North Dakota Beef Cow Producers: Identifying Current Management Practices and Factors that Influence Adoption Rates of Best Management Practices Relating to Surface Water Pollution

Andrea Van Winkle[a]
Joleen Hadrich[b]

[a] North Dakota State University, Department of Agribusiness and Applied Economics, 618 Richard H. Barry Hall, Fargo, ND 58108-6050, USA

[b] North Dakota State University, Department of Agribusiness and Applied Economics, 604 Richard H. Barry Hall, Fargo, ND 58108-6050, USA

Abstract

Best Management Practices (BMP's) relating to surface water pollution abatement for North Dakota beef cow operations are of particular importance due to the production practices used. Probit models were used to estimate the likelihood of North Dakota beef cow producers adopting specific production practices to ensure environmental compliance. Number of beef cows on operation, education, awareness of cost share programs, contact with extension service, ownership structure, debt level, record keeping method, and pasture season usage were found to be significant in the likelihood of adopting a BMP.

Introduction

Water covers three-quarters of the Earth's surface; however, only one percent of this water is available for human consumption. This limited environmental resource is critical for biological existence and survival. Due to the documented importance of clean water, concerns over water quality from agricultural practices are gaining regulatory attention. Attention to water chemistry, sediment, clarity, and macroinvertebrate activity are some of the potential regulations facing agricultural producers (United States Environmental Protection Agency, 2011). Agricultural production practices (non-point pollution sources) contaminating surface water are issues that beef cow producers need to address proactively to ensure that producers have control over pollution abatement practices. Addressing the likelihood of forthcoming surface water pollution regulations for North Dakota beef cow producers has yet to become a priority in North Dakota. Identifying potential North Dakota non-point source pollution by grazing producers will provide the foundation to develop best management practices (BMPs) for surface water pollution.

North Dakota has an estimated 39.6 million acres of land in farmland with 1.7 million cattle, 155 thousand hogs, and 88 thousand sheep. Of the 39.6 million acres of farm land, 13.5 million are identified as grazing lands (National Agricultural Statistics Service, 2011). The North Dakota Department of Health (2009) recognizes 247 lakes and reservoirs for water quality evaluation. These lakes and reservoirs cover approximately 761,000 acres. Additionally, North Dakota has over 54,600 miles of rivers and streams.   Perhaps the most overlooked fact is the 2.5 million acres of wetlands within the state. North Dakota farmland impacts all of these water sources. Potential non-point pollution due to unregulated grazing in North Dakota will increasingly take focus as regulatory enforcement moves forward as more emphasis is placed on surface water health.

Examining potential non-point sources of livestock pollution on surface water quality are vital in order to develop guidelines to help promote the use of BMPs to prevent and abate environmental pollution. Analyzing North Dakota farm operations and producer characteristics provides valuable information on the factors that influence adoption of BMPs in North Dakota. This information will provide necessary data to best address increasing the likelihood of North Dakota beef cow producers adopting pollution abatement practices.

The first step in the process to increase producers' adoption of BMPs is to establish the base level of producer's pollution legislation knowledge and their current management practices in North Dakota. This is a key step in reaching out to grazing producers in order to assist them in selecting appropriate pollution abatement practices. Inadequate knowledge is a primary reason given by producers for not adopting BMPs. This includes the perception/belief that the BMPs are not applicable to their farm and/or they are unfamiliar with the BMPs (Gillespie et el., 2007).

This identifies the importance of educational and direct extension efforts in encouraging adoption of BMPs.

Literature Review

Past studies have evaluated factors affecting BMPs adoption (Johnson et al., 2010, Paudel et al., 2008) while other studies identified BMPs (Collins et al., 2007). Recommended BMPs vary by the type of livestock raised and the topography of the land. Suggested BMPs include stream bank fencing, stream bridging, vegetative buffer strips, and runoff diversions for grazing livestock (Collins et al., 2007, Wilcock et al., 2007).

Adopting pollution abatement practices on a proactive level is influenced by farm and producer characteristics. Daberkow and McBride, (2003) found that producer computer literacy, farm size, and full-time farming positively affected precision agriculture (PA) adoption. In this study, a distinction was made between producer awareness and adoption. It was determined that more formal education increased awareness, but not necessarily adoption.

