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RESEARCH ARTICLE

Grazing Management Plan Adoption and Objective Prioritization in U.S. Cow-Calf and Stocker Operations

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Abstract
This study examines the grazing management plans (GMPs) adoption and prioritization of environmental and economic objectives among U.S. cow-calf and stocker operations, utilizing 2020–2021 survey data and logistic regression analysis. Findings reveal regional adoption differences, with higher rates in the Midwest. Operations with succession plans, larger grazing lands, and stocker activities are more likely to adopt GMPs. Operations with more privately owned land and smaller herd sizes prefer environmental goals, while those with less grazing land prioritize economic outcomes due to resource concerns. The study provides insights for policies promoting GMP adoption and sustainability in the U.S. beef sector.

Keywords: Adoption factors; cow-calf; grazing management plan; stocker; sustainable agriculture

JEL classifications: Q12; Q25

Introduction

The sustainable management of grazing lands represents a critical component in the overall landscape of U.S. agriculture, particularly within cow-calf and stocker operations (Rouquette, 2017). These grazing lands, comprising pastureland and rangeland, account for a significant portion of the nation's agricultural lands and play an integral role in supporting the livestock industry (Talbert, Knight, and Mitchell, 2007), enhancing biodiversity, and maintaining ecological balance (Oerly, Johnson, and Soule, 2022). However, the challenge of managing these lands sustainably is compounded by the potential negative impacts of cattle grazing on grassland ecosystems, such as long-term overgrazing and improper grazing practices (Gillespie, Kim, and Paudel, 2007; Wang et al., 2020, 2018). These concerns are further magnified by evolving consumer attitudes towards the environmental implications of beef production (Stubbs, Scott, and Duarte, 2018; Vanhonacker et al., 2013).

In response to these challenges, the U.S. Roundtable for Sustainable Beef (USRSB) has established a goal to have written grazing management plans (GMPs) cover 385 million acres of grazing lands by 2050 (USRSB, 2022). As outlined by the USDA Natural Resource Conservation Services (USDA-NRCS, 2020), GMPs are comprehensive frameworks designed to address resource concerns on grazing lands through conservation strategies and projects, aiming for sustainable grazing practices that include forage yield improvement, wildlife habitat maintenance, and the enhancement of species diversity and water systems.

Despite the USDA NRCS outlining the specifications for GMPs in 2019, there remains a dearth of research on their adoption (USDA-NRCS, 2020). A 2017 beef study surveying 24 major cow-calf states found that only 7.6% of operations plan to rely on grazing pasture for at least half of the herd's diet during the growing season had a GMP (USDA-APHIS, 2020). A significant knowledge gap exists regarding the factors influencing GMP adoption. To our knowledge, no studies have specifically investigated the determinants influencing cow-calf producer's primary objectives during their operations' GMP development. Our research delves into the priorities of not only environmentally conscious producers, but also those primarily focused on production and profitability.

The study has two main objectives. First, it aims to establish a baseline for the adoption of GMPs among cattle operations across the United States and analyze the determinants that influence their adoption. Secondly, it seeks to examine the primary factors shaping the priority objectives in GMP development. Our research primarily focuses on the cow-calf sector, which include both cow-calf – operations maintaining a breeding herd of cows and bulls that produce weaned calves – and stockers – operations that implement grazing programs for cattle until they are introduced to a finishing ration. Study results show that factors such as geographic location, land ownership, succession planning, and operational size significantly influence both the decision to adopt GMPs and the prioritization of environmental versus economic objectives within these plans.

Several studies have investigated the use of Best Management Practices (BMPs) in the beef cattle industry (Baumgart-Getz, Prokopy, and Floress, 2012; Gillespie et al., 2007; Kim, Gillespie, and Paudel, 2005; Lambert et al., 2020), including rotational grazing (Boyer et al., 2022; Wang et al., 2020). These studies provide valuable insights into the determinants of BMP adoption among cattle producers. However, the management strategies typically examined in these studies are broad in scope, encompassing a range of practices applicable across the entire beef cattle industry (Gillespie et al., 2007). In contrast, GMPs are strategies tailored to specific beef cattle operations and focused on grazing. While a well-developed BMP usually includes relevant recommended management practices, such as rotational grazing and manure and nutrient runoff management (USRSB, 2022), the findings from such studies might not be directly applicable to the adoption of GMPs.

The findings from this research provide insights into the prevalence of GMP adoption among cow-calf only and cow-calf/stocker producers and the potential factors that may promote or hinder broader acceptance. Furthermore, our findings fill a significant knowledge gap regarding producers' operational goals for GMP adoption, specifically concerning the balance between economic and environmental objectives within GMPs. Previous studies have largely focused on the environment, with less attention given to production and profitability (Prokopy et al., 2019). Both aspects warrant closer attention and comparison (Chowdhury et al., 2020). By highlighting this dichotomy, research and outreach efforts can be directed towards ensuring a balance between environmental sustainability and economic viability for U.S. cow-calf and stocker operations. Finally, the implications of this study extend beyond the borders of the United States to include other cattle-producing regions, such as Western Canada, which also advocates for sustainable beef production practices.

GMP economics

A GMP should minimally encompass site background, client objectives, current conditions, and desired future conditions. Documentation of these conditions, along with contingency plans for unexpected events, is also essential. This list, based on USDA-NRCS (2020) recommendations, is not exhaustive, and additional plan examples can be found at local NRCS offices, education centers, and through private consultants. Regular evaluations of GMPs, at least annually before the

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grazing season, are crucial for adjusting the plan based on resource availability, climatic conditions, and operational goals (Ellison and Cummings, 2020). This practice aligns with the USRSB's principle of striving for continuous improvement in sustainability, both at strategic and task levels (2022).

One metric within the U.S. Roundtable for Sustainable Beef framework for the cow-calf sector is the implementation and usage of a GMP targeting water resources, land resources, and air and greenhouse gas emission indicators. Given the vast diversity in the size, scope, and standard practices of U.S. cow-calf operations across different regions (USDA-APHIS, 2020), the implementation of GMPs is bound to vary from one operation to another. A defining characteristic of a GMP is its adaptability, ensuring that each plan is custom-tailored to a specific ranching or farming operation. This tailoring is based on an operation's unique goals and objectives, available resources, conditions, and ecological characteristics (USRSB, 20220).

The implementation of a GMP can require significant investment, including possible efforts towards prescribed burning, irrigation improvements, water quality projects, and new fencing. These activities demand not only substantial financial expenditure, but also considerable allocation of management time and labor (Kim et al., 2005; Thorne, Fukumoto, and Stevenson, 2007). A 2019 study highlighted the potential for considerable expenditures related to fencing construction and material costs in Kansas (Li and Tsoodle, 2020). Moreover, intangible barriers, such as a lack of knowledge about the recommended management practices in cattle grazing production, may also inhibit adoption (Gillespie et al., 2007).

The development and implementation of a GMP can yield multiple benefits across the three pillars of sustainability: economic, environmental, and societal domains (Gregorini et al., 2017). Economically, adopting a GMP can enhance forage productivity and decrease seasonal feeding costs (Jennings, Beck, and Gadberry, 2017). From an environmental perspective, a GMP can mitigate soil erosion, improve water quality, and aid in carbon sequestration within pastures (Herbel and Pieper, 1991; Jennings et al., 2017; Teague and Barnes, 2017). Beyond environmental improvements, these practices foster social benefits by boosting economic viability and sustainability of farming operations, thereby improving community well-being and quality of life (Teague and Kreuter, 2020). Considering the diverse production systems and objectives of U.S. cow-calf operations (Tang et al., 2023), managers often strive to balance profit and production goals with non-financial interests such as environmental sustainability, cultural preferences, and lifestyle considerations (Victurine and Curtin, 2010). The motivation for cow-calf producers to manage grazing lands sustainably arises when the benefits to them are clearly defined (Kennedy, Burbach, and Sliwinski, 2016).

