Grazing management plan adoption in the United States beef industry

by

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B.S., Kansas State University, 2014
B.S., Kansas State University, 2014

A THESIS

Submitted in partial fulfillment of the requirements

for the degree

MASTER OF AGRIBUSINESS

Department of Agricultural Economics

College of Agriculture

KANSAS STATE UNIVERSITY

Manhattan, Kansas

2021

Approved by:

Major Professor
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ABSTRACT

This research focuses on the adoption and use of grazing management plans across the United States. The emphasis on sustainability has increased in the last several years across multiple food supply chains, and the United States beef supply chain is no exception. Through efforts from multiple stakeholders, including cattle producers, and from organizations like the U.S. Roundtable for Sustainable Beef, benchmarks and metrics are being established across prioritized indicators for sectors throughout the cattle and beef value chain. Grazing management plans have been identified as one of the tools useful for monitoring and measuring an operation's progress towards sustainability goals due to their ability to influence land, water, and air and greenhouse gas indicators.

The main objective of this study is to determine the adoption baseline of cattle grazing management plans in the United States and evaluate the potential characteristics influencing the adoption of these plans. An electronic survey is used to collect data from cattle producers across the United States. Descriptive statistics are used to assess the baseline of adoption and a binary logit model analyzed the influential factors in adopting a grazing management plan. Producer age, primary decision maker classification, operation location and type, herd size, grazing acreage size, land ownership classification, and succession planning are all factors that were included in the assessment.

Most influential to the decision-making process for producers are age (written grazing management plans only), size of operation in terms of grazing acres, and succession planning. Stocker operation size and the primary decision-making role seem to

influence the adoption of a grazing management plan as well. In terms of written grazing management plan adoption across the U.S. cattle industry, about 43 percent indicate they do have one, while 56 percent say they do not have a plan.

This study shows the industry is on their way to meeting the sustainability standards set by various organizations and stakeholders. However, additional resources need to be developed and promoted across the industry to further encourage adoption of written plans and improve the robustness of detail included, as well as the constant evaluation and adjustment of the plans over time.

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ACKNOWLEDGMENTS

The author wishes to thank Dr. Dustin Pendell for serving as major professor on this project and for the guidance and support throughout the thesis completion process. Without his direction and encouragement, plus a friendly reminder that I do not need to solve the world's problems in one study, I would still be in phase one of this research. Thank you for being there to answer my many questions, but also pushing me to learn new concepts and figure things out myself along the way. Much gratitude also goes to Dr. Myriah Johnson and Dr. Allen Featherstone for serving on my research committee and providing constructive feedback through the entire process.

This thesis project would not have been possible without the support of Ashley McDonald of the National Cattlemen's Beef Association (NCBA) and the U.S. Roundtable for Sustainable Beef. Ashley was instrumental in defining the need for a study on grazing management plans and distributing the survey through multiple channels. Without her assistance and willingness to promptly answer questions throughout the process, this study would not have been completed.

A thank you also goes to Chad Ellis, the National Grazing Lands Coalition Board of Directors, and the multiple cattle producers from across the country who reviewed the survey questions and helped refine them before sending to the masses. Also, I have much appreciation to the producers who took the time to complete the survey and contribute to this research.

I would be remiss without thanking Deborah Kohl and Mary Emerson-Bowen. The MAB program would not be what it is today without their dedication and efforts to the

students and faculty. Their guidance, encouragement and smiling faces throughout the last few years is very much appreciated.

Finally, I would like to thank my husband, Dustin, and my parents, Kevin and Mary Ann Kniebel, for their support throughout the MAB program. Their unwavering encouragement the last few years kept me focused on completing the program. I have always had the goal of completing a master's degree, and they helped make it happen.

CHAPTER I: INTRODUCTION

1.1 Background and Problem Statement

Defined by the United States Roundtable for Sustainable Beef (USRSB), sustainable beef is a "socially responsible, environmentally sound, and economically viable product that prioritizes planet, people, animals and progress" (U.S. Roundtable for Sustainable Beef 2020). With sustainability being top of mind for consumers and, in turn, beef supply chain partners and cattle producers, the USRSB established the U.S. Beef Industry Sustainability Framework "to identify opportunities for continuous improvement in all types of operations and companies throughout the beef industry." Within the Framework, multiple metrics among six high-priority indicators are tailored to each sector of the cattle and beef value chain. For the cow/calf sector, grazing management plans serve as one of the key metrics for three of the six indicators – water resources, land resources, and air and greenhouse gas emissions. USRSB members are currently establishing a baseline of grazing management plan adoption to know where to focus efforts in promoting their use and benefits to further improve sustainability of the U.S. beef industry (U.S. Roundtable for Sustainable Beef 2020).

In July 2020, the 2021-2025 Beef Industry Long Range Plan was released with the vision of beef being "the protein of choice around the world, trusted and respected for [the beef industry's] commitment to quality, safety and sustainability" (Beef Industry Long Range Plan 2020). Four industry objectives were identified with one being to "intensify efforts in researching, improving and communicating U.S. beef industry sustainability." Identifying sustainability as a key focus area for the next five years is instrumental in ensuring the industry aligns strategies and resources to accomplish the objective. One way

to accomplish this objective is to advance USRSB's efforts in ensuring more producers recognize the importance of meeting the established metrics, such as the implementation of a grazing management plan (Beef Industry Long Range Plan 2020).

Therefore, these organizations and other industry stakeholders seek to better understand the breadth of adoption and detail of grazing management plans in the United States and the economics and gaps of implementation. This information will be useful when promoting further adoption of written grazing management plans across the country, in addition to communicating the use of these plans to industry stakeholders.

1.2 Research Objectives

The overall research objective is to determine the adoption baseline of cattle grazing management plans in the United States in terms of acreage, number of operations, and the level of detail within those plans. In addition, the potential characteristics influencing the adoption of a grazing management plan and the economic impact of implementation, including the costs to implement and the resulting production benefits, will also be evaluated.

The specific objectives are as follows:

1. Develop a survey instrument to deploy to cattle producers across the United States by evaluating previous research on the development and implementation of cattle grazing management plans and related economics.
2. Employ the survey instrument to cattle producers across all regions of the United States to gain a better perspective on the regional variability of adopting grazing management plans.

3. Analyze the survey results to determine the adoption baseline of cattle grazing management plans in the United States in terms of acreage, the number of operations, and the level of detail within those existing plans (e.g. strategies and practices regarding land resource use, water resource use, and/or greenhouse gas emissions). In addition, an analysis will be conducted to evaluate the relationship of certain producer characteristics on the adoption of grazing management plans, and the economic costs and benefits associated with implementation of a grazing management plan will be assessed.

1.3 Thesis Outline

The organization of the thesis will be as follows: Chapter II will provide a review of the relevant literature, with Chapter III describing the methods. Chapter IV will report the data and findings from this research, and Chapter V will describe the results. Finally, Chapter VI will discuss the conclusions, including implications, limitations, and areas for future study.

CHAPTER II: LITERATURE REVIEW

This chapter will begin by discussing the definition, recognition, and prioritization of beef sustainability in the United States. Then an overview of U.S. grazing lands will be covered in the second section, with the definition and components of a grazing management plan, including the benefits and costs of implementation, being reviewed in the third section. The chapter will conclude with a discussion on how this research will contribute to gaps in the literature.

2.1 Beef Sustainability in the United States

The United States produces 18 percent of the world's beef with only six percent of the world's cattle, a testament to the U.S. beef industry being a global leader in beef production efficiency. In the United States, cattle spend more than half of their lives on pasture, on average, typically from the time they are born to when they are sent to a feedlot to be finished on a grain-based diet (Cattlemen's Beef Board and National Cattlemen's Beef Association 2020).

The focus of this thesis will be on the cow/calf sector. As defined by the USRSB, the cow/calf sector is made up of producers with operations that produce weaned calves from a herd of cows and bulls and stocker operations with grazing or high roughage programs for cattle from the weaning stage to when they start a finishing ration. The USRSB definition also includes backgrounder operations, but since those operations are not grazing focused programs, they are excluded from this analysis. The cow/calf sector is the largest and most diverse sector of the beef value chain, and they serve an important part in the process, particularly through their role of grazing cattle (U.S. Roundtable for

Sustainable Beef 2019). When cattle graze, their ruminant digestive system turns human inedible products, like grass and other forages, into high quality protein for human consumption – a process called upcycling (Wickersham 2018). While this process is important for maximizing land resource use to meet an increasing demand in protein from a growing world population, well-managed livestock production also serves as an economically viable use of land at a large scale that can contribute to the conservation of open spaces and natural habitats for wildlife, enhance or improve other ecosystem services, and increase overall benefits to society (Franzluebbers, et al. 2012).