Producer awareness of BMPs is an important factor which affects adoption rates. Obubuafo et al., (2008) and Paudel et al. (2008) studied cow-calf producer awareness of BMPs and Environmental Quality Incentives Program (EQIP), a cost share program. Obubuafo et al. (2008) found that producers who adopted BMPs at their own expense were more likely to be aware of EQIP and thus apply to the program. Other factors that Obubuafo et al. (2008) found which positively affected awareness and application to EQIP included increased farmed land, total household income less than $90,000, highly erodible farmland, and contact with extension personnel.

Producer education has returned mixed results regarding BMP adoption (Obubuafo et al., 2008). Johnson et al. (2010) found that education did not always have the expected positive

affect on adoption probabilities. They hypothesized differentiated fields of education related to agriculture versus non-agriculture fields and possible extension education might factor into this result.

Johnson et al. (2010) noted that additional research into differentiated fields of producer agricultural education might yield a better understanding of the probability of adoption of BMPs by the producers. Popp et al. (1999) studied the role of education and age on the adoption of BMPs and found that neither were significant determinants of BMPs adoption for Arkansas cow-calf producers. Obubuafo et al. (2008) results were consistent with Kim et al. (2005) regarding factors of BMP adoption in beef cattle production, with the exception of education. Kim et al. (2005) found that producers with a bachelor's degree positively affected BMPs adoption rate. Obubuafo et al. (2008) found mixed results in the role of producer education on awareness and adoption of BMPs. The inconsistency in education significance between studies by Popp et al. (1999), Obubuafo et al. (2008), and Johnson et al. (2010) illustrates the need for additional research.

Rahelizatovo and Gillespie (2004) studied the adoption of BMPs in terms of total number of practices implemented by Louisiana dairy producers. Results demonstrated that the percentage of farmland owned versus operated by the producer was a significant determinant in BMPs adoption rate. They found as the percentage of farmland owned increased, the number of BMPs adopted decreased, which is contrary to the results of Obubuafo et al. (2008). Rahelizatovo and Gillespie (2004) addressed this issue by stating that rental arrangements may include conditions requiring the use of conservation practices by the renter. This opens discussion that non-producers are being proactive in pollution abatement practices whereas producers may not be proactive. Additional research to determine why this is occurring would be beneficial to gain

greater understanding of BMP adoption. Additional positive factors influencing BMPs identified by Rahelizatovo and Gillespie (2004) included producer awareness of pollution legislation and extension efforts. Age was found to negatively affect BMPs adoption rate. Paudel et al. (2008) found that years of experience were significant in adopting BMPs for dairy operations along with the presence of farm transition plans to the next generation.

Johnson et al. (2010) and Ward et al. (2008) identified key producer factors which positively affected the probability of adopting BMPs. These key producer factors included reducing labor use (hours) and generating enough farm income to reduce the need for off-farm income. Ghazalian et al. (2009) and Ward et al. (2008) identified size of operation and human capital as positively affecting BMPs adoption rate. Additionally, greater dependency on income from cattle compared to overall producer income also positively affected BMPs adoption rate. Kim et al. (2005) found that as the percentage of income generated from beef cattle production increased, BMPs adoption rate increased.

Ghazalian et al. (2009) evaluated the effect of the gender of the principal operator on adoption of BMPs. Results demonstrated that female producers were more likely to adopt BMPs. Ghazalian, et al. (2009) hypothesized that women have greater concerns for livestock sanitation and health factors that affect the environment than their male counterparts.

There does appear to be some similarity among studies regarding factors affecting producers' adoption of pollution abatement and prevention practices. However, more information is needed regarding producer awareness and adoption of BMPs since few states have actively addressed livestock pollution. Much of the research available and referenced in this paper is focused on states that have a set of proactive BMPs. North Dakota is a state that has not yet addressed proactive BMPs. By studying proactive BMPs of other states and analyzing data of

North Dakota producers, BMPs can be identified and educational opportunities can be developed. This would positively, effectively, and efficiently address surface water pollution abatement practices and the likelihood of forthcoming related regulations for North Dakota beef cow producers. As stated previously in this paper, proactive adoption of BMPs is in the best interest to beef cow producers by keeping more control of farm practices in the hands of the producer.