Data

Data for this study were gathered using an electronic survey disseminated via email to members of the National Cattlemen's Beef Association (NCBA) and its state affiliates. The survey was sent to a total of 2,760 cattle producers on the NCBA distribution list and additional state affiliates. It was available for responses from November 30, 2020, to January 4, 2021, and garnered 994 partially complete or complete responses. Periodic reminders were sent to the distribution groups during the survey period. The survey's participation was voluntary, and no compensation was offered for responses. Out of all the received surveys, 31 respondents indicated that they did not graze cattle, which disqualified them from the survey. Additionally, 200 respondents who completed less than 51 percent of the survey were excluded from the analysis. Responses with logical errors, such as inconsistencies between reported acreage and total land used for agricultural production, were removed. We also discarded responses where the respondent selected "I prefer not to answer" for critical questions necessary for deriving dependent and/or independent variables for the analysis. The final sample size was narrowed down to 711 respondents.

The survey for this study was composed of three main sections. The first section requested information about the farm operator's and operation demographics, such as age, location of operation(s), primary decision maker status, income classification, average herd size, operation acreage, and type of grazing land managed. The second section delved into grazing management, specifically relating to GMPs. Questions on succession or transition plans, components of their GMPs, and reasons for not having a GMP were included. The third section pertained to operation objectives for implementing a GMP. This section listed possible benefits, such as improved water quality, soil health enhancement, optimization of forage production and quality, improved wildlife habitat, improvement in animal efficiency and production, and increased profitability. These objectives generally fall into two categories: "Environment" and "Economic" benefits. The objectives related to water quality, soil health, forage quality, and wildlife habitat fall under the "Environment" objectives, while those related to animal production and profitability are categorized as "Economic" objectives. Respondents were asked to rank these objectives in order of importance for their operation's GMP development.

Respondents were provided a definition of a GMP and asked to identify if they have one. To construct the definition of a GMP in this survey, we synthesized information from operational advice from the USDA Natural Resources Conservation Service (USDA-NRCS, 2020), and practical protocols as delineated by the U.S. Roundtable for Sustainable Beef (USRSB, 2022), as well as state agricultural extension programs. 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 fir 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.*

Empirical model

Cow-calf producers face uncertain outcomes from selecting different discrete choices. It is assumed that these producers make binary decisions based on an objective utility maximization. Following the framework established by Adamowicz et al. (1998) and Lusk, Roosen, and Fox (2003), the utility function received by producer i from choosing alternative j can be represented as:

$$U_{ij} = V_{ij} + \varepsilon_{ij}, \text{and } i = 1, \ldots N, \tag{1}$$

where V_{ij} is the deterministic portion of the utility function, and ε_{ij} is the stochastic error term. The probability that a producer, i, will choose alternative j can be derived from:

$$Prob\{V_{ik} + \varepsilon_{ik} < V_{ij} + \varepsilon_{ij}\}; \forall k \in C_i. \tag{2}$$

C_i is the choice set for producer i and can be defined as follows: $C_i = \{j, k\} =$ {Have a GMP, Not having a GMP}, $C_i = \{j, k\} =$ {Economic objectives are the top priority in a GMP, Economic

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objectives are not the top priority in a GMP}, or $C_i = \{j, k\} =$ {Environmental objectives are the top priority in a GMP, Environmental objectives are not the top priority in a GMP}.

Assuming V_{ij} is linear in parameters, the utility function may be defined as (Lusk et al., 2003): $V_{ij} = \varphi(x'\beta)$, where x is a vector of cow-calf operator's demographics and operation characteristics. The probability of producer i choosing alternative j can be expressed as (Adamowicz et al., 1998):

$$\begin{aligned} \text{Prob}\{\text{jis chosen}\} &= P_r\left(x_i'\beta_k + \varepsilon_{ik} < x_i'\beta_j + \varepsilon_{ij}\right) \\ &= P_r\left[\varepsilon_{ik} - \varepsilon_{ij} < x_i'\left(\beta_j - \beta_k\right)\right] \\ &= P_r\left(\epsilon_i < x_i'\alpha\right) = F(x_i'\alpha) \end{aligned} \tag{3}$$

where $P_r(\cdot)$ is a probability function, $\epsilon_i = \varepsilon_{ik} - \varepsilon_{ij}$ is the random error, $\alpha = \beta_j - \beta_k$ represents the coefficients to be estimated, and $F(x_i'\alpha)$ is the cumulative distribution function. Assuming ϵ_i follows a logistic distribution, a binary logit model is estimated to examine the characteristics of cattle producer and operations influencing the adoption of GMPs among producers involved in either cow-calf or stocker operations. An additional model is run including observations involving both cow-calf and stocker operations. Two more models are run with "*Environment*" and "*Economic*" as the dependent variables.[1]

Dependent and independent variables

The dependent binary variable "*Adopt*" was derived from a question asking if cow-calf producers have a GMP. The GMP could be in written form or not but integrated into everyday management practices. The dependent binary variable "*Environment*" was assigned when "Environment" goals were ranked as the top priority. Similarly, the dependent binary variable "*Economic*" was assigned when "Economic" goals were ranked highest by respondents.

Independent variables in the analysis were systematically classified into categories such as farm/ranch operator demographics and operational characteristics, which included relevant factors like succession plans. Demographic variables included the operator's age and binary data on whether they hold the primary decision-making role. Operational elements incorporated factors such as the proportion of privately owned grazing land, binary representation of stocker operation presence, regional operation location, herd size, and total grazing land size. Two binary variables were included to denote the existence of a succession plan and whether such a plan is currently under development. The ratio of privately owned grazing land was calculated by dividing the acres of privately owned grazing land by the total acreage of grazing land, including privately owned, federally leased, state/local leased, and other types of grazing land.

Herd sizes were categorized based on the number of cows: small (20–49), medium (50–199), and large (200 or more). Grazing land sizes were stratified into small (1–499 acres), medium (500–10,000 acres), and large (over 10,000 acres) categories. The operations' regional breakdown aligns

[1]We attempted to verify if the adoption models and objective models were independent. Initially, we ran a bivariate probit model. However, the results indicated a lack of variation in the dependent variable for the adoption decision.

Although this variable might possess sufficient variation when modeled independently, its variation is insufficient when combined with the second model within a bivariate framework. In addition, we examined the correlation of predicted probabilities. After computing the predicted probabilities from each model, we calculated the correlation between these two sets of predictions, with both correlation coefficients being approximately 0.25. As an alternative approach, we used a two-step estimation method, incorporating the predicted probabilities from the first model as an independent variable in the second model. However, both coefficients obtained in this method were not statistically significant.

with the US census (U.S. Census Bureau, 2023).[2] Due to a limited sample size, operations in the Northeast were excluded from the analysis.

Results

Descriptions and summary statistics of variables used in this analysis are shown in Table 1. A majority of cow-calf producers (83%) indicated that they have a GMP. Among these adopters, 34% identified environmental benefits as the primary objective in their GMPs, and 33% listed production and profitability as their key focus. The rest of the respondents cited other objectives for their GMPs (e.g., improving quality of life, protection of cultural resources, preserving the natural beauty of open land, and adjusting in response to climate change).

The survey of 711 respondents highlighted significant aspects of U.S. grazing operations: 88% identified as primary decision-makers, with an average respondent age of 57. This age aligns closely with the average producer age of 57.5 reported in the 2017 Census of Agriculture by the USDA National Agricultural Statistics Services (USDA-NASS, 2019). When examining income classification in relation to herd sizes, we found that for the majority (65.3%) of large operations (over 200 head), the cattle operation served as the primary source of income. This finding is comparable to the 71.9% figure reported in the 2017 Census of Agriculture (USDA-NASS, 2019). Conversely, smaller operations, with herd sizes ranging from 20 to 49 head and medium operations ranging from 50 to 199 head, reported cattle operations as their primary source of income at lower rates of 1.9% and 27.2%, respectively. In our survey of 711 respondents, herd sizes were more evenly distributed across small, medium, and large categories, each constituting approximately 31% of the sample. This contrasts with the 2017 Census of Agriculture, which reports a distribution skewed towards smaller operations – 54.66% small, 36.67% medium, and only 8.67% large – indicating that our sample has a greater representation of larger operations in comparison to the national data provided by the USDA Census of Agriculture.