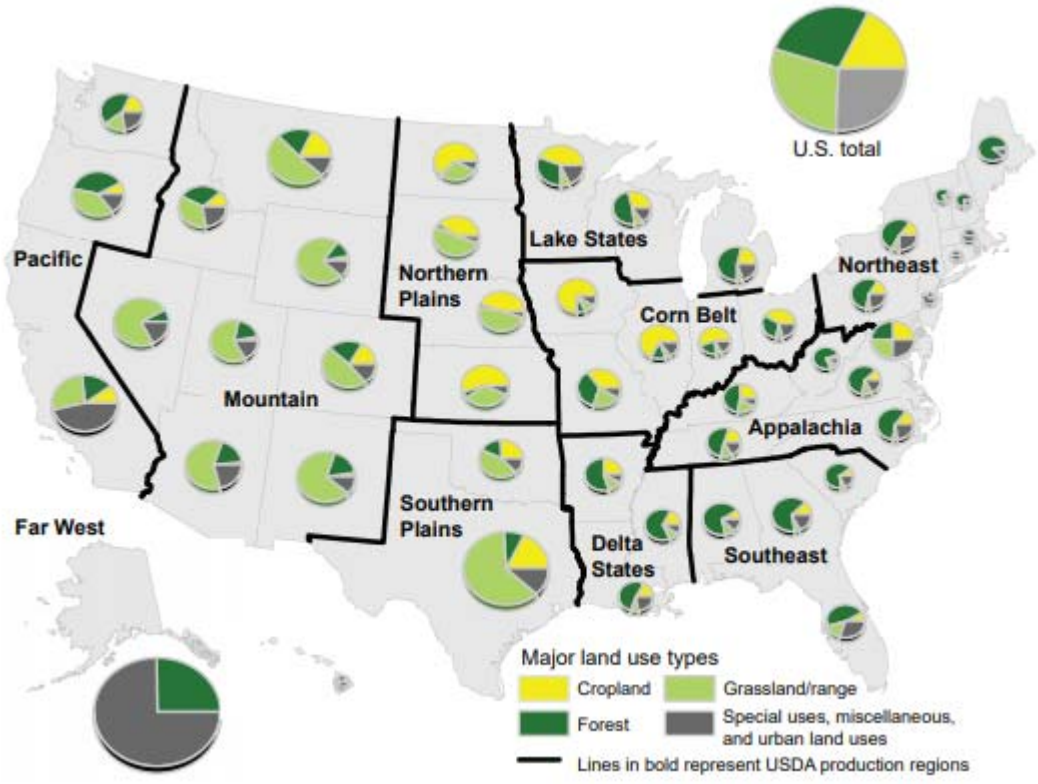
The USRSB's definition of sustainable beef is a "socially responsible, environmentally sound, and economically viable product that prioritizes the planet, people, animals and progress (U.S. Roundtable for Sustainable Beef 2019)." Within the USRSB Beef Industry Framework, multiple metrics among six high-priority indicators are tailored to each sector of the cattle and beef value chain. For the cow/calf sector, the use of a grazing management plan serves as one of the key metrics for three of the six indicators – water resources, land resources, and air and greenhouse gas emissions. USRSB members are currently establishing a baseline of the adoption of grazing management plans to know where to focus efforts in promoting their use and benefits to further improve sustainability of the U.S. beef industry (U.S. Roundtable for Sustainable Beef 2020).

2.2 Grazing Lands in the United States

The U.S. Department of Agriculture (USDA) Economic Research Service (ERS) publishes a report on the major uses of land in the United States about every five years based on the results from the Census of Agriculture. According to the 2012 Census, the

total U.S. land area sits at approximately 2.3 billion acres with grassland pasture and rangeland being the greatest use at 29 percent of the total (655 million acres). Although a downward trend in grazing acres existed from 1945 to 2007, this trend was reversed largely due to methodological changes in the implementation of the Census of Agriculture, with an increase of almost seven percent from 2007 to 2012, or 41 million acres. This was the highest estimate for the grassland pasture and rangeland segment since 1945, contributing to the increase in total available grazing lands, now at 35 percent of the entire U.S. land area (grassland pasture and range, cropland used for pasture, and grazed forests combined). Grasslands and rangelands account for most of the land in the Mountain and Southern Plains regions (Figure 2.1). With livestock grazing accounting for the majority of the grazed pasture and rangeland use (United States Department of Agriculture 2017) and cattle ranchers and farmers managing most of those lands, recording and enhancing land management practices with written grazing management plans is a ripe opportunity for contributing to sustainability efforts.

Figure 2.1: Shares of land major uses in the United States, by State and Region, 2012



Source: (United States Department of Agriculture 2017)

Based on a 2017 survey of over 2,000 U.S. beef cow/calf operations across 24 states conducted by the USDA Animal and Plant Health Inspection Service's (APHIS) National Animal Health Monitoring System (NAHMS), 96.1 percent of respondents indicated they expect grazed pasture to be at least 50 percent of the cattle herd's diet during the grass growing season. Table 2.1 details the percentage breakdown of these respondents by herd size. No regional differences were apparent in the number of operations that anticipated grazed pasture to make up over half the herd's diet during the growing season.

Table 2.1: Percentage of operations in which grazing pasture was expected to make up at least 50 percent of the herd's complete diet during the growing season, by herd size

Percent Operations Herd Size (number of beef cows)							
Small (1-49)		**Medium (50-199)**		**Large (200 or more)**		**All Operations**	
Pct.	Std. error	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error
95.8	(0.9)	96.5	(1.0)	99.0	(0.6)	96.1	(0.7)

Source: (United States Department of Agriculture 2020)

The United States includes both public and privately owned lands. Focusing on the grassland pasture and rangeland segment, 415 million acres (63.4 percent) are privately owned, while 194 million acres (29.6 percent) are publicly owned (federal, state and other public) with the larger concentration of these public lands being in the Pacific and Mountain regions (United States Department of Agriculture 2017). According to the 2017 NAHMS survey, a large majority of operators grazed cattle on their own private land (93.1 percent), and 30.9 percent grazed on leased private land. A very small percentage, 3.0 percent, grazed cattle on State or Federal lands. Herd size did not play a major factor in the percentages of grazed cattle on producers' own private land, but the percentage of grazing on leased private land increased as the herd size increased. In addition, 26.8 percent of large operations (200 head or more) grazed cattle on public lands, much higher than medium or small operations at 6.0 percent and 0.6 percent, respectively (United States Department of Agriculture 2020). These data are important to note when discussing grazing management plans as public lands have varying regulations and restrictions regarding certain practices.

2.3 Grazing Management Plans

As outlined by the USDA Natural Resources Conservation Service (NRCS), a grazing management plan (GMP) includes the conservation strategies and/or projects that are developed and implemented to address resource concerns on grazing land. Plans are to include at a minimum: background and site information; client objectives, such as improving forage yield, maintaining or improving wildlife habitat, preventing or reducing erosion, etc.; existing conditions, such as vegetative species diversity and condition, animal types and number, acres available, watering systems, fencing structures, etc.; and desired future conditions. Documentation of those conditions, in addition to contingency plans for natural disasters, drought, biosecurity measures and other events, are to be included as well. Note, these details are not an exhaustive list of what can be incorporated within a GMP, but represent some of the recommendations from NRCS (Natural Resources Conservation Service 2020). Multiple examples of grazing management plans are available through local NRCS offices, extension and education centers, and private consultants. It is recommended to evaluate GMPs at least once a year prior to the start of the grazing season and adjust based on current resources, climate and weather conditions, and the objectives and goals of the operation (Ellison and Cummings 2020). This constant evaluation and adjustment process follows a key principle outlined in the USRSB Framework – that sustainability is managing an operation while striving for continuous improvement, both at the strategic business and day-to-day task levels (U.S. Roundtable for Sustainable Beef 2019).

One of the metrics within the USRSB Framework for the cow/calf sector is the implementation and use of a GMP for water resources, land resources, and air and greenhouse gas emissions indicators. With the size, scope, and common practices of U.S.

cow/calf operations varying greatly, especially across regions, the implementation of GMPs will also be variable from operation to operation. A key characteristic of a GMP is adaptability, while ensuring each plan is tailored to an individual ranching or farming operation based on their specific goals and objectives, resources, conditions, and ecological features (U.S. Roundtable for Sustainable Beef 2019). By developing and successfully implementing an appropriate grazing management plan, a cow/calf operation can improve ecosystem services, such as carbon sequestration, soil health (Follett and Reed 2010), and wildlife habitat and biodiversity (Briske, et al. 2011). These continuous improvements at the cow/calf sector level contribute to the overall sustainability of the beef industry (U.S. Roundtable for Sustainable Beef 2019).

Based on the 2017 survey conducted by the USDA APHIS's NAHMS, of the producers who indicated grazed pasture made up at least 50 percent of the herd's diet during the growing season (see Table 2.1), 7.6 percent had a written grazing management plan across all size categories, with 19.8 percent of the large operations (200 head herd size or more), 13.4 percent of the medium operations (50 to 199 head), and 5.2 percent of the small operations (1-49 head) being the breakdown by operation size. The breakdown by region of the use of these plans was also evaluated, with the Central region having the greatest adoption, then the West and East regions at 11.7 percent, 7.1 percent, and 5.3 percent, respectively (United States Department of Agriculture 2020).

2.3.1 Benefits of Development and Implementation

Multiple benefits from the development and implementation of a grazing management plan are expected to be realized at the economic, environmental, and societal

levels. Economic benefits are defined as "benefits that contribute to the financial well-being of those living on the land, as well as to trade and exchange of goods and services associated with products derived from grazing lands at the local, regional, or national scale" (Follett and Reed 2010, pg. 5). For example, grazing-land managers can improve the economics of their operation through cost savings by combining the knowledge of when adapted forages grow, how to manage those forages with grazing cattle, and the nutrient needs of the cattle, with proactively planning ahead at least one or multiple grazing seasons. Research led by Jennings et al. (2016) showed that grazing seasons can be extended to 300+ days per year using planned grazing management practices to combine perennial, annual and stockpiled forages. Conducted in Arkansas with spring and fall calving herds, this research could also be applied to stocker and heifer development programs, with cost savings averaging $50 per animal unit for stockpiled forages, $83 per animal unit for winter annual forages during "normal" winters, and over $200 per animal unit during drought years (Jennings, Beck and Gadberry 2016).

Environmental benefits are derived from the maintenance or improvement of the immediate and neighboring resources, including the soil, water, air quality, human and wildlife habitat, and aesthetics. Implementing grazing management practices that retain or increase the long term storage of carbon dioxide (CO_2) in soil organic matter can offset atmospheric CO_2 emissions, leading to improved soil productivity and water quality, a reduction in soil erosion, and improvements in air quality. Globally, the estimated soil organic carbon (SOC) sequestration potential across grazing lands is about 0.2 Pg C $\cdot$ yr^{-1}, which is equivalent to removing approximately 0.7 Pg C $\cdot$ yr^{-1} from the atmosphere. Whether the carbon remains in storage over time depends on management practices and

environmental conditions, with additional research being conducted for land managers to reference when developing a GMP (Follett and Reed 2010). For example, Table 2.2 shows the expected impact of grazing management activities on soil carbon (C) sequestration for pasturelands in the eastern United States.

Balancing the economic and environmental goals is instrumental to providing long term societal benefits and ecosystem services from the grazing land. As an example, grazing lands play a key role in the hydrologic cycle of large watersheds that are important for the economic survival of agricultural producers, towns and cities located downstream. By effectively managing grazing lands through practices that maintain the soil, vegetation and hydrology in and around the watersheds, society can benefit from reduced soil erosion, the prevention or reduction of flooding, enhanced wildlife habitat, and the potential increased carbon sequestration helping to offset atmospheric carbon dioxide emissions (Follett and Reed 2010).