Objectives

The objectives of this paper are (1) to identify awareness of current pollution abatement BMPs for beef cow producers in North Dakota and (2) identify the factors that influence their willingness to adopt these best management practices. This paper specifically focuses on two BMPs for beef cow producers, nutrient management and rotational grazing. Nutrient management is the practice of using organic wastes from agricultural/farm operation in an environmentally sound manner by following recommended application rates. Rotational grazing is the practice of dividing pastures into sections where each section is grazed for a short period of time and then rested from grazing until vegetation in that section has recovered.

The data compiled through this project will provide valuable information that can be used to increase the probability of adoption of BMPs by North Dakota beef cow producers. Proactive adoption of surface water pollution abatement BMPs by North Dakota beef cow producers will lessen financial and resource hardships (real or perceived) for beef cow producers due to potential forthcoming surface water pollution regulations. These hardships would be lessened by allowing producers to choose BMPs that best fit their farm operation and allowing implementation of BMPs over time. Providing North Dakota beef cow producers more

information regarding BMPs and potential pollution regulations can be used to assist them in making the best possible management decisions for their operation.

Model

Adoption of BMPs for beef cow operations is an individual producer decision. The probability of adopting BMPs is estimated using a probit model utilizing both binary and continuous independent variables. The probability of adoption (P_i) is hypothesized to be determined as a function of crop enterprises (c), livestock enterprises (l), awareness of BMPs (a), management characteristics (m), economic characteristics (e), and producer characteristics (q) as presented in equation (1):

(1) $P_i = f(c, l, a, m, e, q)$.

The model is expanded to include independent variables which are theorized to influence adoption rates of BMPs. The probability of adopting BMPs can be expressed as:

(2) $P_i{}^* = X\beta + \varepsilon_t$

$$P_i{}^* = \begin{cases} 1, \text{ if BMPs adopted } (i = \text{nutrient management or rotational grazing}) \\ 0, \text{ if BMPs not adopted,} \end{cases}$$

where P_i is the binary variable equal to 1 for BMP adoption (1 = nutrient management or rotational grazing), and 0 for BMP non-adoption. A vector of independent variables, X, are hypothesized to affect the probability of BMPs adoption, β is a vector of estimated parameters, ε_t is the error term, and i identifies BMP type. The error term, ε_t, is assumed to be normally distributed to allow for maximum likelihood estimation in the probit model from Eq. (2).

Independent variables were divided into six categories: crop enterprises, livestock enterprises, awareness of BMPs, management characteristics, economic/financial characteristics, and producer characteristics. Crop enterprises included farm operation characteristics relating to acres of cropland, acres of pasture land, and pasture season usage. Livestock enterprises

primarily focused on average number of beef cows in herd and any special marketing elements utilized (organic, natural, grassfed, etc.).

Awareness of BMPs included knowledge and awareness of regulatory policies, BMP program availability, and if beef cows have access to surface water (streams, rivers, ponds). Regulatory awareness related to Animal Feeding Operations/Concentrated Animal Feeding Operations (AFO/CAFO). BMP program knowledge included awareness of such programs as, Environmental Quality Incentives Program (EQIP), Livestock Pollution Prevention Program (LP3), and Environmental Services Program (ESP).

Management characteristics included farm record keeping systems, existence of written business plan, and retirement plans of the principal farm operator. Economic/financial characteristics encompassed type of farm operation ownership and percentage of operation debt free. Producer characteristics addressed issues relating to farm operator age, years of farming experience, education level, and contact with extension personnel/programs. Definitions of the independent variables and economic justifications for each independent variable are provided in Table 1.

Data

Data was collected via a mail survey to North Dakota beef cow operations during the winter of 2010-2011. A Dillman tailored design mail survey was mailed to 1,000 North Dakota beef producers randomly selected from the National Agricultural Statistics Service (NASS). The survey included questions in six categories. Beef cow producers were surveyed to obtain information facilitating assessment of current operational practices and factors which may affect the adoption of particular production practices. The survey response rate was 16.8%. Producers

were not required to answer all questions, thus individual question response rates may differ from the overall survey response rate.

