. Producers who do not frame AMP grazing as a BMP, see no benefit in the practice, and expect on farm help and operation set up to hinder their adoption require a higher benefit to adopt. Even though these producers require a higher benefit now, through education strategies we can help them understand the found environmental and production benefits of the practice. Such education efforts can not only change their perceptions of AMP grazing but also lessen required benefits and increase likeliness to adopt. Producers who expect no challenges to hinder their adoption require a lower benefit. Producers who require a lower monetary benefit to adopt AMP grazing should be targeted as they are more willing to adopt the practice.

Heterogeneity does exist among beef producers' motivations for current management practices indicating producers have different motivations when making management decisions. Through best worst scaling we identify motivational differences among AMP and non-AMP grazers. AMP grazers place more importance on environmental motivations, "caring for the land," and less importance on financial motivations, "minimize risk" and "maximize profit," than non-AMP grazers. Motivational differences likely exist among adopters and non-adopters of other BMPs as well. Differences in socioeconomic classes' motivations can further guide AMP grazing adoption and BMP adoption broadly.

AMP grazing has the potential to lessen beef productions' environmental impacts and scrutiny surrounding such impacts. We now have a better understanding of who is already practicing AMP grazing and who remains to be targeted for adoption. Additionally, we have insight as to what the beef industry thinks of the production practice and their willingness to adopt the grazing style. The opportunity to increase AMP grazing adoption throughout the beef industry is vast. Now is the time to lead such adoption efforts.

APPENDICES

APPENDIX A: Survey Instrument

You are being asked to participate in a research study of farmer/rancher motivations and perceptions. Your participation in this study will take about fifteen minutes. You will be asked to respond to a series of about 40 questions asking about your cow-calf operation, what motivates your management practices, and your perceptions of specific grazing management methods. We also ask basic demographic questions. The results from this research will be available to farmers/ranchers, extension educators, and policy makers in order to make informed decisions and to better serve farmers/ranchers. The risks associated with this study are minimal. The risks are not greater than those ordinarily encountered in daily life. Moreover, You can stop at any time after the survey has already started. The researchers will not have access to your name. At no point will a data file be constructed in which your name is linked with your responses. The data will be stored by the principal investigator with no intention to destroy the data. The data will only be released in summaries in which no individual's answers can be identified. You have the right to say no to participate in the research. You can stop at any time after it has already started. There will be no consequences if you stop and you will not be criticized. You will not lose any benefits that you normally receive. Producer incentives will be provided by BEEF Magazine. An additional opt in survey at the end of the original survey will lead you to this opportunity. The survey responses and the contact information collected for the incentives will be stored in two separate pools and will not link to each other. Ten participants will be randomly selected from the opt in survey to receive a $50 gift card. If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researchers McKenna Clifford, cliffo93@msu.edu or Melissa McKendree, mckend14@msu.edu.

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 4000 Collins Rd, Suite 136, Lansing, MI 48910.

1. Do you voluntarily agree to participate in this research study?

○ Yes

○ No

2. Are you a primary operator on a beef cattle operation?

○ Yes

○ No

3. Does your operation graze beef cattle?

◯ Yes

◯ No

4. Please describe your cattle operation by indicating the percentage of your operation devoted to each segment of the beef cattle industry (should sum to 100%):
Seedstock : _______
Cow-calf : _______
Backgrounding/Stocker : _______
Feedlot : _______
Grass Finisher : _______
Other (please describe): : _______
Total : ________

5. What state is your operation located?

▼ Alabama ... I do not reside in the United States

6. How many years has your operation been established?

◯ Less than 5 years

◯ 5 to 10 years

◯ 11 to 20 years

◯ 21 to 30 years

◯ 31 to 40 years

◯ 41 to 50 years

◯ More than 50 years

7. Approximately how many years have you been the primary operator?

- ◯ Less than 5 years
- ◯ 5 to 10 years
- ◯ 11 to 20 years
- ◯ 21 to 30 years
- ◯ 31 to 40 years
- ◯ 41 to 50 years
- ◯ More than 50 years

8. In total, how many beef cows (i.e., lactating, gestating) and replacement heifers were in your operation on January 1, 2019?

____

9. How many head of cattle did your operation sell at the following production stages in 2018?

	Head of Cattle Sold
Calves	
Yearlings	
Finished Cattle	

Please answer the following questions with your largest grazing enterprise in mind (i.e., seedstock, cow-calf, backgrounding/stocker, or grass finisher).

10. What is the average sale weight of your market **steers**?

- ◯ Less than 400 lbs
- ◯ 400 - 499 lbs
- ◯ 500 - 599 lbs
- ◯ 600 - 699 lbs
- ◯ 700 - 799 lbs
- ◯ 800 lbs or more
- ◯ I do not sell market steers

11. What **price** per hundred-weight (cwt) did you receive for **steers** on average in the last year? (If you did not sell any, put "0")

____

12. Do you know your operation's average **cost of production** per head for **steers**?

- ◯ Yes, it is: ____
- ◯ No, I do not.

13. How many total acres do you operate? (Including owned and rented acres)

____

14. How many of the ${Q14/ChoiceTextEntryValue} acres that you operate are allocated to grazing cattle?

____

15. How many of the ${Q15/ChoiceTextEntryValue} acres allocated to grazing cattle do you own?

____

In the following section, you will be presented **twelve** (12) choice questions.

These questions look very similar but note that they are all different. The results could affect the decisions of farmers/ranchers, extension educators, and policy makers, therefore, please answer carefully and thoughtfully.

16. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important
○	**Teaching others** – it is important to me that I teach others (family, farmers, school children, and/or community members) about what I do on my farm/ranch.	○
○	**Enjoying life** – it is important to me that I get pleasure out of my life on the farm/ranch.	○
○	**Feeling proud** – it is important to me that I get pride from my farm/ranch (the animals, my equipment, my land, etc.).	○

17. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important
○	**Maximize profit** – it is important to me that I make the most profit each year given my available resources.	○
○	**Minimize risk to avoid financial loss** – it is important to me that I minimize risk and financial losses so that I am not forced out of business.	○
○	**Caring for the land** – it is important to me that I manage my land in a way that does not negatively affect, or even improves, the environment.	○

18. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important

○	**Minimize risk to avoid financial loss** – it is important to me that I minimize risk and financial losses so that I am not forced out of business.	○
○	**Passing on the land to future generations** – it is important to me that I can pass on my land and farm/ranch to my children and/or grandchildren.	○
○	**Feeling proud** – it is important to me that I get pride from my farm/ranch (the animals, my equipment, my land, etc.).	○

19. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important

○	**Passing on the land to future generations** – it is important to me that I can pass on my land and farm/ranch to my children and/or grandchildren.	○
○	**Maximize profit** – it is important to me that I make the most profit each year given my available resources.	○
○	**Enjoying life** – it is important to me that I get pleasure out of my life on the farm/ranch.	○

20. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important
○	**Caring for the land** – it is important to me that I manage my land in a way that does not negatively affect, or even improves, the environment.	○
○	**Passing on the land to future generations** – it is important to me that I can pass on my land and farm/ranch to my children and/or grandchildren.	○
○	**Teaching others** – it is important to me that I teach others (family, farmers, school children, and/or community members) about what I do on my farm/ranch.	○

21. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important

○	**Teaching others** – it is important to me that I teach others (family, farmers, school children, and/or community members) about what I do on my farm/ranch.	○
○	**Maximize profit** – it is important to me that I make the most profit each year given my available resources.	○
○	**Feeling like I belong** – It is important to me that I am a part of my community and/or feel like I belong in this place.	○

You are half way through these twelve (12) questions! Thank you for sticking with us - your responses are important!

These questions look very similar but note that they are all different.

22. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important

○	**Minimize risk to avoid financial loss** – it is important to me that I minimize risk and financial losses so that I am not forced out of business.	○
○	**Feeling like I belong** – it is important to me that I am a part of my community and/or feel like I belong in this place.	○
○	**Enjoying life** – it is important to me that I get pleasure out of my life on the farm/ranch.	○

23. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important
○	**Feeling like I belong** – it is important to me that I am a part of my community and/or feel like I belong in this place.	○
○	**Trying new things** – it is important to me that I experiment with new management practices, breeds, and/or technologies on the farm/ranch.	○
○	**Passing on the land to future generations** – it is important to me that I can pass on my land and farm/ranch to my children and/or grandchildren.	○

24. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important

○	**Trying new things** – it is important to me that I experiment with new management practices, breeds, and/or technologies on the farm/ranch.	○
○	**Feeling proud** – it is important to me that I get pride from my farm/ranch (the animals, my equipment, my land, etc.).	○
○	**Maximize profit** – it is important to me that I make the most profit each year given my available resources.	○

25. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important
○	**Enjoying life** – it is important to me that I get pleasure out of my life on the farm/ranch.	○
○	**Caring for the land** – it is important to me that I manage my land in a way that does not negatively affect, or even improves, the environment.	○
○	**Trying new things** – it is important to me that I experiment with new management practices, breeds, and/or technologies on the farm/ranch.	○

26. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important
○	**Trying new things** – it is important to me that I experiment with new management practices, breeds, and/or technologies on the farm/ranch.	○
○	**Teaching others** – it is important to me that I teach others (family, farmers, school children, and/or community members) about what I do on my farm/ranch.	○
○	**Minimize risk to avoid financial loss** – it is important to me that I minimize risk and financial losses so that I am not forced out of business.	○

27. Which of the following motivations is the most important and which is the least important for your current management practices? (Please select only 1 as most important and 1 as least important)

Most Important		Least Important

○	**Feeling proud** – it is important to me that I get pride from my farm/ranch (the animals, my equipment, my land, etc.).	○
○	**Feeling like I belong** – it is important to me that I am a part of my community and/or feel like I belong in this place.	○
○	**Caring for the land** – it is important to me that I manage my land in a way that does not negatively affect, or even improves, the environment.	○

28. Which, if any, of these motivations are must haves? (select all that apply)

☐ **Caring for the land** – it is important to me to manage my land in a way that does not negatively affect, or even improves, the environment.

☐ **Enjoying life** – it is important to me to get pleasure out of my life on the farm.

☐ **Trying new things** – it is important to me to experiment with new management practices, breeds, and/or technologies on the farm.

☐ **Teaching others** – it is important to me to teach others (farmers, school children, and/or community members) about what I do on my farm.

☐ **Passing on the land to future generations** – it is important to me to make sure I can pass on my land and farm to my children and/or grandchildren.

☐ **Feeling proud** – it is important to me that my farm (the animals, my equipment, my land, etc.) gives me pride.

☐ **Feeling like I belong** – It is important to me that I am a part of my community and/or feel like I belong in this place.

☐ **Maximize profit** – It is important for me to make the most profit each year given my available resources.

☐ **Minimize risk to avoid financial loss** – It is important me to minimize risk and financial losses so that I am not forced out of business.