The summary statistics of the dependent and independent variables used are presented in Table 2. These summary statistics are grouped into three categories that correspond to distinct logit models applied. "Adoption" Model I investigates the adoption of a GMP among producers operating exclusively either cow-calf or stocker operations. "Adoption" Model II evaluates the likelihood of GMP adoption among producers engaged in both cow-calf and stocker operations. "Objective" Model I examines whether environmental benefits are identified as a principal priority within the GMP by producers involved in either cow-calf or stocker operations[3] who have adopted a GMP. "Objective" Model II assesses if economic and production benefits are ranked within the GMP by adopters managing both cow-calf and stocker operations. Table 3 shows logit model results for both "Adoption" and "Objective" models. Additionally, the odds ratios and marginal effects derived from these logit models are reported in Tables 4 and 5, respectively.

The inclusion of herd size and grazing land acreage in our analysis raised concerns about potential collinearity. To address this, a correlation analysis was conducted, revealing significant correlations: a negative correlation between large herd size and small grazing land acreage (−0.57), as well as between small herd size and small grazing land (0.56). Consequently, to mitigate collinearity issues, we opted to exclude larger herd size and large grazing land acreage from the model, treating them as baseline categories. This decision was validated by subsequent analyses showing that models with either small or large herd size as the baseline yielded consistent results.

[2]The Midwest includes states such as ND, SD, NE, KS, MN, IA, MO, WI, IL, IN, MI, OH, the South includes TX, OK, AR, LA, MS, AL, TN, KY, GA, FL, SC, NC, VA, WV, MD, DC, and the West includes WA, OR, ID, MT, WY, CO, UT, NV, CA, AZ, NM.

[3]Due to limited sample size of stocker-alone operations in our dataset, we were restricted to in our ability to conduct an analytical examination specific to the Stocker Operations group. Consequently, we decided to aggregate the data, combining cow-calf and stocker operations, rather than segmenting them further.

Table 1. Description and summary statistics of the variables with their maximum observations available

Variable	Obs.	Mean	Std. dev.	Min	Max	Type	Description
Adopt	711	0.83	0.37	0	1	Dummy	Dependent variable: If the correspondent has a GMP, 1 = yes; 0 = no
Environment	440	0.34	0.47	0	1	Dummy	Dependent variable: If the priority component of the GMP is related to the maintenance/improvement in water quality, soil health, wildlife habitat, and optimization of forage production and quality; 1 = yes; 0 = no
Economic	440	0.33	0.47	0	1	Dummy	Dependent Variable: If the priority component of the GMP is related to the improvement of animal efficiency and yield, and increased profitability; 1 = yes; 0 = no
Age	674	56.61	13.89	21	86	Continuous	Age of the correspondent
Decision	711	0.88	0.32	0	1	Dummy	If the correspondent is the primary decision maker; 1 = yes; 0 = no
Primary	711	0.32	0.46	0	1	Dummy	If the grazing operation is the primary source of income; 1 = yes; 0 = no
Private	711	0.70	0.36	0	1	Continuous	Proportion of the privately owned land for grazing; non-private land mainly includes leased land for grazing from private owners, federal public lands, and public state or local lands
Succession	711	0.48	0.50	0	1	Dummy	If the correspondent has a succession/transition plan; 1 = yes; 0 = no
Progress	711	0.20	0.40	0	1	Dummy	It the correspondent is in the process of establishing a succession/transition plan; 1 = yes; 0 = no
Stocker	707	0.46	0.50	0	1	Dummy	If the correspondent has a stocker operation; 1 = yes; 0 = no
Midwest[1]	711	0.19	0.39	0	1	Dummy	If the beef operation is in the Midwest; 1 = yes; 0 = no
South[2]	711	0.51	0.50	0	1	Dummy	If the beef operation is in the South; 1 = yes; 0 = no
West[3]	711	0.31	0.46	0	1	Dummy	If the beef operation is in the West; 1 = yes; 0 = no
Cow-Calf Size:>200	680	0.31	0.46	0	1	Dummy	If the number of cattle is greater than 200; 1 = yes; 0 = no
Cow-Calf Size:50-199	680	0.31	0.46	0	1	Dummy	If the number of cattle is between 50 and 199; 1 = yes; 0 = no
Cow-Calf Size: 20-49	680	0.31	0.46	0	1	Dummy	If the number of cattle is between 20 and 49; 1 = yes; 0 = no
Land Acres: >10,000	711	0.16	0.37	0	1	Dummy	If the grazing land area is greater than 10,000 acres; 1 = yes; 0 = no
Land Acres: 500-10,000	711	0.32	0.47	0	1	Dummy	If the grazing land area is between 500 and 100,000 acres; 1 = yes; 0 = no
Land Acres: 1-499	711	0.52	0.50	0	1	Dummy	If the grazing land area is between 1 and 499 acres; 1 = yes; 0 = no

Notes: [1]Region assignment follows the U.S. census (U.S. Census Bureau, 2023). Midwest: ND, SD, NE, KS, MN, IA, MO, WI, IL, IN, MI, and OH; [2]South: TX, OK, AR, LA, MS, AL, TN, KY, GA, FL, SC, NC, VA, WV, MD, DC; [3]West: WA, OR, ID, MT, WY, CO, UT, NV, CA, AZ, and NM. Operations in the Northeast are excluded from our analysis due to small sample size.

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Table 2. Summary statistics of producer demographics and operation characteristics used in the “adoption” and “objective” logit models

Variable	“Adoption” Model I[1] (Cow-calf or stocker)				“Adoption” Model II[2] (Cow-calf and Stocker)				“Objective” Model I & II[3] (Cow-calf or Stocker)			
	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max
Adopt	0.84	0.37	0	1	0.88	0.33	0	1				
Environment									0.33	0.47	0	1
Economic									0.34	0.47	0	1
Age	56.58	13.86	21	86	56.34	13.78	0	1	55.66	13.87	21	86
Decision	0.89	0.32	0	1	0.88	0.32	0	1	0.89	0.31	0	1
Primary	0.31	0.46	0	1	0.42	0.49	0	1	0.32	0.47	0	1
Private	0.69	0.36	0	1	0.64	0.36	0	1	0.68	0.36	0	1
Succession	0.47	0.50	0	1	0.51	0.50	0	1	0.48	0.50	0	1
Progress	0.21	0.41	0	1	0.18	0.39	0	1	0.25	0.43	0	1
Stocker	0.43	0.50	0	1					0.46	0.50	0	1
Midwest	0.18	0.39	0	1	0.22	0.41	0	1	0.21	0.41	0	1
South	0.51	0.50	0	1	0.45	0.50	0	1	0.47	0.50	0	1
West	0.31	0.46	0	1	0.34	0.47	0	1	0.32	0.47	0	1
Herd Size:>200	0.31	0.46	0	1	0.40	0.49	0	1	0.33	0.47	0	1
Herd Size:50-199	0.38	0.48	0	1	0.39	0.49	0	1	0.36	0.48	0	1
Herd Size: 20-49	0.31	0.46	0	1	0.21	0.41	0	1	0.31	0.46	0	1
Land Acres: >10,000	0.17	0.37	0	1	0.24	0.43	0	1	0.19	0.40	0	1
Land Acres: 500-10,000	0.31	0.46	0	1	0.34	0.47	0	1	0.30	0.46	0	1
Land Acres: 1-499	0.52	0.50	0	1	0.43	0.50	0	1	0.50	0.50	0	1
Obs.	645				276				404			

Notes: [1]“Adoption” Model I refers to the Logit model examining factors affecting grazing management plans (GMPs) adoption, and the observations are producers who have either cow-calf or stocker operations. [2]“Adoption” Model II is identical to “Adoption” Model I except that the observations are producers who have both cow-calf and stocker operations. [3]“Objective” Model I refers to the logit model examining factors affecting whether producers prioritize environmental benefits within their GMPs. [4]“Objective” Model II examines the factors affecting whether producers rank production and profitability as the top primary within their GMPs. Both models share the same observation pool, that is, producers managing either cow-calf or stocker operations.