Results

Nutrient Management

Table 2 presents results from the probit model estimated in equation (2) for BMP= nutrient management. Beef cow producers who operate as a sole proprietorship (SOLEPROP) are 305% more likely to adopt nutrient management BMPs than other ownership structures. Ease of decision making in a sole proprietorship structure could explain this result. Probability of BMPs adoption is estimated to increase by nearly 150% if the principal operator is aware of ESP (AWAREESP). We would expect adoption of nutrient management plans to increase with awareness of the ESP program, since ESP (Environmental Service Program available through the North Dakota Stockman's Association) focuses on assisting livestock producers make positive environmental contributions while increasing productivity and profitability of the operation. ESP reimburses producers up to 60 percent of approved BMP implementation cost. The probability of adopting nutrient management BMPs increase by 178% if the operation has developed a short-term business plan (STBUSPLAN). This result is not surprising because a short-term business plan identifies, among other points, strategic plans for future growth/improvements for the farm operation which can help effectively handle potential future regulations. In the case of beef cow operations, a short-term business plan may incorporate the awareness that future generations need to be environmentally conscious. Additionally, a short-term business plan for beef cow operations may include provisions for budget management allocated for adoption of BMPs.

Operations that utilize Fall pasture grazing (PASFALL) were 196% more likely to adopt nutrient management BMPs than if only summer grazing is used. This result could be explained

due to producers' decisions to remove manure from Fall pasture grazing areas before snow covers the pasture to use the manure as fertilizer for next seasons' crops. Farm operators likely considered the decreased nutritional level of fall pasture lands versus summer pasture lands. Operations that utilize Spring grazing (PASSPR) are 133% *less likely* to adopt nutrient management BMPs than if Summer grazing is used.   This is not surprising since spring pasture is typically the most nutritionally dense pasture for the season on beef cow operations. Secondly, farm operators have a tight labor constraint in the spring focusing on livestock production, crop planting, and other various chores.

The debt level of the farm (PRCTDF) also affected BMP adoption. The less debt the farm carried, the more likely the farm would adopt BMPs. This is the expected result because the greater the financial health of an operation, the more likely it is that the operation has the means (in terms of financial and resource availability) to engage in improvements and investments to the farm operation.

For each additional annual contact the principal operator has with extension personnel (PRINEXTNCONTCT), BMP adoption increases by 31%. This result is as expected. It is likely that as contact with extension personnel increases, farm operators gain greater understanding of potential issues relating to surface water pollution and assistance programs which are available to implement BMPs.

Surprisingly, the model used in this paper indicated little impact of producer education on the probability of adopting BMPs. This result creates questions that additional research may answer. More comprehensive research on farm operator education may provide information to better understand the role of education in the adoption of BMPs. Location of achieved

education, category of higher education, and academic performance may be influential factors that affect adoption of BMPs.

McFadden R-squared is 0.46 for Nutrient Management. This R-squared indicates that there are still other factors that affect adoption of Nutrient Management BMPs. These additional factors need to be identified and researched in order to more accurately and effectively develop policy regulations and educational opportunities in order to increase BMP adoption.

Rotational Grazing

Table 3 presents results from the model estimated in equation (2) for BMP = rotational grazing adoption. Operations which utilize Fall grazing (PASFALL) compared to Summer grazing were 240% more likely to adopt rotational grazing BMPs. This result might be explained by the difference in the quality of the grazing pasture between the Summer and Fall seasons. Grazing operations must ensure adequate quality pasture, thus rotational grazing is a necessary management practice.

Manual recordkeeping (RCRDKEEPMAN) increased rotational grazing BMP adoption probability by nearly 135%. This result may be explained by the hands on management demonstrated by the manual recordkeeping practice. Rotational grazing requires this type of management since pastures need to be maintained on a continual basis to ensure adequate pasture quality for the season.

Principal operators with a Bachelor's degree (PRINBACH) are 116% more likely to adopt and Principal operators with a Technical or Community College degree (PRINCOMM) are 148% more likely to adopt rotational grazing BMPs than those with a High School education. These educational results are as expected because it is hypothesized that more education exposure increases farm operator's awareness of benefits and needs for adoption of BMPs.