Table 2.2: Management effects on soil carbon (C) sequestration for pasturelands in the eastern United States

Management activity	Intended management goal	Impact on C storage
Animal management		
Grazing lands	More C returned to soil for rapid incorporation	Increase SOC[1]
Intensive grazing	With adequate moisture, intensive management increases NPP[1], increased foot traffic breaks down residue	Increase SOC
	With limited moisture, increased stocking can damage stands	Decrease SOC
Forage management		
Replacing C3 grasses with C4 grasses	At low to moderate fertility, increase NPP and reduce forage quality	Increase SOC
	At high fertility, little change in NPP	Little change in SOC. May not be sustainable
Replace endophyte-infected fescue with uninfected fescue	Increase forage quality	Decrease SOC
Increased harvest frequency	Reduce NPP, increase forage quality	Decrease SOC
Delay harvest or grazing	Reduce forage quality	Increase SOC
Soil management		
Liming	Increases phosphorus availability and NPP	Increase SOC
Phosphorus fertilization	If phosphorus deficient, increase NPP	Increase SOC
	If phosphorus is adequate or in excess, no change	No change
Nitrogen fertilization	Low inherent fertility, increase NPP and forage quality	Increase SOC
	High inherent fertility; NPP and decomposition of SOC, no change or increase	No change, decrease, or increase in SOC, depending on relative change in NPP and decomposition
Manuring	Increases NPP if fertility limits growth	Increases SOC
Drainage	Increase NPP, increases SOC decomposition	Decreases SOC

[1]SOC indicates soil organic carbon; NPP is net primary productivity.

Source: (Follett and Reed 2010)

2.3.2 Costs of Development and Implementation

While developing and executing a grazing management plan can result in many benefits, costs are part of the implementation process as well. Investments in projects and practices used to improve grassland ecosystem conditions, such as prescribed burning,

reseeding with native or more desirable forage species, irrigation, water access and/or quality projects, new fencing, and other projects, require time and money for the producer to implement (Thorne, Fukumoto and Stevenson 2007).

For example, a 2019 survey conducted by the Land Use Survey Center in the Department of Agricultural Economics at Kansas State University evaluated fence construction and material costs in the state of Kansas. For a quarter-section, square pasture, in central Kansas, the total material cost for a five-wire barbed wire fence with five steel posts for every one wooden post, spaced 12 feet apart, is estimated to be $7,978. Adding in the average labor cost per rod at an estimated $21.86 and the average labor cost for hedge and corner posts at about $147.50, the total investment can be considerable (Li and Tsoodle 2020). As discussed before, many practices, such as new fencing to manage grazing, can be implemented to improve grassland ecosystems as part of a grazing management plan. Overall, the goal is for each producer to evaluate the potential costs and benefits and proceed with practices that make sense for their operation's unique circumstances.

2.4 Gaps in the Literature Review

The 2017 survey conducted by the USDA APHIS's NAHMS captured data regarding the adoption rate (7.6 percent across all size categories) of grazing management plans across the United States. However, the caveat was given that the written GMPs needed to outline the goals, tactics and metrics to measure the plan's progress, although no details were asked of the survey respondents regarding the depth and detail included in the grazing management plan. In addition, the NAHMS survey did not include details of grazing acres covered by a GMP, written or otherwise (United States Department of

Agriculture 2017). Both gaps will be evaluated in this thesis project. Additional research relative to grazing management plan adoption is being conducted by the U.S. Roundtable for Sustainable Beef to complete a full gap analysis for the industry metrics baseline report, with the results being available in mid-2021.

In addition, while much research has been done on estimating the potential costs and benefits of various grazing management practices across the United States, a comprehensive cost to benefit analysis has not been widely studied. The results of this thesis will contribute to this information gap.

CHAPTER III: METHODS

This chapter begins with a discussion around the conceptual and empirical framework used within this thesis. This section is followed by an explanation of the variables used in the empirical model and then a section providing the hypotheses for the variables. The fourth section provides an outline of the sampling and data collection approach, and the chapter concludes with an explanation of the survey instrument.

3.1 Conceptual and Empirical Framework

Both descriptive statistics and econometric analysis were utilized to analyze the collected data. Descriptive statistics included percentages and means. For the econometric analysis, a binary logit model provided the framework to examine specific cattle producer and operation characteristics influencing the adoption of grazing management plans, both written or otherwise, across the United States. It is assumed the utility received by producer p from choosing alternative i can be represented as:

$$U_{ip} = V_{ip} + \varepsilon_{ip,}\ i = 1, \dots, I \ \text{ and } \ p = 1, \dots, P, \tag{1}$$

where U is the producer's expected utility from choosing alternative i, V is the deterministic portion of the utility, and ε is the stochastic error term. The probability a producer, p, will choose alternative i is found by:

$$\begin{aligned} P_p(i) &= \Pr(U_{ip} \geq U_{jp}) \\ &= \Pr(V_{ip} + \varepsilon_{ip} \geq V_{jp} + \varepsilon_{jp}) \\ &\text{for all } i, j \varepsilon C_p \end{aligned} \tag{2}$$

where C_p is the choice set for producer $\left[C_p = \{i, j\} = \{\text{Has a GMP, Does not have a GMP}\}\right.$, or $\left[C_p = \{i, j\} = \{\text{Has a Written GMP, Does not have a Written GMP}\}\right.$.

Assuming the stochastic errors in equation (1) are independently and identically distributed across the *i* alternatives and *p* individuals, then equation (2) is logistically distributed. Lusk, Roosen and Fox (2003) have revealed that the probability of producer *p* choosing between alternative *i* is given by:

$$(3) \qquad P_p(i) = \frac{e^{\mu V_{ip}}}{\sum_{j \varepsilon C_p} e^{\mu V_{jp}}}$$

where μ is the scale parameter and is assumed to be equal to one because it is unidentifiable within any data set and cannot be distinguished from the overall scale of the estimated β parameters. Given two choices, a binary logit model gives the choice probability for alternative *i* as:

$$\begin{aligned} P_p(i=1) &= \frac{e^{\mu V_{ip}}}{e^{\mu V_{ip}} + e^{\mu V_{jp}}} \\ &= \frac{1}{1 + e^{-\mu(V_{ip} - V_{jp})}} \\ &= \Phi(V) \\ &= \Phi(\beta' x), \end{aligned} \qquad (4)$$

where *β'* is the vector of parameters to be estimated and *x* is the vector of observations. Assuming the deterministic portion of utility, V_i, is linear in the parameters, the regression specification is:

$$\begin{aligned} (5) \qquad GMP_{ip} = {} & \beta_0 + \beta_1 Age_n + \beta_2 NAHMSCentral_n + \beta_3 NAHMSEast_n + \\ & \beta_4 YesPDM_n + \beta_5 YesSuccessionPlan_n + \beta_6 SuccessionPlanInProg_n + \\ & \beta_7 PrivateLand_n + \beta_8 OtherLand_n + \beta_9 GrazAcres1-49_n + \\ & \beta_{10} GrazAcres50-99_n + \beta_{11} GrazAcres500-999_n + \\ & \beta_{12} GrazAcres1000-4999_n + \beta_{13} GrazAcres5000orMore_n + \\ & \beta_{14} Cows50-99_n + \beta_{15} Cows100-199_n + \beta_{16} Cows200-499_n + \end{aligned}$$

$$\beta_{17}Cows500-999_n + \beta_{18}Cows1000-2499_n + \beta_{19}Cows2500OrMore_n + \beta_{20}NoCowCalf_n.$$

Similar to equation (5), an additional model was run with the only difference being the dependent variable was replaced with *GMP Written*. Two additional models were run with *GMP* and *GMP Written* as the dependent variables and *Stockers* variables were in place of the *Cows* as independent variables.

3.2 Variable Description

The variables outlined in Table 3.1 include the list of dependent and independent variables, their descriptions, and the mean, median and standard error for each. The two separate dependent variables include if an operation has a GMP (*GMP*) and if they have a written GMP (*Written GMP*). The independent variables are listed as well and include: the age of the producer (*Age*), NAHMS regions as described below in section 4.2 (*NAHMS Central* and *NAHMS East*), the classification of producers who serve as the primary or joint primary decision maker on the operation (*Primary Decision Maker*), the use of a succession plan or the development of one (*Succession Plan* and *Succession Plan In Prog*), land ownership categories with private land indicating the producer manages both owned and leased private land (*Private Land*) and other land indicating not public or private (*Other Land* – such as university land or uncategorized by the survey respondent), and multiple size classifications of operations in terms of grazing acres (*Graz Acres1-49*, etc.), cows (*Cows50-99*, etc.), and stockers (*Stockers50-99*, etc.).

The region variables are compared to producers operating in the West region, the primary decision maker variable is compared to producers who are not the primary decision

maker, the succession plan variables are compared to operators who do not have a succession plan, the type of land variables are compared to those who lease federal public and/or state and local public lands, the grazing acres variables are compared to the producers who manage 100 to 499 grazing acres, and the cows and stockers variables are compared to the operations with 20 to 49 head of cows and/or stockers.

These variables capture some of the demographic information assessed in the survey and have been evaluated using a binary logit regression model to determine the relationship between specific characteristics and the adoption of a GMP. As future GMP educational resources and programs are developed for producers to utilize, a better understanding of these producer traits could be beneficial for educators and consultants.