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Table 3. Logit model results for having grazing management plan (GMP) among producers with cow-calf, stocker, or both operations

	"Adoption" Model I[1] (Cow-calf or stocker)		"Adoption" Model II[2] (Cow-calf and Stocker)		"Objective" Model I[3] (Cow-calf or Stocker)		"Objective" Model II[4] (Cow-calf or Stocker)	
Variable	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.
Age	−0.001	0.008	0.006	0.020	0.007	0.008	−0.016**	0.008
Decision	0.047	0.120	−0.135	0.714	0.347	0.380	−0.130	0.343
Primary	−0.157	0.323	−0.622	0.573	0.014	0.322	0.414	0.322
Private	−0.665*	0.366	−2.067***	0.724	0.906**	0.362	−0.597*	0.351
Succession	0.637**	0.250	1.071**	0.484	0.508*	0.295	−0.109	0.290
Progress	1.423***	0.370	0.588	0.576	0.054	0.333	0.490	0.313
Stocker	0.473**	0.240	–	–	0.260	0.233	0.186	0.233
South	0.076	0.308	−0.225	0.564	0.444	0.322	0.175	0.307
West	−0.431	0.362	−1.186*	0.633	0.500	0.361	−0.211	0.359
Herd Size: 50-199	0.128	0.361	0.618	0.627	0.866**	0.355	−0.615*	0.350
Herd Size: 20-49	−0.097	0.434	0.136	0.759	1.055**	0.446	−1.322***	0.444
Land Acres: 500-10,000	−1.237**	0.510	−1.578*	0.867	−0.183	0.388	0.517	0.389
Land Acres: 1-499	−1.303**	0.623	−2.529**	1.043	−1.086**	0.530	1.463***	0.531
Constant	2.694***	0.803	4.99***	1.438	−2.868***	0.773	0.151	0.734
Model Fit	LR Chi2(13) = 40.39		LR Chi2(13) = 29.49		LR Chi2(13) = 28.36		LR Chi2(13) = 32.18	
	Prob>Chi2 = 0.0001		Prob>Chi2 = 0.0033		Prob>Chi2 = 0.0081		Prob>Chi2 = 0.0023	
Obs.	645		276		404		404	

Notes: Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10, 5, and 1% level. [1]"Adoption" Model I refers to the Logit model examining factors affecting GMPs adoption, and the observations are producers who have either cow-calf or stocker operations. [2]"Adoption" Model II is identical to "Adoption" Model I except that the observations are producers who have both cow-calf and stocker operations. [3]"Objective" Model I refers to the Logit model examining factors affecting whether producers prioritize environmental benefits within their GMPs. [4]"Objective" Model II examines the factors affecting whether producers rank production and profitability as the top primary within their GMPs. Both models share the same observation pool, that is, producers managing either cow-calf or stocker operations.

Table 4. Odds ratios from logit model analysis of having grazing management plan (GMP) among producers with cow-calf, stocker, or both operations

	"Adoption" Model I[1] (Cow-calf or stocker)		"Adoption" Model II[2] (Cow-calf and Stocker)		"Objective" Model I[3] (Cow-calf or Stocker)		"Objective" Model II[4] (Cow-calf or Stocker)	
Variable	Odds Ratio	Std. Err.	Odds Ratio	Std. Err.	Odds Ratio	Std. Err.	Odds Ratio	Std. Err.
Age	0.999	0.008	1.007	0.015	1.007	0.009	0.984**	0.008
Decision	1.049	0.400	0.874	0.624	1.414	0.537	0.878	0.301
Primary	0.854	0.276	0.537	0.308	1.014	0.327	1.513	0.487
Private	0.514*	0.188	0.127***	0.092	2.473**	0.894	0.551*	0.193
Succession	1.891**	0.474	2.919**	1.411	1.661*	0.490	0.897	0.260
Progress	4.150***	1.535	1.800	1.037	1.055	0.351	1.633	0.512
Stocker	1.605**	0.385	1.007	0.015	1.297	0.302	1.204	0.280
South	1.079	0.333	0.798	0.450	1.559	0.502	1.191	0.365
West	0.650	0.235	0.305*	0.193	1.649	0.595	0.810	0.291
Herd Size: 50-199	1.136	0.411	1.855	1.162	2.378**	0.843	0.541*	0.189
Herd Size: 20-49	0.907	0.393	1.145	0.869	2.873**	1.282	0.267***	0.118
Land Acres: 500-10,000	0.290**	0.148	0.206*	0.179	0.833	0.323	1.677	0.652
Land Acres: 1-499	0.272**	0.169	0.080**	0.083	0.338**	0.179	4.319***	2.291
Constant	14.796***	11.885	146.875***	211.196	0.057***	0.044	1.163	0.853
Model Fit	LR Chi2(13) = 40.39		LR Chi2(13) = 29.49		LR Chi2(13) = 28.36		LR Chi2(13) = 32.18	
	Prob>Chi2 = 0.0001		Prob>Chi2 = 0.0033		Prob>Chi2 = 0.0081		Prob>Chi2 = 0.0023	
Obs.	645		276		404		404	

Notes: Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10, 5, and 1% level. [1]"Adoption" Model I refers to the Logit model examining factors affecting GMPs adoption, and the observations are producers who have either cow-calf or stocker operations. [2]"Adoption" Model II is identical to "Adoption" Model I except that the observations are producers who have both cow-calf and stocker operations. [3]"Objective" Model I refers to the Logit model examining factors affecting whether producers prioritize environmental benefits within their GMPs. [4]"Objective" Model II examines the factors affecting whether producers rank production and profitability as the top primary within their GMPs. Both models share the same observation pool, that is, producers managing either cow-calf or stocker operations.

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Table 5. Marginal effects from logit model analysis of having grazing management plan (GMP) among producers with cow-calf, stocker, or both operations

	"Adoption" Model I[1] (Cow-calf or stocker)		"Adoption" Model II[2] (Cow-calf and Stocker)		"Objective" Model I[3] (Cow-calf or Stocker)		"Objective" Model II[4] (Cow-calf or Stocker)	
Variable	Marginal Effect	Std. Err.	Marginal Effect	Std. Err.	Marginal Effect	Std. Err.	Marginal Effect	Std. Err.
Age	0.000	0.001	0.001	0.001	0.001	0.002	−0.003**	0.002
Decision	0.006	0.049	−0.013	0.066	0.071	0.077	−0.027	0.071
Primary	−0.020	0.041	−0.058	0.053	0.003	0.066	0.086	0.066
Private	−0.085*	0.047	−0.192***	0.066	0.185**	0.072	−0.123*	0.072
Succession	0.082**	0.032	0.100**	0.044	0.104*	0.060	−0.022	0.060
Progress	0.182***	0.047	0.055	0.053	0.011	0.068	0.101	0.064
Stocker	0.061**	0.031	–	–	0.053	0.047	0.038	0.048
South	0.009	0.037	−0.017	0.042	0.087	0.061	0.037	0.064
West	−0.060	0.050	−0.122*	0.065	0.099	0.070	−0.042	0.072
Herd Size: 50-199	0.016	0.046	0.057	0.062	0.162**	0.060	−0.134*	0.073
Herd Size: 20-49	−0.013	0.057	0.014	0.081	0.203**	0.080	−0.264***	0.081
Land Acres: 500-10,000	−0.116**	0.037	−0.075*	0.036	−0.041	0.086	0.083	0.058
Land Acres: 1-499	−0.125**	0.049	−0.184**	0.070	−0.221**	0.105	0.276***	0.082
Constant	–	–	–	–	–	–	–	–
Model Fit	LR Chi2(13) = 40.39		LR Chi2(13) = 29.49		LR Chi2(13) = 28.36		LR Chi2(13) = 32.18	
	Prob>Chi2 = 0.0001		Prob>Chi2 = 0.0033		Prob>Chi2 = 0.0081		Prob>Chi2 = 0.0023	
Obs.	645		276		404		404	