Interestingly, contact with extension personnel was significant for nutrient management BMPs but *not* rotational grazing BMPs. This could be due to possible emphasis by extension personnel on nutrient management education. However, additional research is needed to identify the reasons for this result.

Increased number of beef cows in herd also positively increased BMPs adoption. As the average head of beef cows (AVGBEEFCOWS) is increased by one unit, the probability of adopting rotational grazing increases by 1%. The result is not surprising due to the increased use of limited resources (such as pasture land) as herd size increases.

McFadden R-squared is 0.39 for Rotational Grazing. This R-squared indicates that there are still other factors that affect adoption of Rotational Grazing BMPs. Additional research to identify and analyze these factors would result in more accurate and effective development of policy regulations and educational opportunities to increase BMP adoption.

Conclusions/Implications

Increased emphasis on livestock operations in regards to surface water issues will continue to gain attention as water quality issues gain momentum. This increased emphasis will inevitably bring pollution abatement regulations to North Dakota. Pollution abatement regulations will place pressure on beef cow producers to comply with this regulation or face potential consequences. This paper identified and analyzed factors that affect the adoption of two pollution abatement practices (BMPs) in use in North Dakota, Nutrient Management and Rotational Grazing.

The results of this paper suggest that factors such as size of beef cow herd, pasture usage, awareness of cost share programs, extension services, and the education level of the principal operator influence adoption of nutrient management and/or rotational grazing BMPs. The results

and survey data indicate opportunities for educational and policy enhancement. Education of available cost share programs is needed in North Dakota. Many beef cow producers indicated awareness of EQIP, however less than half of the survey respondents were aware of the ESP or LP3 programs. Table 4 summarizes the number of beef cow producers who were aware of each of these programs. Table 4 also identifies how many of the survey respondents applied for, received, or did not receive cost share payments. Increased contact with Extension services will provide many educational benefits to the producers including greater knowledge of the purpose of these programs, availability of cost-share benefits, and the application process for each program. This increased knowledge will increase the adoption probability of BMPs by beef cow producers in North Dakota.

There are differences in which variables are significant in each of the two BMP probability models. However, inference of the results indicates that focusing education on higher educated producers who have structured the operation as a sole proprietorship will be most effective. This could be explained by the theory that more highly educated producers are more likely to be open to new practices and sole proprietorships are able to more efficiently make decisions regarding adoption of BMPs.

The model for Rotational Grazing implies that policies should be developed to encourage increased herd size as this increases BMP adoption probability. Both models, Rotational Grazing and Nutrient Management, suggests Fall pasture grazing utilization as an important element that can be used to address increasing BMP adoption in North Dakota.

Proactive efforts addressing potential pollution regulations would be in the best interest of North Dakota beef cow producers, as these proactive efforts preserves producer control of farm operations. This control allows producers to select pollution abatement practices that best

fit the needs of the individual producers, while complying with potential environmental regulations.

Limitations of this research should be mentioned. There is limited data available on BMPs in North Dakota. However, beef cow producers are an important economic component of North Dakota's economy and the impact of non-point source surface water pollutants has impacts well outside of North Dakota. Thus the scope of this paper has regional implications as well due to the dynamic nature of water and the economic activity across borders.

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Table 1. Explanation of Variables Used in Probit Models