Table 3.1: Summary Statistics for Dependent and Explanatory Variables Used in the Logit Regression

Variable	Description	Mean	Median	Std. Error
GMP	1 if operation has GMP, 0 if not	0.828	1	0.377
Written GMP	1 if operation has written GMP, 0 if not	0.429	0	0.495
Age	Age of the producer	56.700	59	14.000
NAHMS West	1 if operation is located in West region, 0 if not	0.364	0	0.482
NAHMS Central	1 if operation is located in Central region, 0 if not	0.159	0	0.366
NAHMS East	1 if operation is located in East region, 0 if not	0.273	0	0.446
Primary Decision Maker	1 if a primary decision maker, 0 if not	0.938	1	0.241
Succession Plan	1 if operation has succession plan, 0 if not	0.482	0	0.500
Succession Plan In Prog	1 if operation has succession plan in progress, 0 if not	0.198	0	0.399
No Succession Plan	1 if operation does not have a succession plan, 0 if they do	0.317	0	0.466
Private Land	1 if operation has owned or leased private land, 2 if both, 0 if neither	1.420	1	0.507
Public Land	1 if operation has leased federal or leased state/local land, 2 if both, 0 if neither	0.270	0	0.571
Other Land	1 if operation has other categories of land, 0 if not	0.005	0	0.072
Graz Acres1-49	1 if operation has 1-49 grazing acres, 0 if not	0.127	0	0.333
Graz Acres50-99	1 if operation has 50-99 grazing acres, 0 if not	0.136	0	0.343

Table 3.1: Summary Statistics for Dependent and Explanatory Variables Used in the Logit Regression (cont'd)

Variable	Description	Mean	Median	Std. Error
Graz Acres100-499	1 if operation has 100-499 grazing acres, 0 if not	0.241	0	0.428
Graz Acres500-999	1 if operation has 500-999 grazing acres, 0 if not	0.090	0	0.287
Graz Acres1,000-4,999	1 if operation has 1,000-4,999 grazing acres, 0 if not	0.155	0	0.362
Graz Acres5,000OrMore	1 if operation has 5,000 or more grazing acres, 0 if not	0.248	0	0.432
Cows20-49	1 if operation has 20-49 cows, 0 if not	0.290	0	0.454
Cows50-99	1 if operation has 50-99 cows, 0 if not	0.193	0	0.395
Cows100-199	1 if operation has 100-199 cows, 0 if not	0.157	0	0.364
Cows200-499	1 if operation has 200-499 cows, 0 if not	0.155	0	0.362
Cows500-999	1 if operation has 500-999 cows, 0 if not	0.089	0	0.285
Cows1,000-2,499	1 if operation has 1,000-2,499 cows, 0 if not	0.043	0	0.204
Cows2,500OrMore	1 if operation has 2,500 cows or more, 0 if not	0.021	0	0.143
No Cow/Calf Operation	1 if not a cow/calf operation, 0 if they are	0.050	0	0.218
Stockers20-49	1 if operation has 20-49 stockers, 0 if not	0.160	0	0.367
Stockers50-99	1 if operation has 50-99 stockers, 0 if not	0.071	0	0.257
Stockers100-199	1 if operation has 100-199 stockers, 0 if not	0.059	0	0.236

Table 3.1: Summary Statistics for Dependent and Explanatory Variables Used in the Logit Regression (cont'd)

Variable	Description	Mean	Median	Std. Error
Stockers200-499	1 if operation has 200-499 stockers, 0 if not	0.067	0	0.250
Stockers500-999	1 if operation has 500-999 stockers, 0 if not	0.022	0	0.148
Stockers1,000-2,499	1 if operation has 1,000-2,499 stockers, 0 if not	0.046	0	0.209
Stockers2,500OrMore	1 if operation has 2,500 stockers or more, 0 if not	0.028	0	0.164
No Stocker Operation	1 if not a stocker operation, 0 if they are	0.539	1	0.499

3.3 Variable Hypotheses

The relationship between *Age* and *GMP* adoption is expected to be negative, meaning as age increases, they are less likely to adopt a GMP. For the *NAHMS Central* and *NAHMS East* regions, the relationship between those variables and GMP adoption compared to the West region is expected to be negative. The Western region has a greater percentage of public grazing lands that have various land management requirements which are included in GMPs. The relationship between *Primary Decision Maker*, *Succession Plan* and *Succession Plan in Prog* variables are all expected to be positive compared to the non-primary decision makers and the producers without a succession plan relative to GMP adoption. For the *Private Land* and *Other Land* variables, the sign on the coefficient is anticipated to be negative compared to the producers who manage public lands. With the grazing acres categories being compared to the 100 to 499 acre category, the signs for the *Graz Acres1-49* and *Graz Acres50-99* variables are expected to be negative and the

remaining grazing acre variable signs are expected to be positive, indicating that larger operations are more likely to have a GMP. The cows and stockers variables are compared to the 20 to 49 head category for each with the signs for all cows and stockers variables expected to be positive, except for the *No Cow/Calf Operation* and *No Stocker Operation* variables. This also follows the size of operation logic.

3.3 Sampling and Data Collection Approach

To collect data regarding the adoption and use of grazing management plans in the United States, an electronic survey instrument was developed and delivered via email to the membership list of the National Cattlemen's Beef Association (NCBA) and several of their state affiliate organizations. Defined on the NCBA website, the association is "a consumer-focused, producer-directed organization representing the largest segment of the nation's food and fiber industry" (https://www.ncba.org/about.aspx). NCBA has over 25,000 individual members and several industry organization members. Although not all cattle grazing operations in the United States are NCBA or NCBA state affiliate organization members, the sample is assumed to be representative of the cow/calf operations in the United States with NCBA being "the nation's largest and oldest association representing cattle and beef producers" (https://www.ncba.org/membership.aspx).

Along with a cover letter providing an explanation of research study goals, the survey was distributed via email to 2,760 cattle producers on the NCBA distribution list and an additional 44 state affiliates asked to distribute to their respective membership lists. The survey remained open for 36 days (November 30, 2020 through January 4, 2021), and reminders were sent periodically to the different distribution groups.

3.4 Survey Instrument

The survey question development and design were informed by previous research and pretesting with a group of the National Grazing Lands Coalition producer board members, the National Cattlemen's Beef Association staff, cow/calf producers, and Kansas State University faculty and students to refine the question logic and regionally specific terminology. The complete survey instrument can be found in Appendix A.

The survey instrument was divided into three sections. The first section focused on demographic data from the respondents, including age, operation location(s), primary decision maker status, general classification of operation income, average herd size, operation size in terms of acres, and type of managed grazing land. These data are important to help define the adoption of grazing management plans (GMPs) by state, region, and total managed acres, in addition to other demographic factors potentially impacting adoption.

The second section of the survey is focused on grazing management; specifically, the use and components of grazing management plans. Because succession or transition plans are an element of the USRSB cow/calf sector metric for land resources, a question was included in the survey. A key objective of this research is to evaluate the adoption rate of GMPs in the United States. Therefore, questions are included regarding the use or absence of a GMP across all or part of the operation, the reasoning for why a producer has or does not have a GMP, the resources utilized to develop a GMP, and the documentation methods for a GMP, written or otherwise. In addition, both NRCS and USRSB have recommendations on what information should be included to constitute a complete GMP.

Thus, respondents are asked about the components of their operational plans at a high level with the list of options being condensed and summarized from the NRCS Grazing Management Plan Activity Code (Natural Resources Conservation Service 2020) and USRSB Framework (U.S. Roundtable for Sustainable Beef 2019). Based on the feedback from the pretest, a question was also included regarding the willingness to pay a consultant to assist in the development and/or improvement of a written GMP.

The third section of the survey examines the economics, with both the costs and benefits referenced. The ranked factors of importance during the development of an operator's GMP are a condensed list from the USRSB Framework cow/calf sector indicators for land resources, water resources, and air and greenhouse gas emissions (U.S. Roundtable for Sustainable Beef 2019). A gap in current data was identified regarding the costs of developing and implementing a GMP, including the amount of time invested in developing a plan and the total investment in various practices implemented over a 10-year period. Examples of infrastructure changes and improvements are listed to prompt survey respondents to reflect on the specific management strategies and an estimation of dollars invested in their operation. This list of examples is a condensed sample of conservation practices included as a guide in the NRCS Grazing Management Plan Activity Code (Natural Resources Conservation Service 2020). This section also includes questions regarding the perceived and realized benefits resulting from implementing a GMP, also an area with little current research. A list of potential benefits is summarized from the examples within the USRSB Framework (U.S. Roundtable for Sustainable Beef 2019) and NRCS Grazing Management Plan Activity Code (Natural Resources Conservation Service 2020), with a prompt for respondents to include estimated dollar benefits.

The survey instrument was evaluated by Kansas State University's Committee on Research Involving Human Subjects and Institutional Review Board (Proposal Number 10308). They granted the approval and an exemption from further review. Appendix B provides a copy of the exemption letter from the Committee on Research Involving Human Subjects / IRB.

CHAPTER IV: DATA

This chapter begins by summarizing the data for the entire United States. A regional overview of the data collected in the study will follow.

4.1 Data Description

Survey responses were accepted from November 30, 2020, through January 4, 2021, with 994 partially complete or complete responses being submitted. Of those responses, 31 indicated the respondent did not graze cattle which removed them from participating in the survey, and 200 completed less than 51 percent of the survey. Therefore, the sample size was narrowed to 763 partially complete or complete responses.

4.1.1 Producer Age

Several questions captured basic demographic information of the survey respondents, with age being one component. The average age of survey participants is 56.7, which is comparable to the average producer age of 57.5 reported from the 2017 Census of Agriculture data (U.S. Department of Agriculture, National Agricultural Statistics Service 2019). In fact, the breakdown across age groups is similar with specific percentages shown in Table 4.1.

Table 4.1: Comparison of the age group breakdown between survey respondents and the 2017 USDA Census of Agriculture

	Survey Respondents		USDA Census of Agriculture	
Age group	**Number of respondents[1]**	**Percentage of total**	**All producers[2]**	**Percentage of total**
Under 25	7	1.0%	50,943	1.5%
25-34	50	7.0%	234,496	6.9%
35-44	94	13.1%	390,345	11.5%
45-54	139	19.3%	614,654	18.1%
55-64	179	24.9%	955,354	28.1%
65-74	196	27.3%	757,936	22.3%
75 and older	54	7.5%	396,106	11.7%
Total	**719**	**100.0%**	**3,399,834**	**100.0%**

[1] The total number of survey respondents (719) does not align with the initial total because 44 respondents preferred not to answer or had an unusable response.