Notes: Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10, 5, and 1% level. [1]"Adoption" Model I refers to the Logit model examining factors affecting GMPs adoption, and the observations are producers who have either cow-calf or stocker operations. [2]"Adoption" Model II is identical to "Adoption" Model I except that the observations are producers who have both cow-calf and stocker operations. [3]"Objective" Model I refers to the Logit model examining factors affecting whether producers prioritize environmental benefits within their GMPs. [4]"Objective" Model II examines the factors affecting whether producers rank production and profitability as the top primary within their GMPs. Both models share the same observation pool, that is, producers managing either cow-calf or stocker operations.

Further, the examination of variance inflation factors (VIF) confirmed that multicollinearity was effectively addressed, with overall VIF values low or around 2, suggesting that multicollinearity does not pose a significant concern.

Adoption model I

Cow-calf operations with a larger proportion of privately owned land tend to be less inclined to adopt GMPs. Analysis reveals that an increase in privately owned land by 1% (all else being equal) reduces the odds of implementing a GMP by approximately 48.6% (odds ratio: 0.514), This translates to an 8.5% decrease in the probability of adopting GMP for every 1% increase in privately owned land. This finding confirms the established relationship between rancher land ownership and land-use decision-making (Kreuter et al., 2006; Peterson and Coppock, 2001). Contrary to expectations that private landowners might engage more in proactive management, the data suggest a more complex relationship. While permittees, who often manage extensive lands, display a stronger entrepreneurial approach due to the requirements of their leases, private landowners may not always pursue intensive management practices (Peterson and Coppock, 2001).

An additional possible explanation could be that producers who depend on leased land for grazing might be required to implement a land-use planning and conservation, thus prompting the adoption of specific types of GMPs (Pool, 2009). Such regulations may include compliance with federal grazing permit requirements or comprehensive farm/ranch plans (Pool, 2009). For instance, livestock grazing on public lands typically necessitates a grazing permit from the Bureau of Land Management. This permit outlines fundamental terms and conditions, specifying the number, kind, and class of livestock allowed, as well as the designated grazing season (Feller, 1991). On the contrary, private landowners are not required to obtain a grazing permit, which may result in them feeling less compelled to adopt GMPs. Furthermore, American ranchers are often characterized as staunch defenders of individual property rights and regularly oppose public policies that could restrict their freedom to manage or develop their lands according to their preferences (Jackson-Smith, Kreuter, and Krannich, 2005).

Cow-calf operations with established succession plans or plans currently in development are more likely to adopt a GMP. The odds of adopting a GMP are 89.1% higher for operations with an established plan and 315% higher for those actively developing a plan, in comparison to those without any succession plan. Furthermore, marginal effects reveal that having a succession plan or succession plan in progress increases the probability of adopting a GMP by 8.2% and 18.2%, respectively. Sottomayor, Tranter, and Costa (2011) reported a positive correlation between the existence of a successor and farmers' willingness to adopt new activities and intensify future production. Many cow-calf operations function as family businesses (McBride and Mathews, 2011), and those operators with a succession plan often view ranching as a life-long and potentially multi-generational endeavor (Lubell et al., 2013; Wilmer and Fernández-Giménez, 2015). This long-term outlook could foster the adoption of a GMP as a strategy to ensure the sustained viability and productivity of the land.

Stocker operations are more likely to have a GMP than traditional cow-calf operations.

The odds of adopting a GMP are 60.5% higher for operations incorporating a stocker component, as indicated by an odds ratio of 1.605. This translates into a 6.1% increase in the probability of GMP implementation for stocker-involved operations, as shown by the marginal effect of 0.061. Unlike the standard practices of cow-calf operations, which typically sell calves at weaning as part of a traditional production-marketing strategy, stocker operations adopt a value-added approach (Peel, 2006). In stocker operations, setting an appropriate stocking rate is crucial to success, as animal growth and forage utilization are emphasized during the stocker phase, making them significant cost factors in production (Popp, Faminow, and Parsch, 1999).

A GMP allows for an assessment of anticipated forage yields for pasture or rangeland, facilitating the alignment of stocking rate with the land's carrying capacity (USDA-NRCS, 2020). While establishing an appropriate stocking rate might not be unique to stocker operations, such operations seem to achieve this goal through the establishment of a GMP. Given the alignment between the characteristics of stocker operations and the principles of a GMP, the positive parameter estimates associated with the stocker dummy variable are unsurprising.

Cow-calf operations with larger grazing lands (>10,000 acres) are more likely to adopt GMPs compared to smaller or medium acreage operations. The likelihood of GMP adoption in operations with large grazing lands significantly surpasses that of smaller (27.2%) and medium-sized operations (29%) when compared on an odds ratio basis. This translates to a decrease in the probability of GMP adoption by 12.5% for operations with small grazing lands and 11.6% for those with medium-sized lands. Previous surveys have shown that a higher percentage of larger cow-calf operations based on herd size had a GMP in place compared to their smaller counterparts (USDA-APHIS, 2020). While many studies have used herd size as an indicator of operation scale (e.g., Gentner and Tanaka, 2002; Krause, 1992; Martin et al., 2019), few have evaluated the size of cow-calf operations in terms of grazing land acreage.

The acreage devoted to cattle grazing and the number of cows bred serve as distinct indicators of a cow-calf operation's scale. Expanding the acreage used for grazing typically reflects an extensification of operations, achievable through land acquisitions, leases, or other forms of resource exchange. Conversely, an increase in the number of cows, while often perceived as an indication of intensification, does not necessarily equate to increased intensity without considering stocking density or carrying capacity adjustments (Peterson and Coppock, 2001).

Some studies on landowners' participation in forest conservation programs reveal that those with larger land holdings were more likely to engage in various types of forest management programs (Ma et al., 2012). Moreover, a larger farmland size has been associated with an increased adoption of diverse conservation strategies in crop production, such as tillage techniques (Belknap and Saupe, 1988), soil conservation (Caswell et al., 2001), and the usage of cover crops (Dunn et al., 2016). Larger operations, in terms of the number of privately owned or leased acres and acres leased on public land, are more likely to run economically and environmentally viable strategies and substantial budget to experiment with innovative strategies (Lacey, Wight, and Workman, 1985), because their primary income is dependent upon long-term productivity of the land. Therefore, the finding that operations with larger grazing lands demonstrate a higher rate of GMP adoption aligns with expectations.

Adoption model II

The results from Adoption Model II generally align with those of Adoption Model I, as expected given that the observations for this model encompass operations involved in both cow-calf and stocker operations. A notable difference, however, lies in the regional variations in the adoption of GMPs. Cow-calf-stocker operators in the West are less likely to implement a GMP compared to their Midwest counterparts. An odds ratio of 0.305 indicates that the odds of GMP adoption in the West are only about 30.5% of those in the Midwest. Moreover, the marginal effects of −0.122 suggests that the probability of GMP adoption among cow-calf-stocker operators in the West is 12.2% lower compared to those in the Midwest, highlighting a notable regional variation in GMP adoption rates.