☐ **None**

29. Please answer the following questions with your largest grazing enterprise in mind (i.e., seedstock, cow-calf, backgrounding/stocker, or grass finisher).

30. Which grazing style is most similar to how you graze your cattle?

- ○ The cattle have access to all available pasture(s) during the entire year and can move freely wherever they like.
- ○ The cattle are moved between different pastures throughout the grazing season based on time.
- ○ The cattle are moved between different pastures throughout the grazing season based on forage health and recovery.

31. On average, how often are the cattle moved to a different paddock or pasture by you or another person?

- ○ Never
- ○ Once a season
- ○ Once a month
- ○ Twice a month
- ○ Once a week
- ○ Two or three times a week
- ○ Every day
- ○ Multiple times each day
- ○ Other (please explain) ____

32. How many years has your operation been using its current grazing management practices?

- ◯ Less than 5 years
- ◯ 5 to 10 years
- ◯ 11 to 20 years
- ◯ 21 to 30 years
- ◯ 31 to 40 years
- ◯ 41 to 50 years
- ◯ More than 50 years

Adaptive multi-paddock (AMP) grazing is an intensive grazing method in which lightweight, portable fencing systems are used to move animals strategically around a large pasture, allowing for dense grazing interspersed by long periods of recovery for the land. This grazing method may be known by other names including holistic management or high intensity-short duration grazing.

33. Have you heard of adaptive multi-paddock grazing?

- ◯ Yes
- ◯ I'm familiar with the concept but not the name
- ◯ No

34. Given what you know of adaptive multi-paddock grazing, would you frame it as a best-management practice?

- ◯ Yes
- ◯ No
- ◯ Don't know/mixed

35. Do you use adaptive multi-paddock grazing?

- ○ Yes
- ○ No
- ○ A similar adaptive style but not classified as adaptive multi-paddock grazing

36. How many adaptive multi-paddock grazers do you know?

- ○ 1
- ○ 2-5
- ○ 6-10
- ○ More than 10
- ○ None

Adaptive multi-paddock (AMP) grazing is an intensive grazing method in which lightweight, portable fencing systems are used to move animals strategically around a large pasture, allowing for dense grazing interspersed by long periods of recovery for the land. AMP is hypothesized to be a best-management practice, improving environmental quality, farm/ranch economics, and farmer/rancher quality of life.

37. Which of the following would hinder your adoption of adaptive multi-paddock grazing? (select all that apply)

- [ ] It is too time consuming
- [ ] I do not know enough about the management style
- [ ] The financial requirement for set up is too high
- [ ] I do not have enough help on the farm
- [ ] I would have to change my herd size
- [ ] My operation is not set up for this kind of grazing
- [ ] My forage quality is not good enough
- [ ] I do not see any benefit in the management practice
- [ ] None of the above
- [ ] Other (please describe):

38. Which of the following was the biggest challenge when adopting adaptive multi-paddock grazing?

- ◯ It is much more time consuming
- ◯ Finding enough information about the management style
- ◯ The financial requirements
- ◯ Changing my herd size
- ◯ Setting up my operation for this grazing management style
- ◯ Getting my forage quality high enough
- ◯ There were no challenges
- ◯ Other (please describe): ____

Adaptive multi-paddock (AMP) grazing is an intensive grazing method in which lightweight, portable fencing systems are used to move animals strategically around a large pasture, allowing for dense grazing interspersed by long periods of recovery for the land. This grazing method may be known by other names including holistic management or high intensity-short duration grazing.

39.1 Would you be willing to adopt an adaptive multi-paddock grazing method for a **premium** of $ $e{ round(e://Field/Premium ,2) } /cwt on each 500-599 lb. steer sold?

- ◯ Yes
- ◯ No

39.1.1 Would you be willing to adopt an adaptive multi-paddock grazing method for a **premium** of $ $e{ (round(e://Field/Premium * 0.5 ,2)) } /cwt on each 500-599 lb. steer sold?

- ◯ Yes
- ◯ No

39.1.2 Would you be willing to adopt an adaptive multi-paddock grazing method for a **premium** of $ $e{ (round(e://Field/Premium * 1.5 ,2)) } /cwt on each 500-599 lb. steer sold?

- ○ Yes
- ○ No

Adaptive multi-paddock (AMP) grazing is an intensive grazing method in which lightweight, portable fencing systems are used to move animals strategically around a large pasture, allowing for dense grazing interspersed by long periods of recovery for the land. This grazing method may be known by other names including holistic management or high intensity-short duration grazing.

39.2 Would you be willing to adopt an adaptive multi-paddock grazing method for a **cost reduction** of $ $e{ round(e://Field/Premium ,2) } /cwt on each 500-599 lb. steer sold?

- ○ Yes
- ○ No

39.2.1 Would you be willing to adopt an adaptive multi-paddock grazing method for a **cost reduction** of $ $e{ (round(e://Field/Premium * 0.5 ,2)) } /cwt on each 500-599 lb. steer sold?

- ○ Yes
- ○ No

39.2.2 Would you be willing to adopt an adaptive multi-paddock grazing method for a **cost reduction** of $ $e{ (round(e://Field/Premium * 1.5 ,2)) } /cwt on each 500-599 lb. steer sold?