[2] The "all producers" terminology includes both principal producers, those who are designated as the only or one of the primary decision makers on the operation, and non-principal producers, those who did not indicate they are a primary decision maker. Source: (U.S. Department of Agriculture, National Agricultural Statistics Service 2019)

4.1.2 Producer Decision Maker

Survey participants were asked if they serve as the primary decision maker on the operation. Out of the 763 respondents, 672 (88 percent) indicated they are the primary decision maker, 41 (5 percent) said they are not the primary decision maker, and 50 (7 percent) selected the "other, please specify" option and provided additional detail. Of those who selected the "other, please specify" response, 90 percent indicated they have some form of primary decision-making responsibility as a co-principal producer with one or more family members or business partners. Defined in the 2017 U.S. Census of Agriculture, a principal producer is someone who is designated as the only or one of the primary decision makers on the operation (U.S. Department of Agriculture, National Agricultural Statistics Service 2019). The other 10 percent stated their primary decision-making role is in transition to the next generation or they serve in a ranch management role

with the owners holding the primary decision-making responsibilities. Out of the respondents who said they are the primary decision maker, their median tenure is from 20 to 29 years.

4.1.3 Producer Income

Out of the 763 survey participants, 32 percent indicated their grazing operation serves as a primary source of income, while 61 percent said their grazing operation is a supplemental source of income. The remaining 7 percent either preferred not to answer or selected the "other" response. Out of the 40 individuals who selected "other," 50 percent detailed their grazing operation represented part of their overall income, 23 percent identify as hobby farmers, 8 percent use the output of their grazing operation as a personal food source, 10 percent indicated their grazing operation provides no income, and 10 percent detailed other classifications, such as university operations or being retired and transitioning to the next generation.

In terms of income classification versus size of operation, the USDA classifies operations into three categories in the 2017 Beef Cow-Calf Management Practices in the United States report: small (1 to 49 cows), medium (50 to 199 cows), and large (200 or more cows). On the majority of small (89.0 percent) and medium (66.6 percent) operations, the cow/calf operation was a supplemental source of income. On the majority of large operations (71.9 percent), the cow/calf operation was a primary source of income (United States Department of Agriculture 2020). Compared to the USDA data, the survey data are similar with the majority of small operations (20-49 cows) and medium operations (50-199 cows) indicating they are a supplemental source of income at 88.2 percent and 66.3

percent, respectively. In addition, the large operations with 200 cows or more show the majority are a primary source of income (63.0 percent), although the percentage is not as high relative to the USDA data.

4.1.4 Operation Size and Grazing Land Type

As shown in Table 4.2, the breakdown of survey respondents by size of cow/calf operation favors larger operations compared to the USDA Census of Agriculture data on a percentage basis. The smaller operations are underrepresented, which is likely attributed to the sample population and distribution method. This data combined with the decreasing percentage of survey responses as the cow/calf operation size increases does follow the census data.

Table 4.2: Comparison of beef cow/calf operation herd sizes between survey respondents and the 2017 USDA Census of Agriculture

	Survey Results		USDA Census of Agriculture	
Herd size (# cows)	**Number of farms reporting[1]**	**Percent reporting**	**Number of farms[2]**	**Percent of total**
20-49	221	30.57%	183,640	54.66%
50-99	147	20.33%	80,411	23.94%
100-199	120	16.60%	42,774	12.73%
200-499	118	16.32%	23,188	6.90%
500-999	68	9.41%	4,538	1.35%
1,000-2,499	33	4.56%	1,202	0.36%
2,500-4,999	12	1.66%	198	0.06%
5,000 or more	4	0.55%	-	-
Total	**723**	**100.00%**	**335,951**	**100.00%**

[1]The total number reported in this table does not correspond to the original sample of 763 because some respondents indicated they do not have a cow/calf operation or left the answer blank.

[2]The total does not include all farms with beef cows in the Census dataset because we excluded operations with less than 20 head. Source: (U.S. Department of Agriculture, National Agricultural Statistics Service 2019)

The number of stocker operations within the sample population is shown in Table 4.3. While the USDA, nor other industry sources, do not report detailed data for stocker

operations, the results show some notable differences between cow/calf and stocker operations in terms of GMP adoption. Out of the survey respondents, 313 indicated they had both a cow/calf and a stocker operation.

Table 4.3: Number of stocker operations reported by herd size from survey respondents

Herd size (# stockers)	Number reporting[1]	Percent reporting
20-49	122	35.4%
50-99	54	15.7%
100-199	45	13.0%
200-499	51	14.8%
500-999	17	4.9%
1,000-2,499	35	10.1%
2,500-4,999	10	2.9%
5,000 or more	11	3.2%
Total	**345**	**100.0%**

[1]The total number reported in this table does not correspond to the original sample of 763 because some respondents indicated they do not have a stocker operation or left the answer blank.

Similar to the cow/calf herd size, the survey sample also leans toward the larger operations compared to the USDA Census of Agriculture data. Table 4.4 compares the operation sizes between survey respondents and the 2017 census data, showing almost 42 percent of farms managing 1 to 49 total acres and 1.3 percent in the 5,000 or more acres category. In contrast, only 6.4 percent and 26.7 percent of the survey respondents indicated they manage 1 to 49 total acres and 5,000 or more acres, respectively. However, the 100 to 499 total acres category is similar. Again, these data in this study highlight the higher response rate for larger operators.

Table 4.4: Comparison of operation sizes between survey respondents and the 2017 USDA Census of Agriculture in terms of acres of land

	USDA Census of Agriculture Data		Total Agricultural Land		Grazing Land Only	
Number of Acres	**Number of Farms**	**Percentage of Farms**	**Number Reporting**	**Percentage Reporting**	**Number Reporting**	**Percentage Reporting**
1-49	856,326	41.9%	49	6.4%	97	12.7%
50-99	298,377	14.6%	71	9.3%	104	13.6%
100-499	581,403	28.5%	214	28.0%	184	24.1%
500-999	133,321	6.5%	75	9.8%	69	9.0%
1,000-4,999	147,108	7.2%	148	19.4%	118	15.5%
5,000 or more	25,685	1.3%	204	26.7%	189	24.8%
Prefer not to answer	-	0.0%	1	0.1%	1	0.1%
Blank	-	0.0%	1	0.1%	1	0.1%
Total	**2,042,220**	**100.0%**	**763**	**100.0%**	**763**	**100.0%**

Source: (U.S. Department of Agriculture, National Agricultural Statistics Service 2019)

4.1.5 Grazing Management Plan Adoption and Succession Planning

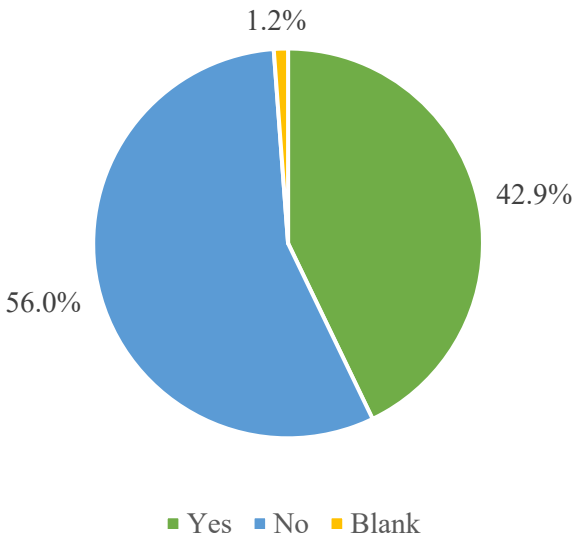
The following definition and explanation of a GMP was shared with survey respondents at the beginning of the survey.

> *A grazing management plan (GMP) includes the detailed conservation strategies and/or projects that are developed and implemented to improve the use of available resources, such as land and water, on land grazed by livestock. Plans may include: operation background and site information; clearly defined producer objectives; methods to monitor forage quantity and quality; inventory of existing water resources (e.g. storage capacity, number of head that can be supplied with water, etc.), land resource in acres and forage productivity, air conditions; desired future land, water and air conditions; and, contingency plans for drought, natural disasters and other events.*
>
> *Not all documents or records are called grazing management plans, but if you have documentation with any of the above information, those are considered part of a GMP. Please refer to those when answering the following questions. Examples include federal grazing permit documentation, a whole farm/ranch plan, etc.*

Based on the provided definition, 17.2 percent (131) of the survey respondents indicated they do not have a GMP, while 82.8 percent (632) said they do have one. Delving further, 52 percent of the 632 respondents with a GMP have some form of a written plan, while 47 percent do not, and one percent of the responses were blank.

Figure 4.1 shows the written GMP adoption breakdown across the whole sample population. In the 2017 NAHMS Beef Study, 7.6 percent of cow/calf producers indicated they have a written GMP, which is much lower than the 42.9 percent for survey participants. However, almost 20 percent of the producers in the NAHMS study for operations with 200 head or more said they have a GMP (United States Department of Agriculture 2020). Since the survey sample population includes a greater proportion of larger operations, the higher adoption rate seems reasonable. In addition, the different definitions of a GMP used for this survey and the NAHMS survey could also influence how participants respond. For the NAHMS survey, the guidance was given that the written plans needed to outline the goals, tactics and metrics to measure the plan's progress.

Figure 4.1: Written grazing management plan adoption across all survey respondents



Focusing on the 632 survey respondents who indicated they do have a GMP (written or otherwise), 89.2 percent said their GMP covers all their grazing land acres, 10.6 percent said their GMP does not cover all their grazing land acres, and 0.2 percent preferred not to answer. Of the 10.6 percent who indicated their GMP does not cover all

their grazing land acres, about 65 percent, on average, of their managed grazing acres are covered under a GMP.

In addition, participants with GMPs were asked what details are included in their plans. The top category (73 percent) of information included was management actions to achieve operational goals, such as animal movement records, duration of grazing period(s), pasture size and number, stocking rate, and infrastructure management or improvements. The next three categories were the assessment of current resource conditions, plans for regular monitoring, and operation goals and objectives, at 69 percent, 67 percent, and 62 percent, respectively. About 46 percent include contingency plans for drought and other risks, and 26 percent have details related to wildlife resource inventory and management. See the survey instrument in Appendix A for the entire description of GMP component categories.