Cow-calf-stocker operations typically demand a larger acreage to sustain post-weaning grazing for calves, compared to traditional cow-calf operations. The regional dummy variable may partially control for regional variation in proportions of privately owned land. Specifically, in the West and Midwest, the proportions of private landowners operating independently of leased grazing lands are 59 and 42%, respectively. Across the three regions, privately owned lands account for the majority of grazing lands operated, with the West at 79%, the Midwest at 74%, and the South at 52%. Correspondingly, the proportion of leased public land is the lowest in all three regions: 17% in the South, 2% in the Midwest, and 0% in the West.

In addition, geographic and climatic differences between these two regions might contribute to the distinct practices associated with cattle grazing. Western ranchers, often managing operations of larger acreage, may face higher costs when implementing a GMP (Krause, 1992). Data to substantiate this hypothesis is limited in the scope of this study. Nevertheless, the relationship between regional factors and GMP adoption requires more extensive investigation to fully understand these dynamics.

Objective model I and II

The observed statistical significance of age in Objective Model II implies a diminished emphasis on production and profitability among older adopters compared to their younger counterparts. An odds ratio of 0.984 for age, coupled with a marginal effect of −0.0003, suggests a decrease in the prioritization of production and profitability with advancing age, with each year reducing the likelihood of focusing on these objectives by 0.03%. This observation highlights age-related differences in the prioritization of GMP goals.

Moreover, adopters with greater proportion of privately owned grazing land were more inclined to prioritize environmental benefits and were less likely to prioritize production and profitability as the primary objectives in their GMPs. According to Objective Model I, these operators are more than twice as likely to focus on environmental goals, as indicated by an odds ratio of 2.473, which translates to an 18.5% increase in the likelihood of prioritizing such objectives. In contrast, Objective Model II suggests a diminished emphasis on production and profitability among these landowners, with an odds ratio of 0.551, resulting in a 12.3% decrease in the probability of prioritizing these economic objectives.

The proportion of private or leased land is often used as an indicator of tenure status (Featherstone and Goodwin, 1993). A study by Chowdhury et al. (2020) revealed a negative association between the ratio of leased grassland acres to total grassland acres and perceived benefits of grazing period, drought recovery, livestock health, and soil erosion among cattle producers implementing rotational grazing. Similarly, Bergtold et al. (2012) discovered a negative relationship between the percentage of leased land and perceived benefits from cover crops. The relationship between the proportion of privately owned grazing land and the objectives of GMPs suggest tenure-related variances in the prioritization of goals when implementing GMPs. This finding conforms with conventional wisdom that operators who lease are more likely to prioritize production and profitability, whereas those who own their land are more likely to prioritize environmental benefits (Peterson and Coppock, 2001; Soule, Tegene, and Wiebe, 2000).

Adopters who already have a succession plan in place tend to prioritize environmental benefits in their GMPs. The odds ratio of 1.661 indicates that having a succession plan raises the likelihood of prioritizing environmental benefits by 66.1% relative to those without such a plan. Furthermore, the marginal effect of 0.104 reveals that the presence of a succession increases the probability of focusing on environmental benefits by 10.4%. The existence of a succession plan likely provides producers with stronger incentives to engage in practice and investments that yield environmental benefits (Baxter, 2012; Lubell et al., 2013) ensuring long-term success of the ranch for future generations. These management strategies might involve new technologies but are typically inherited within families or learned from peers within a rancher's knowledge network (Lubell, Hillis, and Hoffman, 2011).

The lack of a designated successor implies that the agriculture operator has no individual to whom they can transfer the skillset, values associated the responsible ranching, and the necessary material resources for its implementation (Rogers and Salamon, 1983). Conversely, a producer who has a successor possess a "generational stake" which provides continuous motivation for forward planning and sustainable production (Potter and Lobley, 1992).

Cow-calf operations with smaller herds (20 to 49 head) are typically managed by part-time operators who regard cattle production as a lifestyle, emphasizing environmental benefits in their GMPs. In contrast, operations managing larger herds (over 200 head) prioritize production and profitability in their GMPs. Accordingly, small and medium herd operations are 2.873 and 2.378 times more inclined to emphasize environmental benefits than larger herds, with probabilities increased by 20.3% and 16.2%, respectively. On the flip side, the focus on production and profitability is 73.3% and 45.9% less likely for small and medium herds, respectively, with a corresponding decrease in the probability of 26.4% for small herds and 13.4% for medium herds. Prior research has explored and contrasted the production goals of cow-calf producers, concluding that small-herd operations often prioritize non-economic benefits, such as quality of life and environmental sustainability, over economic returns, such as profit maximization (Gentner and Tanaka, 2002; Torell and Bailey, 2000; Young and Shumway, 1991) because ranching is only a small part of their income.

When we consider land size, a distinct pattern emerges. Operations with smaller grazing land acres (1–499 acres) tend to focus on production and profitability within their GMPs, unlike those managing larger land areas (over 10,000 acres). Specifically, the odds of prioritizing environmental benefits are reduced for smaller lands, with a 22.1% lower probability. Conversely, these smaller operations are over four times more likely to emphasize production and profitability, showing a 27.6% increase in this focus.

The relationship between land size and herd size adds a layer of complexity to this pattern. While smaller herds can be managed on various land sizes, larger herds generally require more extensive land. However, there are scenarios where larger herds are intensively managed on smaller land areas, leading to a strategic focus on economic gains. This non-linear relationship between herd size and land size results in diverse impacts on GMP prioritization.

The acreage devoted to grazing is often indicative of a reduced dependence on purchased or homegrown feed (Nehring et al., 2014). Typically, grazing is the most economical method of fulling the nutritional requirements of beef cows (Mathis and Sawyer, 2007). Consequently, operations with extensive grazing lands are usually low-cost, able to support a larger herd, and likely to use minimal mechanically stored or transported feed, whether purchased feed or homegrown (Ramsey et al., 2005). Conversely, operations limited in acreage usually incur higher costs and are more reliant on purchased or harvested feed (Krause, 1992; Ramsey et al., 2005).

A statewide survey of Texas ranchers found that ranchers with less acreage tend to focus more on animal management, rather than improving rangeland conditions (Rowan, 1994). The implementation of GMP objectives is invariably influenced by both the acreage allocated for cattle grazing and the size of the herd. The intensive nature of calf production explains why producers managing larger herds on smaller land areas often adopt strategic economic management practices, prioritizing economic gains (Dill et al., 2015).

Conclusion

The objective of this research was to examine the characteristics of cow-calf and stocker producers and their operations that influence the adoption of GMPs, along with the underlying objectives – environmental or economic – within GMP implementation among U.S. cow-calf and stocker operations. Data used for this study were gathered from an electronic survey, conducted from November 2020 to January 2021, among U.S. cow-calf producers. These data were analyzed using logistic regression models, structured into an independent four-model framework.

Our study shows that operations located in the West have a lower tendency to adopt GMPs compared with those in the Midwest. We also discovered that cow-calf operations with a smaller proportion of privately owned land, an established succession plan, and larger grazing lands were more likely to implement a GMP. Additionally, it was noted that stocker operations have a higher inclination to adopt GMPs compared to traditional cow-calf operations.

In terms of the prioritization of objectives in the implementation of GMPs, our results indicated that operators owning larger portions of privately owned land, those with a succession plan in place, and those managing smaller herd sizes are more likely to prioritize environmental benefits. Conversely, older producers, operations with a significant proportion of privately owned grazing land, and those with smaller herd sizes were less inclined to emphasize economic benefits in their GMPs. Moreover, operations managing smaller grazing land acreage were found to be less likely to prioritize environmental benefits, instead leaning more towards economic objectives within their GMPs. This suggests that operators managing smaller acreages may be concerned about their capacity to meet the nutritional needs of their livestock, due to the constraints associated with limited land resources.