- ○ Yes
- ○ No

40. Which of the following claims do you frequently use when marketing your cattle? (select all that apply)

- ☐ None (conventional production)
- ☐ Age and source verified (ASV/SAV)
- ☐ Natural (no hormones/no antibiotics)
- ☐ Organic
- ☐ Humanely raised
- ☐ NHTC (Non-hormone treated)
- ☐ Pre-Conditioned (weaning or vaccination claims)
- ☐ Grass-fed
- ☐ Other (please describe):

____

41. Which one of the following methods/outlets do you use most frequently to market cattle?

- ◯ Local auction
- ◯ Video/Internet auction
- ◯ Direct to background/stocker operation
- ◯ Direct to feedlot operation
- ◯ Direct to packing plant/processor
- ◯ Direct to consumers
- ◯ Retain Ownership
- ◯ Other (please describe): ____

42. Are the following production or management practices being used in your beef farm/operation?

	Yes	No	Not Applicable
A method of animal identification (e.g., ear tags, brands, etc.)	○	○	○
Written or computer health records for the herd	○	○	○
Written or computer financial records	○	○	○
Perform a visual health check of your herd at least twice per week	○	○	○
Body condition score your cattle to gauge their nutritional state during the production cycle	○	○	○
Have an established client relationship with a veterinarian	○	○	○
Maintain a herd health program that includes vaccinations for cows and calves	○	○	○
Quarantine new cattle at least 30 days after arriving onto ranch	○	○	○
Use a low stress weaning program (fence line, etc.)	○	○	○
Castrate bull calves within the first three months of age	○	○	○

Ability to safely restrain cattle (e.g., squeeze chute) for procedures	○	○	○
Train your employees on low stress cattle handling and care (includes family workers)	○	○	○
Planned breeding and calving season	○	○	○
Beef Quality Assurance Certified	○	○	○

43. Which of the following would you like to improve within your beef operation? (select all that apply)

- [ ] Profitability
- [ ] Minimize costs
- [ ] My quality of life
- [ ] Animal welfare
- [ ] Water infiltration
- [ ] Wildlife habitat/habitation
- [ ] Forage quality
- [ ] Community involvement
- [ ] Reduce greenhouse gas emissions
- [ ] Reduce water runoff
- [ ] None
- [ ] Other (please describe)

____

44. What is your gender?

- ◯ Male
- ◯ Female
- ◯ I'd rather not say

45. What is your age?

____

46. The best description of your educational background is:

- ◯ Did not obtain High School diploma
- ◯ High School graduate
- ◯ Some college
- ◯ Technical Training (Certificate or Assoc. Degree)
- ◯ Bachelor's (B.S. or B.A.) Degree
- ◯ Grad. or Professional Degree (e.g., MS, PhD, DVM)
- ◯ Other (please describe): ____

47. Do you have an off farm job?

- ◯ Yes, full time
- ◯ Yes, part time
- ◯ No

48. Do you have any other employees or help on your farm/ranch? (Check all that apply)

- [ ] Yes, full time
- [ ] Yes, part time
- [ ] No

49. 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
- ○ I'd rather not say

50. Approximately what portion of your household income is from the beef operation?

- ○ 0%
- ○ Less than 25%
- ○ 26%-50%
- ○ 51%-75%
- ○ Over 75%

51. Generally speaking, do you usually think of yourself as a Republican, a Democrat, an Independent, or something else?

◯ Republican

◯ Democrat

◯ Independent

◯ No preference

◯ I'd rather not say

◯ Other (please describe): ____

Thank you for taking the time to complete this survey. If you have any feedback, or would like to leave a comment, please feel free to do so below.

____

____

____

____

____

52. Would you like to be included in the random drawing for one of ten $50 gift cards?

◯ Yes

◯ No

APPENDIX B: Survey Email Messages

BEEF Magazine First Email:

Subject Line: Seeking your opinions on grazing management practices

Dear Beef Industry Member,

Below you will find a link to participate in a short survey designed to assess perceptions of grazing management practices along with beef producer motivations for current management practices. This study is being conducted by faculty and graduate students at Michigan State University. We value your input as it helps us conduct impactful research and draw appropriate conclusions regarding U.S. beef operations. This project's findings will appear in various fact sheets and publicly available reports. Accordingly, your input is critical.

The survey should take approximately 15 minutes to complete. Once you begin the survey you will have one week to complete it. To pick up where you left off simply click on the link again. Producer incentives will be provided by BEEF Magazine. An additional opt in survey at the end of the original survey will lead you to this opportunity. The survey responses and the contact information collected for the incentives will be stored in two separate pools and will not link to each other. Ten participants will be randomly selected from the opt in survey to receive a $50 gift card.

Your participation in this survey is entirely voluntary. All responses will be kept in strict confidence. Typical demographic questions are included to ensure our sample is representative of the U.S. beef industry. If you wish to provide comments please use the space at the end of the survey.

Thank you for your assistance with this important project and look forward to receiving your completed survey. If you have any questions or comments regarding this survey, please feel free to contact McKenna Clifford (cliffo93@msu.edu) or Dr. Melissa McKendree (mckend14@msu.edu) by email or by phone 517-432-7640.

https://msu.co1.qualtrics.com/jfe/form/SV_5j538jdEnEEBIxf

We appreciate your participation,

McKenna Clifford and Melissa McKendree

MICHIGAN STATE UNIVERSITY

BEEF Magazine Second Email:

Subject Line: Awaiting your response! | Grazing Management Practices

Beef Industry Member,

We are awaiting your survey response! Faculty and graduate students at Michigan State University want to know your perceptions of grazing management practices along with your motivations for current management practices.

https://msu.co1.qualtrics.com/jfe/form/SV_5j538jdEnEEBIxf

Your input will qualify you for one of ten randomly selected **$50 gift cards** provided by BEEF Magazine! The survey should take approximately 15 minutes to complete. If you need to close out and pick up where you left off simply click on the link again.
We truly value your assistance and look forward to hearing your perceptions and motivations. If you have any questions or comments regarding this survey, please feel free to contact McKenna Clifford (cliffo93@msu.edu) or Dr. Melissa McKendree (mckend14@msu.edu) by email or by phone 517-432-7640.