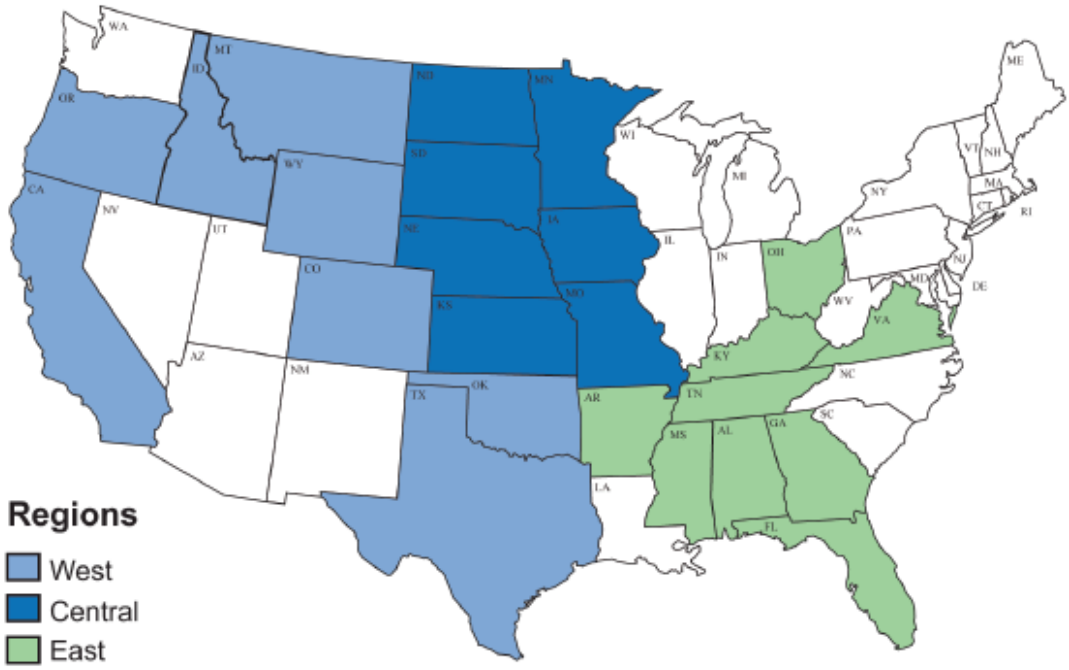
The survey participants who indicated they do not have a GMP were asked why they do not have one. Of the 131 respondents, 7 percent said developing a GMP takes a lot of time and effort, 26 percent are not sure what a GMP is or how it would benefit their operation, 13 percent said they do not have the resources available to develop and implement a plan, 21 percent are in the process of developing a GMP, 13 percent know what a GMP is but do not believe it would benefit their operation, and 20 percent selected other or left the answer blank. Participants were also asked to select from a list of potential resources, assistance, and other information they would need to develop a GMP (multiple selection allowed). Of the 103 who responded, about 40 percent indicated a consultant (e.g., technical service providers, university extension and education services, government organizations, nongovernment organizations, private consultants, etc.) would be beneficial,

while about 36 percent said educational tools, such as books, educational guides or handbooks would be helpful. Almost 43 percent selected a GMP template as a useful resource, and 20 percent indicated various other reasons, ranging from needing additional assistance from the USDA Natural Resources Conservation Services to not being interested. The final question for participants without a GMP asked if they were willing to pay a consultant to assist in the development of a plan, with 8 percent saying yes, 68 percent selecting no, and 24 percent indicating they might pay a consultant.

4.2 Regional Breakdown of Grazing Management Plan Adoption and Use

The survey responses were categorized into three regions based on the NAHMS Beef 2017 study. Figure 4.2 shows the states included and excluded in the regional categories. If an operation within the survey data is in one of the excluded states, they were omitted from the regional analysis to provide a fair comparison to the USDA NAHMS data.

Figure 4.2: States/regions in the NAHMS Beef 2017 study



Source: (United States Department of Agriculture 2020)

When evaluating the survey respondent data, 490 observations were classified into the three regions. The West region has the highest written GMP adoption rate at 60 percent, followed by the Central region at 55 percent, then the East region at 43 percent. This differs from the NAHMS study, with the Central region having the greatest adoption, then the West and East regions at 11.7 percent, 7.1 percent, and 5.3 percent, respectively (United States Department of Agriculture 2020).

Although the NAHMS report did not evaluate GMP adoption and coverage at the acreage level, this survey provided the opportunity to do so. Analyzing the 769 regional observations that indicated they do have a GMP, written or otherwise (i.e., some operations are located in multiple regions and were categorized into multiple regions), about 92% of the West region indicated their GMP covers all of their grazing land acres, with 80% in the Central region, and 88% in the East region. For those producers with GMPs that do not

cover all their managed grazing land, the West region averages about 74% of covered grazing acres, with the Central and East regions at 62% and 65%, respectively.

CHAPTER V: RESULTS

This chapter includes two sections. The first section details the results of the binary logit regression models, showing the relationships between producer and operation characteristics to the likelihood of adopting a grazing management plan. The second and final section concentrates on the cost and benefit analysis of implementing a grazing management plan.

5.1 Regression Analysis

Table 5.1 reports the four binary logit models results. All models were run in the statistical software, Gretl. The first model includes *GMP* as the dependent variable and the second one with *Written GMP* as the dependent variable, both evaluating the set of independent variables, including cow/calf operations and not stockers. The third model includes *GMP* as the dependent variable and the fourth with *Written GMP* as the dependent variable, but with stocker operations included as independent variables and not cow/calf operations. The first model had 604 cases correctly predicted (84 percent), the second had 451 (62.7 percent), the third with 605 (84.1 percent), and the fourth with 457 (63.6 percent). For both *GMP* models, the *Other Land* variable was dropped by Gretl.

Table 5.1: GMP and Written GMP Logit Regression Models for Cow/Calf and Stocker Operations

Variable	GMP Cow/Calf Coefficient[1]	Written GMP Cow/Calf Coefficient[1]	GMP Stockers Coefficient[1]	Written GMP Stockers Coefficient[1]
Constant	-0.137 (0.694)	-0.187 (0.562)	0.040 (0.703)	-0.245 (0.570)
Age	-0.007 (0.007)	-0.012** (0.006)	-0.007 (0.007)	-0.013** (0.006)
NAHMS Central	-0.208 (0.295)	-0.187 (0.228)	-0.338 (0.306)	-0.227 (0.235)
NAHMS East	0.144 (0.259)	-0.190 (0.203)	0.102 (0.261)	-0.191 (0.200)
Primary Decision Maker	0.719* (0.381)	0.302 (0.327)	0.803** (0.388)	0.312 (0.327)
Succession Plan	0.684*** (0.242)	0.577*** (0.190)	0.669*** (0.239)	0.596*** (0.189)
Succession Plan In Prog	1.252*** (0.345)	0.479** (0.227)	1.336*** (0.358)	0.509** (0.230)
Private Land	0.342 (0.217)	-0.101 (0.162)	0.277 (0.219)	-0.134 (0.164)
Other Land	-	0.955 (1.205)	-	0.835 (1.091)
Graz Acres1-49	0.280 (0.377)	-0.241 (0.335)	0.160 (0.343)	-0.160 (0.293)
Graz Acres50-99	0.275 (0.348)	-0.427 (0.294)	0.257 (0.346)	-0.354 (0.283)
Graz Acres500-999	0.121 (0.420)	0.241 (0.322)	0.052 (0.396)	0.195 (0.308)
Graz Acres1000-4999	0.188 (0.363)	0.277 (0.282)	-0.018 (0.352)	0.194 (0.266)
Graz Acres5000OrMore	0.863* (0.452)	0.782** (0.324)	0.612 (0.420)	0.744*** (0.264)
Cows50-99	0.664** (0.325)	0.099 (0.273)	-	-
Cows100-199	0.056 (0.349)	-0.161 (0.318)	-	-
Cows200-499	0.189 (0.400)	-0.023 (0.343)	-	-
Cows500-999	0.517 (0.604)	0.057 (0.416)	-	-
Cows1,000-2,499	0.388 (0.754)	-0.039 (0.510)	-	-

Cows2500OrMore	0.357 (1.133)	0.413 (0.662)	-	-
No Cow/Calf Operation	0.012 (0.494)	-0.132 (0.420)	-	-
Stockers50-99	-	-	1.140* (0.608)	0.636* (0.349)
Stockers100-199	-	-	1.090* (0.657)	0.343 (0.389)
Stockers200-499	-	-	0.620 (0.568)	0.553 (0.393)
Stockers500-999	-	-	0.911 (1.188)	-0.533 (0.625)
Stockers1,000-2,499	-	-	1.799* (1.084)	0.572 (0.462)
Stockers2500Or More	-	-	0.436 (0.777)	-0.115 (0.545)
No Stocker Operation	-	-	-0.069 (0.277)	0.034 (0.230)
Akaike criterion	640.125	971.689	631.030	963.956
McFadden R-squared	0.065	0.056	0.079	0.064

[1]The standard error for each variable is included in parentheses below each coefficient.

The first model evaluating the likelihood of GMP adoption for cow/calf operations has five statistically significant variables as indicated by the asterisks next to the coefficients (Table 5.1). The *Primary Decision Maker* variable has a positive coefficient which follows the hypothesis and is significant at the 10 percent level. This means that compared to producers who are not the primary decision maker, those who are in a primary or co-primary decision-making role are more likely to adopt a GMP. Similarly, the succession plan variables are statistically significant at the one percent level, so producers who have a succession plan or one in progress are more likely to adopt a GMP as well. The *Graz Acres5,000OrMore* variable is also significant at the 10 percent level, meaning larger operations are more likely to adopt a GMP than the operations with 100 to 499 grazing acres. The *Cows50-99* variable is significant at the five percent level, which indicates that

operations at that size are more likely to adopt a GMP than operations with 20 to 49 head. Both variable relationships also follow the original hypotheses.

The second model assesses the likelihood of an operation adopting a *Written GMP* for cow/calf operations. *Age* is significant at the five percent level with a negative sign, which aligns with the hypothesis that an increase in age indicates the producer is less likely to adopt a written GMP. According to the U.S. Census of Agriculture, young producers (under 35 years of age) are more likely than other age groups to make decisions related to livestock. Producers aged 35 to 64 tend to be more responsible for land use and/or crop decisions, record keeping and financial management details, and the day-to-day operations, although the differences are slight across the age groups (U.S. Department of Agriculture, National Agricultural Statistics Service 2019). Based on the census data, the age and written GMP adoption relationship follows expectations. The succession plan variables are also significant and again follow the hypothesis, meaning producers with a succession plan (one percent significance) or one in progress (five percent significance) are more likely to have a written GMP. Like the first model, the *Graz Acres5000OrMore* variable is significant (five percent level), meaning those larger operations are more likely to adopt a written GMP than the operations with 100 to 499 grazing acres.