Findings of this study could help guide policy and extension efforts to improve the adoption of environmentally sustainable GMPs in the U.S. cow-calf operations. Understanding the factors that influence GMP adoption and the priority objectives within GMPs could enable policy makers to tailor interventions to the specific needs and characteristics of various producer groups. For instance, in regions with lower adoption rates, educational and outreach programs could be intensified, possibly incorporating successful adopters as change agents. Policies could also be formulated to facilitate the establishment of succession plans, given their positive impact on GMP adoption and environmental prioritization.

Finally, it is crucial to contextualize the 83% adoption rate of GMPs reported by our survey respondents to avoid overestimating the prevalence of GMP implementation. This percentage reflects the share of respondents who reported implanting any form of GMP in their operations. A distinction must be made between the adoption rate per producer and the actual extent of land managed under GMPs. A high adoption rate among survey participants does not necessarily equate to a comprehensive application of these practices across the total land areas. Additionally, the high adoption rate may partly result from selection bias within our survey sample. To enhance representativeness in future research, strategies such as random participant selection and offering participation incentives are recommended to encompass a wider array of perspectives, beyond those already engaged in or interested in GMPs.

Data availability statement. The data that support the findings of this study are available on request from the corresponding author.

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References

Adamowicz, W., P. Boxall, M. Williams, and J. Louviere. "Stated preference approaches for measuring passive use values: choice experiments and contingent valuation." *American Journal of Agricultural Economics* **80**,1(1998):64–75.

Baumgart-Getz, A., L.S. Prokopy, and K. Floress. "Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature." *Journal of Environmental Management* **96**,1(2012):17–25.

Baxter, J. "Legal institutions of farmland succession: Implications for sustainable food systems." *Maine Law Review* **65**(2012):381.

Belknap, J., and W.E. Saupe. "Farm family resources and the adoption of no-plow tillage in southwestern Wisconsin." *Review of Agricultural Economics* **10**, 1(1988):13–23.

Bergtold, J.S., P.A. Duffy, D. Hite, and R.L. Raper. "Demographic and management factors affecting the adoption and perceived yield benefit of winter cover crops in the southeast." *Journal of Agricultural and Applied Economics* **44**,1(2012):99–116.

Boyer, C.N., D.M. Lambert, A.P. Griffith, and C.D. Clark. "Factors influencing use and frequency of rotational grazing for beef cattle in Tennessee." *Journal of Agricultural and Applied Economics* **54**, 2(2022):394–406.

Caswell, M., K.O. Fuglie, C. Ingram, S. Jans, and C. Kascak. *Adoption of Agricultural Production Practices: Lessons Learned from the US Department of Agriculture Area Studies Project*. United States Department of Agriculture, Economic Research Service, 2001

Chowdhury, I.U.A., T. Wang, H. Jin, and A.J. Smart. (2020). Exploring the Determinants of Perceived Benefits of Rotational Grazing in the US Great Plains. In: *Paper presented at the 2020 Agricultural and Applied Economics Association*, July 26-28, 2020, Kansas City, MO.

Dill, M.D., G. Emvalomatis, H. Saatkamp, J.A. Rossi, G.R. Pereira, and J.O.J. Barcellos. "Factors affecting adoption of economic management practices in beef cattle production in Rio Grande do Sul state, Brazil." *Journal of Rural Studies* **42**(2015):21–8.

Dunn, M., J.D. Ulrich-Schad, L.S. Prokopy, R.L. Myers, C.R. Watts, and K. Scanlon. "Perceptions and use of cover crops among early adopters: Findings from a national survey." *Journal of Soil and Water Conservation* **71**(2016):29–40.

Ellison, M., and N.M. Cummings. Developing a grazing management plan. Internet site: https://www.agproud.com/articles/53637-developing-a-grazing-management-plan, (Accessed June 8, 2023).

Featherstone, A.M., and B.K. Goodwin. "Factors influencing a farmer's decision to invest in long-term conservation improvements." *Land Economics* **69**,1(1993):67–81

Feller, J.M. "Grazing management on the public lands: Opening the process to public participation." *Land and Water Review* **26**(1991):571–96.

Gentner, B.J., and J.A. Tanaka. "Classifying federal public land grazing permittees." *Rangeland Ecology & Management/Journal of Range Management Archives* **55**,1(2002):2–11.

Gillespie, J., S. Kim, and K. Paudel. "Why don't producers adopt best management practices? An analysis of the beef cattle industry." *Agricultural Economics* **36**,1(2007):89–102.

Gregorini, P., J.J. Villalba, P. Chilibroste, and F.D. Provenza. "Grazing management: setting the table, designing the menu and influencing the diner." *Animal Production Science* **57**,7(2017):1248–68.

Herbel, C.H., and R. Pieper. "Grazing management." *Semiarid Lands and Deserts: Soil Resources and Reclamation*. vol. **361**, Herbel, C.H., and R. Pieper. (ed.), Marcel Dekker, Inc, 1991, 385.

Jackson-Smith, D., U. Kreuter, and R.S. Krannich. "Understanding the multidimensionality of property rights orientations: evidence from Utah and Texas ranchers." *Society and Natural Resources* **18**,7(2005):587–610.

Jennings, J., P. Beck, and S. Gadberry. "Developing a grazing management plan that matches forage systems to the nutrient needs of cattle." *Journal of Animal Science* **95**,suppl_1(2017):62–62.

Kennedy, S.M., M.E. Burbach, and M.S. Sliwinski. "Sustainable grassland management: an exploratory study of progressive ranchers in Nebraska." *Sustainable Agriculture Research* **5**,2(2016):103–13.

Kim, S., J.M. Gillespie, and K.P. Paudel. "The effect of socioeconomic factors on the adoption of best management practices in beef cattle production." *Journal of Soil and Water Conservation* **60**, 3(2005):111–20.

Krause, K.R. *The Beef Cow-Calf Industry, 1964-87: Location and Size*. Washington, DC: U.S. Department of Agriculture/Economic Research Service, Report No. 659, 1992.

Kreuter, U.P., M.V. Nair, D. Jackson-Smith, J.R. Conner, and J.E. Johnston. "Property rights orientations and rangeland management objectives: Texas, Utah, and Colorado." *Rangeland Ecology & Management* **59**,6(2006):632–9.

Lacey, J.R., J. Wight, and J.P. Workman. "Investment rationale for range improvement practices in Eastern Montana." *Rangeland Ecology & Management/Journal of Range Management Archives* **38**,1(1985):2–6.

Lambert, D.M., C.D. Clark, L.J. Medwid, S.A. Hawkins, and H.A. McClellan. "Best pasture management practice adoption and sediment abatement." *Journal of Agricultural and Applied Economics* **52**,2(2020):204–21.

Li, X., and L.J. Tsoodle. *2019 Fence Material and Construction Cost in Kansas*. Manhattan, KS: Kansas State University, Department of Agricultural Economics, Extension Service Report, 2020, p. 4.

Lubell, M., V. Hillis, and M. Hoffman. "Innovation, cooperation, and the perceived benefits and costs of sustainable agriculture practices." *Ecology and Society* **16**,4(2011):23.

Lubell, M.N., B.B. Cutts, L.M. Roche, M. Hamilton, J.D. Derner, E. Kachergis, and K.W. Tate. "Conservation program participation and adaptive rangeland decision-making." *Rangeland Ecology & Management* **66**,6(2013):609–20.

Lusk, J.L., J. Roosen, and J.A. Fox. "Demand for beef from cattle administered growth hormones or fed genetically modified corn: A comparison of consumers in France, Germany, the United Kingdom, and the United States." *American Journal of Agricultural Economics* **85**,1(2003):16–29.