We appreciate your participation,

McKenna Clifford and Melissa McKendree

MICHIGAN STATE UNIVERSITY

Suggested Email for Livestock Associations:

Title/Subject Line: Let your voice be heard on grazing management practices

The beef industry has been scrutinized recently in media and political discussions – with some questioning the efficacy of industry practices. However, what has been missing from this discussion are beef producers' perceptions and motivations.
For this reason, faculty and graduate students at Michigan State University want to better understand why you do what you do as a beef producer. What motivates your grazing management practices? To share your opinions please take our survey:

https://msu.co1.qualtrics.com/jfe/form/SV_1HUh6ZrsY6zANUN

Your response will qualify you for one of ten randomly selected $50 gift cards provided by BEEF Magazine. The survey should take approximately 15 minutes to complete. If you need to close out and pick up where you left off simply click on the link again.
Your input is truly valued and critical for this research. If you have any questions or comments regarding this survey, please feel free to contact McKenna Clifford (cliffo93@msu.edu) or Dr. Melissa McKendree (mckend14@msu.edu) by email or by phone 517-432-7640.

MICHIGAN STATE
UNIVERSITY

APPENDIX C: Coefficient Estimates

Table A1. Multinomial Logit and Latent Class Model Coefficients

		LCMs				
Motivation	MNL	Class 1	Class 2	Class 3	Class 4	Class 5
Trying New Things	0.00	0.00	0.00	0.00	0.00	0.00
Caring for the Land	1.39***	1.94***	1.62***	1.19***	1.81***	2.23***
	(0.06)	(0.21)	(0.16)	(0.17)	(0.45)	(0.3)
Minimize Risk	0.74***	2.17***	0.49***	1.20***	-1.19***	0.41***
	(0.05)	(0.26)	(0.16)	(0.21)	(0.37)	(0.15)
Passing on the Land	0.64***	2.30***	0.14	-1.11***	-1.47***	2.35***
	(0.05)	(0.21)	(0.16)	(0.21)	(0.37)	(0.28)
Enjoying Life	0.63***	0.98***	1.67***	0.13	0.18	0.49***
	(0.05)	(0.2)	(0.17)	(0.18)	(0.33)	(0.18)
Maximize Profit	0.35***	1.79***	-0.05	1.28***	-2.11***	-0.48***
	(0.05)	(0.23)	(0.16)	(0.18)	(0.36)	(0.17)
Teaching Others	0.10**	0.12	0.58***	-0.28*	-1.30***	0.39**
	(0.05)	(0.16)	(0.14)	(0.16)	(0.38)	(0.16)
Feeling Proud	-0.14***	0.25	0.78***	-0.66***	-2.75***	-0.46***
	(0.05)	(0.18)	(0.14)	(0.16)	(0.43)	(0.15)
Feeling like I Belong	-0.76***	-0.81***	0.11	-1.51***	-2.58***	-1.09***
	(0.06)	(0.17)	(0.14)	(0.2)	(0.37)	(0.16)
Log likelihood	-5,567.03			-5,020.56		
Membership percent		28.9%	19.5%	18.9%	8.4%	24.4%
Akaike information criterion/ Bayesian information criterion				10,161.74/10,185.74		

Notes: Standard errors are shown in parentheses. The multinomial logit (MNL) model assumes that all individuals have homogenous views production practice motivations. Latent class models (LCMs) assume that views are homogenous within a group but heterogenous across the groups. Asterisks (***, **, *) indicate significance at the 0.01, 0.05, and 0.10 levels, respectively.

REFERENCES

REFERENCES

Alberini, A., Kanninen, B., & Carson, R. T. (1997). Modeling Response Incentive Effects in Dichotomous Choice Contingent Valuation Data. Land Economics, 73(3), 309–324. JSTOR. https://doi.org/10.2307/3147170

Bateman, I. J., Langford, I. H., Jones, A. P., & Kerr, G. N. (2001). Bound and path effects in double and triple bounded dichotomous choice contingent valuation. Resource and Energy Economics, 23(3), 191–213. https://doi.org/10.1016/S0928-7655(00)00044-0

Becker, W., Kreuter, U., Atkinson, S., & Teague, R. (2017). Whole-Ranch Unit Analysis of Multipaddock Grazing on Rangeland Sustainability in North Central Texas. Rangeland Ecology and Management; Lawrence, 70(4), 448–455. http://dx.doi.org.proxy1.cl.msu.edu/10.1016/j.rama.2016.12.002

Beilin, R. (2005). Photo-elicitation and the agricultural landscape: ‘Seeing’ and ‘telling’ about farming, community and place. Visual Studies, 20(1), 56–68. https://doi.org/10.1080/14725860500064904

Boxall, P. C., & Adamowicz, W. L. (2002). Understanding Heterogeneous Preferences in Random Utility Models: A Latent Class Approach. Environmental and Resource Economics; Dordrecht, 23(4), 421–446.