The third model shifts to evaluating stocker operations and their likelihood of adopting a GMP. Six variables are significant: *PDM*, succession planning variables, and the 50 to 99, 100 to 199, and 1,000 to 2,499 stockers variables. They all follow the predicted signs with primary decision makers and those with a succession plan or one in progress being more likely to adopt a GMP versus producers who are not the primary decision maker or do not have a succession plan. In addition, the statistically significant stocker

variables indicate that the aforementioned stocker operation sizes are more likely to adopt a GMP versus an operation with 20 to 49 stockers.

The fourth model includes *Written GMP* as the dependent variable and stockers size categories included as independent variables. *Age* is statistically significant at the five percent level and follows the hypothesis saying an increase in age is expected to decrease the likelihood of adopting a written GMP. Like the second model, the succession plan variables are statistically significant and are consistent with the hypothesis. Producers with a succession plan (one percent significance) or one in progress (five percent significance) are more likely to adopt a written GMP. In addition, the *Graz Acres5000OrMore* variable is statistically significant, as is *Stockers50-99*, suggesting those larger operations in terms of grazing acres are more likely to adopt a written GMP when compared to operations with 100 to 499 grazing acres, and operations with 50 to 99 stockers are more likely to utilize a written GMP compared to the operations with 20 to 49 stockers.

The information presented in the models shows some of the producer and operation characteristics that can be indicators of the likelihood of adopting a GMP, written or otherwise. When running multiple iterations of the initial models, the influence of income on the adoption of a GMP was also evaluated in terms of the grazing operation being a primary source of income or supplementary source of income. However, none of the results showed income as being statistically significant so the variable was not included in the final models. It is recommended to evaluate additional demographics and characteristics of adoption, such as gender, education level, social network connections and social values, for the purposes of developing resources and a communication and marketing strategy to reach the right set of producers for optimal growth in GMP adoption.

5.2 Costs and Benefits of Implementation

Survey respondents were asked to provide estimates for both the investments in and the realized benefits as a result of the operational strategies and/or improvements they made as part of implementing a GMP, focusing on the last 10-year time period. More survey participants (393) shared estimated values for strategies or improvements they have invested in over the last 10 years versus the benefits category with an average cost (using the mid-point of the grazing acreage range) of $242 per grazing land acre. The more common types of projects listed by survey respondents fell into new fencing (e.g. cross fencing), water management projects (e.g. solar pump installation, water access point control, etc.), brush management, erosion control, and forage development and management projects (e.g. reseeding, fertilizer, etc.).

The benefits section of the survey asked participants to reflect on the benefits they have observed on their operation since implementing a GMP (limited to a 10-year period as well). A list of potential benefits was provided, with the opportunity to select multiple options and type an estimated dollar benefit value for each. Only 179 survey participants shared both estimated investment costs and estimated dollar benefit values for the 10-year period. Approximately 56 percent of the participants indicated they felt the benefits outweighed the costs, or at least broke even. Several producers shared about the difficulty of estimating the dollar value for benefits, emphasizing the values they provided were broad swaths and best estimates.

Table 5.2 shows the list of potential benefit options and the percentage of respondents who indicated they have realized that particular result on their operation. Of those listed, the large majority of respondents indicated increased forage production and

improved utilization, improved access to water for cattle on pastures, and improved animal efficiency and yield were observed on their operations. Of the seven percent of survey respondents who provided an "other" benefit as free text, some provided context on specific benefits they have witnessed over the years, such as raising soil pH without fertilizer or doubling the carrying capacity of their land. Several others provided comments around not being able to come up with accurate dollar values for benefits they have realized on their operations from implementing a GMP.

Table 5.2: Potential benefits from implementing a GMP realized by survey respondents

Potential Benefit Category	Number of Respondents	Percentage of Respondents[1]
Maintained or improved native ecosystems	157	48%
Protected and/or improved riparian areas	138	42%
Reduced soil erosion	124	38%
Optimized plant cover	120	36%
Improved access to water for cattle on pastures	238	72%
Increased forage production and improved utilization	252	77%
Increased water filtration and retention	134	41%
Improved wildlife habitat	143	43%
Improved animal efficiency and yield	205	62%
Documented improvements that can help your operation's reputation and/or market access	87	26%
Increased profitability	156	47%
Other	23	7%

[1]Note that 329 survey respondents checked one or more benefit categories, so the percentages are based on this number.

CHAPTER VI: CONCLUSION

For the last several years, sustainability has been important for consumers, and in turn beef supply chain partners and cattle producers. This increased attention and awareness has heightened the focus of multiple stakeholders to better understand the current state of sustainability in the United States beef industry and to establish realistic metrics and goals for each sector of the supply chain. With the U.S. Roundtable for Sustainable Beef identifying grazing management plans as a comprehensive and useful tool for producers to use in tracking and improving their sustainability methods, additional research and effort is being directed at further developing this resource.

This study had an overall research objective of determining the adoption baseline of cattle grazing management plans in the United States. A survey instrument was developed and deployed to cattle producers across the United States by sending it to members of NCBA and their state affiliates. With 763 useable responses, an analysis was conducted to evaluate the adoption baseline of GMPs in terms of acreage, number of operations, and the level of detail within those plans, in addition to the relationship between certain producer characteristics and the adoption of grazing management plans. Data from this study aligns relatively well with the USDA 2017 Census of Agriculture in terms of demographics. The average age of survey respondents is 56.7, and the income breakdown shows the majority of small (88.2 percent) and medium (66.3 percent) operators see their grazing operations as supplemental income with large operators identifying theirs as a primary source of income (63 percent). A key difference between the Census and this study is the operation size of respondents. The breakdown of survey respondents by size of cow/calf operation favors larger operations compared to the USDA Census of Agriculture data on a percentage basis.

Smaller operations are underrepresented, which is likely attributed to the sample population and distribution method. However, this data combined with the decreasing percentage of survey responses as the cow/calf operation size increases does follow the Census, indicating the results of this study can be useful. When evaluating the adoption of written GMPs across the U.S. cattle industry, about 43 percent indicate they do have one, while 56 percent say they do not have a plan. On a regional level, the West region has the highest written GMP adoption rate at 60 percent, followed by the Central region at 55 percent, then the East region at 43 percent.

The four binary logit regression model results revealed that the age of a producer is statistically significant when evaluating the adoption of a written GMP for both cow/calf and stocker operations, but not for GMP adoption in general. On the other hand, primary decision makers appear to have more influence on having a GMP in general (also for both cow/calf and stocker operations), but not for having a written plan. Succession planning is key for adopting a GMP, written or otherwise, whether a succession plan is already established or in progress for cow/calf and stocker producers. The data also showed that larger cow/calf operations with 5,000 grazing acres or more are more likely adopt a GMP, written or otherwise, and stocker operations of the same size, are more likely to adopt a written plan.

Based on the feedback from the pretest, a question was also included regarding the willingness to pay a consultant to assist in the development and/or improvement of a written GMP to seek data for future potential policy implications. While this study reveals a majority of producers are not willing to pay for a consultant, additional research on the reasoning for both sides would be beneficial. Also, to further develop specific educational

resources and programs regarding the development and implementation of grazing management plans across regions in the United States, characteristics of producers and/or operations that adopt GMPs should be evaluated. While this thesis evaluates some characteristics, additional research is encouraged.

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APPENDICES

Appendix A. Grazing Management Plan Adoption and Economics of Implementation Survey Instrument

Grazing Management Plans in the United States
Survey Questions

Survey Opening Text:

The objective of this study is to determine the adoption baseline of cattle grazing management plans in the United States and the economic impact of implementation, including the costs to implement and the resulting production benefits.

For the purposes of this survey, the cow-calf sector of the beef industry includes producers with operations that produce weaned calves from a herd of cows and bulls, and stocker operations with grazing or high roughage programs for cattle from the weaning stage to when they start a finishing ration.

The following questions will refer to "your operation," meaning your cow-calf and/or stocker operation. If your operation includes multiple cow-calf and/or stocker operation locations, please answer for them collectively.

If you have a grazing management plan or other farm or ranch management documentation, you are encouraged to reference them while completing the survey. However, this information is not necessary to complete the survey.

Thank you for your assistance with this project.

QUALIFYING QUESTION:
For this survey, the term "grazing land" includes pasture, pasture land, paddocks, grassland and rangeland – land that is primarily used for livestock grazing.

1. Do you graze cattle on grazing land (see definition above)?
    a. Yes
    b. No

IF NO, THE SURVEY ENDS.

PART 1: DEMOGRAPHICS

A grazing management plan (GMP) includes the detailed conservation strategies and/or projects that are developed and implemented to improve the use of available resources, such as land and water, on land grazed by livestock. Plans may include: operation background and site information; clearly defined producer objectives; methods to monitor forage quantity and

quality; inventory of existing water resources (e.g. storage capacity, number of head that can be supplied with water, etc.), land resource in acres and forage productivity, air conditions; desired future land, water and air conditions; and, contingency plans for drought, natural disasters and other events.

Not all documents or records are called grazing management plans, but if you have documentation with any of the above information, those are considered part of a GMP. Please refer to those when answering the following questions. Examples include federal grazing permit documentation, a whole farm/ranch plan, etc.

Again, for this survey, the term "grazing land" includes pasture, pasture land, paddocks, and rangeland – land that is primarily used for livestock grazing.

1. What is your age in years?
    a. Please specify: _____
    b. I prefer not to answer.

2. Where is your operation(s) located? Please select all that apply.

    (To select multiple states on a desktop or laptop computer, hold down the CTRL key and click on the state names. To select multiple states on a phone or tablet, click on the state names.)

    a. Drop down list of states
        i. Allow multiple selections
        ii. Included "Other"

3. Are you the primary decision maker on your operation?
    a. Yes
    b. No
    c. Other, please specify: _____

IF NO OR OTHER, PROCEED TO QUESTION 4.
IF YES, PROCEED TO QUESTION 5.