Ma, Z., B.J. Butler, D.B. Kittredge, and P. Catanzaro. "Factors associated with landowner involvement in forest conservation programs in the US: Implications for policy design and outreach." *Land Use Policy* **29**,1(2012):53–61.

Martin, M.S., S.A. Grau, B.W. Rutherford, T. Grandin, and L.N. Edwards-Callaway. "Survey of cow-calf producer perspectives on management strategies and industry challenges. Part 1: handling practices, and health and industry challenges." *Translational Animal Science* **3**,1(2019):195–203.

Mathis, C.P., and J.E. Sawyer. "Nutritional management of grazing beef cows." *Veterinary Clinics of North America: Food Animal Practice* **23**,1(2007), 1–19.

McBride, W.D., and K. Mathews, *Jr.* "The Diverse Structure and Organization of U.S. Beef Cow-Calf Farms." *Economic Information* Bulletin No. 73, USDA-Economic Research Service, March 2011.

Nehring, R., J. Gillespie, C. Hallahan, J. Harris, and K. Erickson. "What is driving economic and financial success of US cow-calf operations?" *Agricultural Finance Review* **74**,3(2014):311–25.

Oerly, A., M. Johnson, and J. Soule. "Economic, social, and environmental impacts of cattle on grazing land ecosystems." *Rangelands* **44**,2(2022):148–56.

Peel, D.S. "Economics of stocker production." *Veterinary Clinics: Food Animal Practice* **22**,2(2006):271–96.

Peterson, R., and D.L. Coppock. "Economics and demographics constrain investment in Utah private grazing lands." *Rangeland Ecology & Management/Journal of Range Management Archives* **54**,2(2001):106–14.

Pool, J.R. "An end to grazing lease litigation: an examination of alternative dispute resolution schemes that could resolve the overgrazing dispute on state and federally owned rangelands in the western United States." *Pace Environmental Law Review* **27**,1(2009):325.

Popp, M.P., M.D. Faminow, and L.D. Parsch. "Factors affecting the adoption of value-added production on cow-calf farms." *Journal of Agricultural and Applied Economics* **31**,1(1999):97–108.

Potter, C., and M. Lobley. "Ageing and succession on family farms: the impact on decision-making and land use." *Sociologia Ruralis* **32**,2-3(1992):317–34.

Prokopy, L.S., K. Floress, J.G. Arbuckle, S.P. Church, F.R. Eanes, Y. Gao, B.M. Graming, P. Ranjan, and A.S. Singh. "Adoption of agricultural conservation practices in the United States: Evidence from 35 years of quantitative literature." *Journal of Soil and Water Conservation* **74**,5(2019):520–34.

Ramsey, R., D. Doye, C. Ward, J. McGrann, L. Falconer, and S. Bevers. "Factors affecting beef cow-herd costs, production, and profits." *Journal of Agricultural and Applied Economics* **37**,1(2005):91–9.

Rogers, S.C., and S. Salamon. "Inheritance and social organization among family farmers." *American Ethnologist* **10**,3(1983):529–50.

Rouquette, F. "Invited review: Management strategies for intensive, sustainable cow-calf production systems in the southeastern United States: Bermudagrass pastures overseeded with cool-season annual grasses and legumes." *The Professional Animal Scientist* **33**,3(2017):297–309.

Rowan, R. "Are small-acreage livestock producers real ranchers?" *Rangelands Archives* **16**, 4(1994):161–6.

Sottomayor, M., R. Tranter, and L. Costa. "Likelihood of succession and farmers' attitudes towards their future behaviour: evidence from a survey in Germany, the United Kingdom and Portugal." *The International Journal of Sociology of Agriculture and Food* **18**, 2(2011):121–33.

Soule, M.J., A. Tegene, and K.D. Wiebe. "Land tenure and the adoption of conservation practices." *American Journal of Agricultural Economics* **82**,4(2000):993–1005.

Stubbs, R., S. Scott, and C. Duarte. "Responding to food, environment and health challenges by changing meat consumption behaviours in consumers." *Nutrition Bulletin* **43**,2(2018):125–34.

Talbert, C.B., R.L. Knight, and J.E. Mitchell. "Private ranchlands and public land grazing in the southern Rocky Mountains." *Rangelands* **29**,3(2007):5–8.

Tang, M., N.M. Thompson, C.N. Boyer, N.O. Widmar, and J.L. Lusk. "Implicit market segmentation and valuation of Angus Bull attributes." *Journal of Agricultural and Resource Economics* **48**, 2(2023):412–27.

Teague, R., and M. Barnes. "Grazing management that regenerates ecosystem function and grazingland livelihoods." *African Journal of Range & Forage Science* **34**,2(2017):77–86.

Teague, R., and U. Kreuter. "Managing grazing to restore soil health, ecosystem function, and ecosystem services." *Frontiers in Sustainable Food Systems* **4**(2020):157.

Thorne, M.S., G.K. Fukumoto, and M.H. Stevenson. *Foraging Behavior and Grazing Management Planning*. Honolulu, HI: University of Hawaii, Cooperative Extension Service, College of Tropical Agriculture and Human Resources, PRM-2, 2007, 11 p.

Torell, L.A., and S.A. Bailey. (2000). "Is the profit motive an important determinant of grazing land use and rancher motive?" *2000 Western Agricultural Economics Association Annual Meeting*, June 29-July 1, 2000, Vancouver, British Columbia.

U.S. Census Bureau. Census regions and divisions of the United States. Internet site: https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf (Accessed June 11, 2023).

U.S. Department of Agriculture-Animal and Plant Health (USDA-APHIS). *Beef Cow-calf Management Practices in the United States, 2017 (No. 782.0520).* Fort Collins, CO: USDA-APHIS–VS-CEAH–NAHMS, 2020.

U.S. Department of Agriculture-National Agricultural Statistics Service (USDA-NASS). Census of agriculture." Internet site: https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_US/usv1.pdf (Accesses January, 15, 2024).

https://doi.org/10.1017/aae.2024.13 Published online by Cambridge University Press

U.S. Department of Agriculture-Natural Resource Conservation Service (USDA-NRCS). (2019). FY 2019 EQIP Conservation Guidance Document. Internet site: https://www.nrcs.usda.gov/programs-initiatives/eqip-environmental-quality-incentives (Accessed June 8, 2023).

U.S. Roundtable for Sustainable Beef (USRSB). (2022). Beef Industry Sustainability Framework. Internet site: https://www.usrsb.org/Media/USRSB/Docs/usrsbgoalsandtargets_supportingdocument_2022.pdf (Accessed September 24, 2023).

Vanhonacker, F., E.J. Van Loo, X. Gellynck, and W. Verbeke. "Flemish consumer attitudes towards more sustainable food choices." *Appetite* **62**(2013):7–16.

Victurine, R., and C. Curtin. "Financial Incentives for Rangeland Conservation: Addressing the Show-Us-the-MoneyChallenge." *Wild Rangelands: Conserving Wildlife While Maintaining Livestock in Semi-Arid Ecosystems*, 2010, pp. 152–87.

Wang, T., H. Jin, U. Kreuter, H. Feng, D.A. Hennessy, R. Teague, and Y. Che. "Challenges for rotational grazing practice: Views from non-adopters across the Great Plains, USA." *Journal of Environmental Management* **256**(2020):109941.

Wang, T., W.R. Teague, S.C. Park, and S. Bevers. "Evaluating long-term economic and ecological consequences of continuous and multi-paddock grazing-a modeling approach." *Agricultural Systems* **165**(2018):197–207.

Wilmer, H., and M.E. Fernández-Giménez. "Rethinking rancher decision-making: a grounded theory of ranching approaches to drought and succession management." *The Rangeland Journal* **37**,5(2015):517–28.

Young, K.D., and C.R. Shumway. "Cow-calf producers' perceived profit maximization objective: a logit analysis." *Journal of Agricultural and Applied Economics* **23**,1(1991):129–36.

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