VARIABLE	DESCRIPTION	DEFINITION	ECONOMIC JUSTIFICATION
ROTATEGRAZE		Rotational Grazing	
NUTRNMANG		Nutrient Management	
CROPACRES	Continuous	Acres of Cropland	As cropland acres increases, adoption of BMPs decreases due to increased labor input
PASACRES	Continuous	Acres of Pasture Land	As acres of pasture land increase, adoption of BMPs decreases due to operator perceived non-necessity
AVGBEEFCOWS	Continuous	Average number of beef cows in farm operation	As average number of beef cows increase, adoption of BMPs increased due to increase use of given resources
AWAREAFO_CAFO	Yes = 1, No = 0	Aware of AFO/CAFO Regulations	As awareness of AFO/CAFO regulations increases, adoption of BMPs increase due to increased knowledge of potential negative impact of non-compliance
AWAREEQIP	Yes = 1, No = 0	Aware of EQIP Program	As awareness of EQIP program increases, adoption of BMPs increases due to increase knowledge of financial assistance available
AWAREESP	Yes = 1, No = 0	Aware of ESP Program	As awareness of ESP program increases, adoption of BMPs increases due to increase knowledge of financial assistance available
AWARELP3	Yes = 1, No = 0	Aware of LP3 Program	As awareness of LP3 program increases, adoption of BMPs increases due to increase knowledge of financial assistance available
SURFACCESS	Yes = 1, No = 0	Beef cows have access to surface water	If beef cows have access to surface water, adoption of BMPs increases due to increased non-point source pollution potential
PRINRETIRE	Yes = 1, No = 0	Principal Operator Plans to Retire in next 10 years	BMP adoption decreases if Principal operator has plans to retire in the next 10 years due to perceived cost of implementation
SOLEPROP	Yes = 1, No = 0	Sole Proprietorship ownership Structure	BMP adoption increases relative to other types of ownership structure due to ease of decision making
STBUSPLAN	Yes = 1, No = 0	Short Term Business Plan (3 years)	BMP adoption increases if the operation has a short term business plan (within 3 years) which identifies improvements to the operation
LTBUSPLAN	Yes = 1, No = 0	Long Term Business Plan (10 years)	BMP adoption increases if the operation has a long term business plan (within 10 years) which identifies improvements to the operation
PRINAGE	Continuous	Age of Principal Operator	As age of principal operator increases, adoption of BMPs decreases due to perceived cost vs. benefit
PRINSOMECOLL	Yes = 1, No = 0	Principal Operator has some college education beyond high school	As education level of principal operator increases, adoption of BMPs increases due to greater understanding of potential surface water pollution effects

Table 1. Explanation of Variables Used in Probit Models Continued

VARIABLE	DESCRIPTION	DEFINITION	ECONOMIC JUSTIFICATION
PRINCOMM	Yes = 1, No = 0	Principal operator has a Community or Technical College degree	As education level of principal operator increases, adoption of BMPs increases due to greater understanding of potential surface water pollution effects
PRINBACH	Yes = 1, No = 0	Principal operator has a Bachelor's Degree	As education level of principal operator increases, adoption of BMPs increases due to greater understanding of potential surface water pollution effects
PRINFRMEXP	Continuous	Years of Experience of Principal Operator	As years of experience of principal operator increases, adoption of BMPs decrease due to established management practices of the principal operator.
PRINEXTNCONTCT	Continuous	Annual Number of Contacts with Extension Personal	As frequency of contact with Extension Personal increases, adoption of BMPs increases due to greater understanding of potential issues and assistance programs available
SPCLMARKT	Yes = 1, No = 0	Farm Operation uses special marketing elements (organic, grass-fed, natural, etc.)	BMP adoption increases if farm operations utilizes special marketing elements due to greater awareness of benefits of BMPs
PRCTDF	Continuous	Debt Free Percent of Farm Operation	BMP adoption increases as debt level percentage of farm operation decreases due to increased financial health
RCRDKEEPMAN	Yes = 1, No = 0	Manual Recordkeeping processes used in farm operation	BMP adoption increases as manual recordkeeping methods increase due to hands on management practices
PASSPR	Yes = 1, No = 0	Pasture Grazing used during Spring	BMP adoption decreases when Spring Grazing in utilized due to the increased nutrient level of spring pasture lands
PASFALL	Yes = 1, No = 0	Pasture Grazing used during Fall	BMP adoption increases when Fall Grazing is utilized due to the decreased nutrient level of fall pasture lands