Boyle, K. J., Bishop, R. C., & Welsh, M. P. (1985). Starting Point Bias in Contingent Valuation Bidding Games. Land Economics, 61(2), 188–194. JSTOR. https://doi.org/10.2307/3145811

Boyle, K. J., Johnson, F. R., & McCollum, D. W. (1997). Anchoring and Adjustment in Single-Bounded, Contingent-Valuation Questions. American Journal of Agricultural Economics, 79(5), 1495–1500. https://doi.org/10.2307/1244370

BQA - Manuals. (2020). BQA. https://www.bqa.org/resources/manuals

Bulut, H., & Lawrence, J. D. (2007). The Value of Third-Party Certification of Preconditioning Claims at Iowa Feeder Cattle Auctions. Journal of Agricultural and Applied Economics; Baton Rouge, 39(3), 625–640.

Calia, P., & Strazzera, E. (2000). Bias and efficiency of single versus double bound models for contingent valuation studies: A Monte Carlo analysis. Applied Economics, 32(10), 1329–1336. https://doi.org/10.1080/000368400404489

Cameron, T. A., & Quiggin, J. (1994). Estimation Using Contingent Valuation Data from a “Dichotomous Choice with Follow-Up” Questionnaire. Journal of Environmental Economics and Management, 27(3), 218–234. https://doi.org/10.1006/jeem.1994.1035

Cary, J. W., & Wilkinson, R. L. (1997). Perceived Profitability and Producers' Conservation Behavior. Journal of Agricultural Economics, 48(1), 13–21.

Chouinard, H. H., Paterson, T., Wandschneider, P. R., & Ohler, A. M. (2008). Will Farmers Trade Profits for Stewardship? Heterogeneous Motivations for Farm Practice Selection. Land Economics, 84(1), 66–82. JSTOR.

DeShazo, J. R. (2002). Designing Transactions without Framing Effects in Iterative Question Formats. Journal of Environmental Economics and Management, 43(3), 360–385. https://doi.org/10.1006/jeem.2000.1185

Dziak, J. J., Coffman, D. L., Lanza, S. T., & Li, R. (2019). Sensitivity and Specificity of Information Criteria. Briefings in Bioinformatics. https://doi.org/10.1093/bib/bbz016

Finn, A., & Louviere, J. J. (1992). Determining the Appropriate Response to Evidence of Public Concern: The Case of Food Safety. Journal of Public Policy & Marketing, 11(2), 12–25.

Gillespie, J., Kim, S.-A., & Paudel, K. (2007). Why don't producers adopt best management practices? An analysis of the beef cattle industry. Agricultural Economics, 36(1), 89–102. https://doi.org/10.1111/j.1574-0862.2007.00179.x

Gosnell, H., Grimm, K., & Goldstein, B. E. (2020). A half century of Holistic Management: What does the evidence reveal? Agriculture and Human Values. https://doi.org/10.1007/s10460-020-10016-w

Greiner, R., Patterson, L., & Miller, O. (2009). Motivations, risk perceptions and adoption of conservation practices by farmers. Agricultural Systems, 99(2), 86–104. https://doi.org/10.1016/j.agsy.2008.10.003

Hanemann, M., Loomis, J., & Kanninen, B. (1991). Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation. American Journal of Agricultural Economics, 73(4), 1255–1263. JSTOR. https://doi.org/10.2307/1242453

Harper, D. (2002). Talking about pictures: A case for photo elicitation. Visual Studies, 17(1), 13–26. https://doi.org/10.1080/14725860220137345

Harris, C. K., & Bailey, C. (2002). Public support for a clean, green, US agricultural machine. The Social Risks of Agriculture: Americans Speak out on Food, Farming, and the Environment.

Herrero, M., & Thornton, P. K. (2013). Livestock and global change: Emerging issues for sustainable food systems. Proceedings of the National Academy of Sciences, 110(52), 20878–20881. https://doi.org/10.1073/pnas.1321844111

Herriges, J. A., & Shogren, J. F. (1996). Starting Point Bias in Dichotomous Choice Valuation with Follow-Up Questioning. Journal of Environmental Economics and Management, 30(1), 112–131. https://doi.org/10.1006/jeem.1996.0008

Horne, J. (2012). How Anchored Tradeoffs Reveal Customer Preferences.

Jelinski, M., Bergen, R., Grant, B., & Waldner, C. (2019). Adoption of technology and management practices by Canadian cow-calf producers. The Canadian Veterinary Journal = La Revue Veterinaire Canadienne, 60(3), 287–293.

Jensen, K. L., Lambert, D. M., Clark, C. D., Holt, C., English, B. C., Larson, J. A., Yu, T. E., & Hellwinckel, C. (2015). Cattle Producers' Willingness to Adopt or Expand Prescribed Grazing in the United States. Journal of Agricultural and Applied Economics; Baton Rouge, 47(2), 213–242. http://dx.doi.org.proxy1.cl.msu.edu/10.1017/aae.2015.6

Johnson, R. J., Doye, D., Lalman, D. L., Peel, D. S., Raper, K. C., & Chung, C. (2010). Factors Affecting Adoption of Recommended Management Practices in Stocker Cattle Production. Journal of Agricultural and Applied Economics; Baton Rouge, 42(1), 15–30.

Kim, S. A., Gillespie, J. M., & Paudel, K. P. (2005). The effect of socioeconomic factors on the adoption of best management practices in beef cattle production. Journal of Soil and Water Conservation, 60(3), 111-. Gale General OneFile.