---

4. If you are not the primary decision maker on your operation, do you plan on developing and implementing a grazing management plan (GMP) in the future if you do not already have one?
    a. Yes
    b. No
    c. My operation already has a GMP, and I will continue to utilize it.

PROCEED TO QUESTION 6.

---

5. How many years have you been leading the decision-making efforts for the management of grazing land and/or other agricultural enterprises (cow-calf operation, stocker or backgrounder operation, feedyard, crop production, etc.)?
    a. Under 10 years
    b. 10-19 years
    c. 20-29 years
    d. 30-39 years
    e. 40 years or more

PROCEED TO QUESTION 6.

---

6. How would you classify your grazing operation (cow-calf and/or stocker operation) in terms of income?
    a. Primary source of income
    b. Supplemental source of income
    c. Other, please specify: _____
    d. Prefer not to answer

7. **On average**, how many head of cattle do you run on your **cow-calf** operation? Please include your total number of cows.
    a. 20-49
    b. 50-99
    c. 100-199
    d. 200-499
    e. 500-999
    f. 1,000-2,499
    g. 2,500-4,999
    h. 5,000 or more
    i. I do not have a cow-calf operation.

8. **On average**, how many head of cattle do you run on your **stocker** operation? Please include the total average inventory of stocker cattle.
    a. 50-99
    b. 100-199
    c. 200-499
    d. 500-999
    e. 1,000-2,499
    f. 2,500-4,999
    g. 5,000 or more
    h. I do not have a stocker operation.

9. How many **total acres** does your operation cover? (i.e. land under your management, meaning owned **and** leased grazing land, crop land, etc.)

a. 1-49 acres
b. 50-99 acres
c. 100-249 acres
d. 250-499 acres
e. 500-999 acres
f. 1,000-2,499 acres
g. 2,500-4,999 acres
h. 5,000-7,499 acres
i. 7,500-10,000 acres
j. Greater than 10,000 acres

10. How many acres of **grazing land** does your operation cover?
    a. 1-49 acres
    b. 50-99 acres
    c. 100-249 acres
    d. 250-499 acres
    e. 500-999 acres
    f. 1,000-2,499 acres
    g. 2,500-4,999 acres
    h. 5,000-7,499 acres
    i. 7,500-10,000 acres
    j. Greater than 10,000 acres

11. What type of **grazing land** do you manage by percentage? The total must not be greater than 100%.
    a. Privately owned land: _____%
    b. Leased private land: _____%
    c. Leased public federal lands: _____%
    d. Leased public state/local lands: _____%
    e. Other, please specify: _____, ____%

PART 2: GRAZING MANAGEMENT

A grazing management plan (GMP) includes the detailed conservation strategies and/or projects that are developed and implemented to improve the use of available resources, such as land and water, on land grazed by livestock. Plans may include: operation background and site information; clearly defined producer objectives; methods to monitor forage quantity and quality; inventory of existing water resources (e.g. storage capacity, number of head that can be supplied with water, etc.), land resource in acres and forage productivity, air conditions; desired future land, water and air conditions; and, contingency plans for drought, natural disasters and other events.

Not all documents or records are called grazing management plans, but if you have documentation with any of the above information, those are considered part of a GMP. Please refer to those as well when answering the following questions. Examples include federal grazing permit documentation, a whole farm/ranch plan, etc.

12. Part of maintaining productive and sustainable grazing lands is ensuring they can be passed on to future generations. Do you have a succession/transition plan that includes your grazing lands?
    a. Yes
    b. No
    c. We are in the process of establishing our succession/transition plan.

13. Do you have a grazing management plan? (The GMP could be in written form or not in a written form, but integrated into everyday management practices.)
    a. Yes
    b. No

IF NO, THEN PROCEED TO QUESTION 13.
IF YES, THEN PROCEED TO QUESTION 16.

---

14. Out of the following options, what is the most relevant reason as to why you do not have a GMP?
    a. I am in the process of developing a GMP for my operation.
    b. I do not have the resources available to develop and implement a grazing management plan. (e.g., educational materials, templates, and/or consultants)
    c. Developing a GMP takes a lot of time and effort.
    d. I am not sure what a GMP is or how it would benefit my operation.
    e. I know what a GMP is, but do not believe it would benefit my operation.
        i. Please expand on why you feel it would not benefit your operation: _____
    f. Other, please specify: _____

15. What resources, assistance and/or other information would you need to develop a GMP? Please select all that apply.
    a. Grazing management plan template
    b. Educational tools (e.g., books, educational guides or handbooks, etc.)
    c. Consultant support (e.g., technical service providers, university extension and education services, government organizations, nongovernment organizations, private consultants, etc.)
    d. Other, please specify: _____

16. Are you willing to pay a consultant to assist in the development and/or improvement of a **written** GMP for your operation?
    a. Yes
    b. No
    c. Maybe

THE SURVEY ENDS.

---

17. Does your grazing management plan cover all your grazing land acres?
    a. Yes
    b. No

17a. If your GMP does not cover all your grazing land acres, what percentage does it cover?

_____%

18. Approximately, how long have you had a grazing management plan?

    Please include your **best estimate in years**.

    a. _____

19. Is your GMP documented in written form?

    (e.g., farm/ranch management software, grazing management plan template, Word document, spreadsheet, recorded in a calendar, recorded in a notebook, etc.)

    a. Yes
    b. No

IF YES, THEN ANSWER QUESTION 19.
IF NO, PROCEED TO QUESTION 20.

---

20. In what form is your GMP recorded?
    a. Farm/ranch management software
    b. Grazing management plan template (handwritten or electronic)
    c. Other electronic documentation (e.g., Word document, spreadsheet, calendar, etc.)
    d. Written in a notebook or some other form of pen/pencil to paper
    e. Other, please specify: _____

CONTINUE TO QUESTION 21.

---

21. What is included in your GMP? Please select all that apply.
    a. Assessment of current resource conditions (e.g., land and water use inventory)
    b. Operation goals and objectives (e.g., improving forage yield, maintaining or improving wildlife habitat, preventing or reducing erosion, etc.)
    c. Management actions to achieve goals (e.g., stocking rate, animal movement records, duration of grazing period(s), rest period(s), intensity, pasture size and number, infrastructure management and/or improvements, prescribed burning, business management changes, etc.)
    d. Contingency plans for drought and other risks
    e. Wildlife resource inventory and management
    f. Plans for regular monitoring (e.g., animal performance and/or health indicators, plant diversity, and/or soil health indicators, etc.)
    g. Other, please specify: _____

22. What resources did you consult or review when developing your GMP? Please select all that apply.
    a. University or extension research, resources and/or staff and consultants
    b. Government conservation program resources (e.g. NRCS grazing management plan templates) and/or staff and consultants
    c. Non-government organization (NGO) staff/consultants and/or resources
    d. Private resources and/or consultants
    e. None
    f. Other, please specify: _____

23. Are you willing to pay a consultant to assist in the development and/or improvement of a **written** grazing management plan for your operation?
    a. Yes
    b. No
    c. Maybe

PART 3: ECONOMICS

For the following questions, please think about the development process and implementation of the various components of your grazing management plan (GMP).

24. Please **rank** the following in order of importance when thinking about the development of your operation's GMP.
    a. Maintenance and/or improvement in water use and water quality
    b. Improvement in soil health
    c. Optimized forage production and quality
    d. Improvement in animal efficiency and yield

e. Increased profitability
f. Improvement in wildlife habitat
g. Other, please specify:

_____

25. **Approximately** how long did it take to develop and implement your GMP? Please include a value in terms of **months**.

    a. Please specify (# months): _____
    b. Still in process

26. **Approximately** how much time do you spend on evaluating and/or updating your GMP **per year**?
    a. Less than 10 hours
    b. 10-19 hours
    c. 20-40 hours
    d. Greater than 40 hours
    e. Other, please specify:

    _____

27. **In the last 10 years**, how much was invested **(approximately)** in the operational strategies and/or improvements as part of your GMP in **terms of dollars**? Please reflect on any infrastructure changes and/or improvements, such as new fencing, water development projects, erosion control methods, brush management, reseeding, etc. Include the total for each type of investment over the 10-year time period.

    Example
    Strategy/Improvement and Dollar Investment:
    Solar pump/well sites; $15,000

    a. Strategy/Improvement and Dollar Investment:
        i. _____
    b. Strategy/Improvement and Dollar Investment:
        i. _____
    c. Strategy/Improvement and Dollar Investment:
        i. _____
    d. Strategy/Improvement and Dollar Investment:
        i. _____
    e. Strategy/Improvement and Dollar Investment:
        i. _____
    f. Strategy/Improvement and Dollar Investment:
        i. _____

28. What benefits have you observed on your operation since you implemented a GMP (or in the last 10 years if you have had a GMP 10 years or more)? **Please select all that apply.**

    For the benefits selected, please indicate the **estimated dollar benefit** by typing a number in the provided text box for each option. If you are unsure about a dollar value for different benefits, please leave them blank.

    a. Maintained or improved native ecosystems
        i. _____
    b. Protected and/or improved riparian areas (the area between land and a river or stream)
        i. _____
    c. Reduced soil erosion
        i. _____
    d. Optimized plant cover (relative to fire fuel loads)
        i. _____
    e. Improved access to water for cattle on pastures
        i. _____
    f. Increased forage production and improved utilization
        i. _____
    g. Increased water filtration and retention
        i. _____
    h. Improved wildlife habitat
        i. _____
    i. Improved animal efficiency and yield
        i. _____
    j. Documented improvements that can help your operation's reputation and/or market access
        i. _____
    k. Increased profitability
        i. _____
    l. Other, please list: _____
        i. _____

Appendix B. Kansas State University Institutional Review Board Exemption Letter

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Dr. Dustin Pendell
Agricultural Economics
Waters Hall

Proposal Number: 10308

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

DATE: 11/17/2020

RE: Proposal Entitled, "Grazing Management Plan Adoption and Economics of Implementation in the United States"

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

Based upon information provided to the IRB, this activity is exempt under the criteria set forth in the Federal Policy for the Protection of Human Subjects, **45 CFR §104(d), category: 2, subsection: ii.**

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

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