Table 2. Results of Probit Model for Nutrient Management BMP

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-6.5672	2.7138	-2.4199	0.0155
PASACRES	-0.0000	0.0002	-0.0578	0.9539
AVGBEEFCOWS	0.0028	0.0025	1.1109	0.2666
AWAREAFO_CAFO	0.6529	0.4333	1.5068	0.1319
AWAREEQIP	0.7435	1.0526	0.7063	0.4800
AWAREESP	1.4999	0.7804	1.9222	0.0546*
AWARELP3	-1.0617	0.7081	-1.4994	0.1338
SURFACCESS	-1.0077	0.7875	-1.2796	0.2007
STBUSPLAN[1]	1.7886	0.6885	2.5976	0.0094***
LTBUSPLAN[1]	-1.4537	0.9432	-1.5412	0.1233
PRINRETIRE	-0.6296	0.5322	-1.1828	0.2369
SOLEPROP[2]	3.0549	1.0907	2.8009	0.0051***
PRINFRMEXP	-0.0529	0.0410	-1.2900	0.1970
PRINEXTNCONTCT	0.3135	0.1604	1.9539	0.0507**
SPCLMARKT	0.1674	0.5371	0.3118	0.7552
PRCTDF	0.0271	0.0118	2.2953	0.0217**
PASSPR[3]	-1.3381	0.7927	-1.6881	0.0914*
PASFALL[3]	1.9631	1.1748	1.6709	0.0947*
RCRDKEEPMAN[4]	0.5756	0.5025	1.1453	0.2521
PRINSOMECOLL[5]	-0.1641	0.7909	-0.2075	0.8356
PRINCOMM[5]	0.7818	0.6853	1.1408	0.2540
PRINBACH[5]	0.8756	0.7207	1.2149	0.2244
McFadden R-squared	0.464121			
LR statistic	50.90991			
Prob(LR statistic)	0.000272			
Obs with Dep=0	52			
Obs with Dep=1	31			

*** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level
[1]Base business plan type = none
[2]Base ownership type = all others
[3]Base pasture usage season = summer
[4]Base record keeping type = electronic
[5]Base education level = high school

Table 3. Results of Probit Model for Rotational Grazing BMP

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-1.8869	2.2057	-0.8555	0.3923
CROPACRES	0.0002	0.0002	0.8317	0.4056
PASACRES	0.0004	0.0003	1.0617	0.2884
AVGBEEFCOWS	0.0101	0.0054	1.8659	0.0620*
AWAREAFO_CAFO	0.1463	0.4846	0.3019	0.7627
AWAREEQIP	-0.2272	0.8224	-0.2763	0.7823
AWAREESP	-0.7300	0.7606	-0.9598	0.3372
AWARELP3	0.3047	0.7395	0.4120	0.6803
SURFACCESS	-0.1997	0.6357	-0.3141	0.7534
STBUSPLAN[1]	0.6769	0.6792	0.9966	0.3190
LTBUSPLAN[1]	1.0971	0.9157	1.1981	0.2309
PRINRETIRE	0.4717	0.7247	0.6509	0.5151
SOLEPROP[2]	0.9123	0.7259	1.2568	0.2088
PRINAGE	-0.0149	0.0318	-0.4699	0.6384
PRINFRMEXP	-0.0369	0.0489	-0.7554	0.4500
PRINEXTNCONTCT	-0.1250	0.1850	-0.6759	0.4991
SPCLMARKT	0.8901	0.5831	1.5276	0.1266
PRCTDF	-0.0172	0.0131	-1.3119	0.1896
PASSPR[3]	-0.7885	0.7227	-1.0911	0.2752
PASFALL[3]	2.4028	1.0447	2.3001	0.0214**
RCRDKEEPMAN[4]	1.3489	0.6319	2.1345	0.0328**
PRINSOMECOLL[5]	-0.4390	0.6884	-0.6378	0.5236
PRINCOMM[5]	1.4845	0.7865	1.8876	0.0591*
PRINBACH[5]	1.1638	0.7097	1.6398	0.1011*
McFadden R-squared	0.3926			
LR statistic	39.4579			
Prob(LR statistic)	0.0177			
Obs with Dep=0	23			
Obs with Dep=1	64			

*** Significant at the 1% level, ** significant at the 5% level, * significant at the 10% level
[1]Base business plan type = none
[2]Base ownership type = all others
[3]Base pasture usage season = summer
[4]Base record keeping type = electronic
[5]Base education level = high school

Table 4. Summary of Cost Share Program Awareness

AWARENESS LEVEL	EQIP	LP3	ESP
YES, NOT APPLIED	75	61	67
YES, APPLIED, NOT APPROVED	9	1	1
YES, COST-SHARE RECEIVED	50	0	1
NO	17	88	80