Kim, S. A., Gillespie, J. M., & Paudel, K. P. (2008). Rotational grazing adoption in cattle production under a cost-share agreement: Does uncertainty have a role in conservation technology adoption? Australian Journal of Agricultural and Resource Economics, 52(3), 235–252. https://doi.org/10.1111/j.1467-8489.2007.00434.x

King, A. E. H., Lauri, M. B., & Peter, J. T. (2017). Community-based grazing marketing: Barriers and benefits related to the adoption of best management practices in grazing systems. Journal of Applied Communications, 44–56.

King, M. E., Salman, M. D., Wittum, T. E., Odde, K. G., Seeger, J. T., Grotelueschen, D. M., Rogers, G. M., & Quakenbush, G. A. (2006). Effect of certified health programs on the sale price of beef calves marketed through a livestock videotape auction service from 1995 through 2005. Journal of the American Veterinary Medical Association, 229(9), 1389–1400. https://doi.org/10.2460/javma.229.9.1389

Klonsky, K., Brodt, S., Tourte, L., Dunan, R., Hendricks, L., Ohmart, C., & Verdegaal, P. (2004). Influence of Farm Management Style on Adoption of Biologically Integrated Farming Practices in California. Renewable Agriculture and Food Systems, 19(4), 237–247.

Krinsky, I., & Robb, L. A. (1986). On Approximating the Statistical Properties of Elasticities. The Review of Economics and Statistics, 68(4), 715–719.

Li, X., Jensen, K. L., Clark, C. D., & Lambert, D. M. (2016). Consumer willingness to pay for beef grown using climate friendly production practices. Food Policy, 64, 93–106. https://doi.org/10.1016/j.foodpol.2016.09.003

Livestock Marketing Information Center. (2020). Annual January 1 Cattle Inventory by State. Retrieved April 7, 2020, from https://www.lmic.info/members-only/Spreadsheets/Cattle/InventorySlaughter

Livestock Marketing Information Center. (2020). Daily and Weekly Feeder Futures Prices. Retrieved April 9, 2020, from https://www.lmic.info/members-only/Spreadsheets/Cattle/FeederPrices

Louviere, J., Lings, I., Islam, T., Gudergan, S., & Flynn, T. (2013). An introduction to the application of (case 1) best–worst scaling in marketing research. International Journal of Research in Marketing, 30(3), 292–303. https://doi.org/10.1016/j.ijresmar.2012.10.002

Lusk, J. L., & Briggeman, B. C. (2009). Food Values. American Journal of Agricultural Economics, 91(1), 184–196. JSTOR.

Lusk, J. L., & Parker, N. (2009). Consumer Preferences for Amount and Type of Fat in Ground Beef. Journal of Agricultural and Applied Economics, 41(1), 75–90.

Mann, C., & Sherren, K. (2018). Holistic Management and Adaptive Grazing: A Trainers' View. Sustainability, 10(6), 1848. https://doi.org/10.3390/su10061848

Marley, A. A. J., & Louviere, J. J. (2005). Some probabilistic models of best, worst, and best–worst choices. Journal of Mathematical Psychology, 49(6), 464–480. https://doi.org/10.1016/j.jmp.2005.05.003

Mathison, M., & Hodbod, J. (2020). Beef Producer Motivations from Photo Elicitation.

McGuire, J., Morton, L. W., & Cast, A. D. (2013). Reconstructing the good farmer identity: Shifts in farmer identities and farm management practices to improve water quality. Agriculture and Human Values, 30(1), 57–69. https://doi.org/10.1007/s10460-012-9381-y

McKendree, M. G. S., Tonsor, G. T., & Wolf, C. A. (2018). Animal Welfare Perceptions of the U.S. Public and Cow-Calf Producers. Journal of Agricultural and Applied Economics, 50(4), 544–578. https://doi.org/10.1017/aae.2018.14

McLachlan, S. M., & Yestrau, M. (2009). From the ground up: Holistic management and grassroots rural adaptation to bovine spongiform encephalopathy across western Canada. Mitigation and Adaptation Strategies for Global Change, 14(4), 299–316. https://doi.org/10.1007/s11027-008-9165-2

Mitchell, R., & Carson, R. (n.d.). Using Surveys to Value Public Goods: The Contingent Valuation Method. Resources for the Future, Washington, DC.

National Institute of Food and Agriculture (NIFA). (2019). Sustainable Agriculture. Retrieved December 13, 2019, from https://nifa.usda.gov/topic/sustainable-agriculture

NCBA. (2019). Industry Statistics. Retrieved December 12, 2019, from https://www.ncba.org/beefindustrystatistics.aspx

Nowak, P. J. (1987). The Adoption of Agricultural Conservation Technologies: Economic and Diffusion Explanations. Rural Sociology; College Station, Tex., Etc., 52(2), 208–220.

Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. Australian Journal of Experimental Agriculture, 46(11), 1407. https://doi.org/10.1071/EA05037

Park, J.-Y., Ale, S., Teague, W. R., & Jeong, J. (2017). Evaluating the ranch and watershed scale impacts of using traditional and adaptive multi-paddock grazing on runoff, sediment and nutrient losses in North Texas, USA. Agriculture, Ecosystems & Environment, 240, 32–44. https://doi.org/10.1016/j.agee.2017.02.004

Paudel, K. P., Gauthier, W. M., Westra, J. V., & Hall, L. M. (2008). Factors Influencing and Steps Leading to the Adoption of Best Management Practices by Louisiana Dairy Farmers. Journal of Agricultural and Applied Economics; Baton Rouge, 40(1), 203–222.

Poe, G. L., Giraud, K. L., & Loomis, J. B. (2005). Computational Methods for Measuring the Difference of Empirical Distributions. American Journal of Agricultural Economics, 87(2), 353–365.

Prokopy, L. S., Floress, K., Klotthor-Weinkauf, D., & Baumgart-Getz, A. (2008). Determinants of agricultural best management practice adoption: Evidence from the literature. Journal of Soil and Water Conservation; Ankeny, 63(5), 300–311.

Quinn, C. E., & Halfacre, A. C. (2014). Place Matters: An Investigation of Farmers' Attachment to Their Land. Human Ecology Review; Bar Harbor, 20(2). https://doi.org/10.22459

SAS Software (Version 9.4). (2002). [Computer software].

Savory, A., & Butterfield, J. (1998). Holistic management: a new framework for decision making. Island press.

Schulz, L. L., & Tonsor, G. T. (2010). Cow-Calf Producer Preferences for Voluntary Traceability Systems. Journal of Agricultural Economics, 61(1), 138–162. https://doi.org/10.1111/j.1477-9552.2009.00226.x

Schumacher, T., Schroeder, T. C., & Tonsor, G. T. (2012). Willingness-to-Pay for Calf Health Programs and Certification Agents. Journal of Agricultural and Applied Economics; Baton Rouge, 44(2), 191–202.

Severino, R. (n.d.). PROC FREQ: It's More Than Counts. 10.

Sherren, K., Fischer, J., & Price, R. (2010). Using photography to elicit grazier values and management practices relating to tree survival and recruitment. Land Use Policy, 27(4), 1056–1067. https://doi.org/10.1016/j.landusepol.2010.02.002

Simon, G. E., Hoar, B. R., & Tucker, C. B. (2016). Assessing cow–calf welfare. Part 1: Benchmarking beef cow health and behavior, handling; and management, facilities, and producer perspectives1. Journal of Animal Science, 94(8), 3476–3487. https://doi.org/10.2527/jas.2016-0308

Smith, D., & Capstick, D. F. (1976). Establishing Priorities Among Multiple Management Goals. Southern Journal of Agricultural Economics; Knoxville, Tenn., Etc., 0, 37–43.

Speer, N. (2019, May 1). Fed cattle price and producers' share of the retail dollar. Beef Magazine. https://www.beefmagazine.com/prices/fed-cattle-price-and-producers-share-retail-dollar

Stanley, P. L., Rowntree, J. E., Beede, D. K., DeLonge, M. S., & Hamm, M. W. (2018). Impacts of soil carbon sequestration on life cycle greenhouse gas emissions in Midwestern USA beef finishing systems. Agricultural Systems, 162, 249–258. https://doi.org/10.1016/j.agsy.2018.02.003

Stinner, D. H., Stinner, B. R., & Martsolf, E. (1997). Biodiversity as an organizing principle in agroecosystem management: Case studies of holistic resource management practitioners in the USA. Agriculture, Ecosystems & Environment, 62(2–3), 199–213. https://doi.org/10.1016/S0167-8809(96)01135-8

Teague, R., Grant, B., & Wang, H. H. (2015). Assessing optimal configurations of multi-paddock grazing strategies in tallgrass prairie using a simulation model. Journal of Environmental Management, 150, 262–273. https://doi.org/10.1016/j.jenvman.2014.09.027

Teague, R., & Barnes, M. (2017). Grazing management that regenerates ecosystem function and grazingland livelihoods. African Journal of Range & Forage Science, 34(2), 77–86. https://doi.org/10.2989/10220119.2017.1334706

Thompson, N. M., Bir, C., & Widmar, N. J. O. (2019). Farmer perceptions of risk in 2017. Agribusiness, 35(2), 182–199. https://doi.org/10.1002/agr.21566

United States Department of Agriculture (USDA). (2019). 2017 Census of Agriculture.

United States Department of Agriculture (USDA). (2019). Commodity Costs and Returns. Retrieved April 9, 2020, from https://www.ers.usda.gov/data-products/commodity-costs-and-returns/commodity-costs-and-returns/#Recent%20Cost%20and%20Returns

U.S. Census Bureau. (2019). Census Regions and Divisions of the United States. Retrieved April 3, 2020, from https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

U.S. Census Bureau. (2019). Educational Attainment. Retrieved April 7, 2020, from https://data.census.gov/cedsci/table?hidePreview=false&tid=ACSST1Y2018.S1501&t=Education

U.S. EPA. (2015, December 29). Sources of Greenhouse Gas Emissions [Overviews and Factsheets]. US EPA. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

Ward, C. E., Vestal, M. K., Doye, D. G., & Lalman, D. L. (2008). Factors Affecting Adoption of Cow-Calf Production Practices in Oklahoma. Journal of Agricultural and Applied Economics; Baton Rouge, 40(3), 851–863.

Williams, B. R., Raper, K. C., DeVuyst, E. A., Peel, D. S., Lalman, D. L., Richards, C., & Doye, D. G. (2012). Demographic Factors Affecting the Adoption of Multiple Value-Added Practices by Oklahoma Cow-Calf Producers. AgEcon Search. https://doi.org/10.22004/ag.econ.119743

Wolf, C. A., & Tonsor, G. T. (2013). Dairy Farmer Policy Preferences. Journal of Agricultural and Resource Economics, 38(2), 220–234.

Zimmerman, L. C., Schroeder, T. C., Dhuyvetter, K. C., Olson, K. C., Stokka, G. L., Seeger, J. T., & Grotelueschen, D. M. (2012). The Effect of Value-Added Management on Calf Prices at Superior Livestock Auction Video Markets. Journal of Agricultural and Resource Economics; Logan, 37(1), 128–143.