NORTH DAKOTA BEEF COW OPERATORS: IDENTIFYING CURRENT MANAGEMENT PRACTICES AND FACTORS THAT INFLUENCE ADOPTION RATES OF BEST MANAGEMENT PRACTICES RELATING TO SURFACE WATER POLLUTION

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Title

North Dakota Beef Cow Producers: Identifying Current Management Practices and

Factors that Influence Adoption Rates of Best Management Practices Relating to Surface Water Pollution

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

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ABSTRACT

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Best management practices are methods that have been determined to be the most effective and practical means of preventing or reducing pollution. Best Management Practices (BMPs) relating to surface water pollution abatement for North Dakota beef cow operations are of particular importance due to the importance of the agriculture industry in North Dakota. North Dakota has yet to address the use of voluntary BMPs to address potential surface water pollution regulations. Probit models were used to estimate the likelihood of North Dakota beef cow operators adopting specific production practices to reduce potential surface water pollution through the use of BMPs. The six BMPs discussed in this research include nutrient management, rotational grazing, filterstrips, riparian buffers, streambank fencing, and streambank bridging/crossing. 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.

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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 increased awareness of the importance of clean water, concerns over water quality from agricultural practices (both crop and livestock) are gaining regulatory attention. Attention to water chemistry, sediment, clarity, and macroinvertebrate activity are some of the potential regulations facing agricultural operators (United States Environmental Protection Agency, 2011). Agricultural production practices (non-point pollution sources) contaminating surface water are issues that beef cow operators need to address proactively to ensure that operators have control over pollution abatement practices. Addressing the likelihood of forthcoming surface water pollution regulations for North Dakota beef cow operators has yet to become a priority in North Dakota. Identifying potential North Dakota non-point source pollution by grazing operators will provide the foundation to develop best 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) reports 247 lakes and reservoirs for water quality evaluation. These lakes and reservoirs cover approximately 761 thousand acres. Additionally, North Dakota has over 54 thousand 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 quality.

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 beef cow operations and operator characteristics provides valuable information on the factors that influence the awareness and adoption of BMPs in North Dakota. This information will provide necessary data to best address increasing the likelihood of North Dakota beef cow operators adopting pollution abatement practices.

The first step in the process to increase operators' adoption of BMPs is to establish the base level of operator's pollution regulatory knowledge and their current management practices in North Dakota. This is a key step in reaching out to grazing operators in order to assist them in selecting appropriate pollution abatement practices. Gillespie et al. (2007) discussed two primary reasons why operators cited non-adoption of BMPs. These two reasons include 1) perception by the operators that BMPs were not applicable to their farm and 2) unfamiliarity with BMPs. This identifies the importance of direct efforts of additional education regarding BMPs focused toward beef cow operators.

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).

Hadrich and Wolf (2011) studied the relationship between citizen complaints relating to livestock production characteristics and costs associated with dealing with citizen complaints. Hadrich and Wolf (2010) found that proactive adoption of BMPs through voluntary environmental programs helped prevent fines and potential legal actions regarding environmental compliance.

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

Operator awareness of BMPs is an important factor which affects adoption rates. Obubuafo et al., (2008) and Paudel et al. (2008) studied cow-calf operator awareness of BMPs and Environmental Quality Incentives Program (EQIP), a cost share program. Obubuafo et al. (2008) found that operators 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 acres planted, total household income less than $90,000, highly erodible farmland, and contact with extension personnel.

Operator 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 effect 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 operator agricultural education might yield a better understanding of the probability of adoption of BMPs by the operators. 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 operators. 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 operators with a bachelor's degree positively affected BMPs adoption rate. Obubuafo et al. (2008) found mixed results in the role of operator 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 operators. Results demonstrated that the percentage of farmland owned versus operated by the operator 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-operators (i.e. landlords or landowners) are being proactive in pollution abatement practices whereas operators 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 operator 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 operator characteristics which positively affected the probability of adopting BMPs. These key operator 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 operator 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 operators 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 operators' adoption of pollution abatement and prevention practices. However, more information is needed regarding operator awareness and adoption of BMPs since few states have actively addressed livestock pollution. Daberkow et al. (2003) studied characteristics affecting awareness and adoption of technology related to precision agriculture, but there are no studies relating to beef cow operator's awareness of BMPs and the adoption rate of the BMPs.

Much of the research available and referenced in this thesis 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 operators, BMPs can be identified and educational opportunities can be developed. This would positively, effectively, and efficiently address surface water pollution abatement practices for North Dakota beef cow operators. As stated previously in this thesis, proactive adoption of BMPs is in the best interest to beef cow operators by keeping more control of farm practices in the hands of the operator.

OBJECTIVES

The objectives of this thesis are (1) to identify awareness of current pollution abatement BMPs for beef cow operators in North Dakota and (2) identify the factors that influence their willingness to adopt these BMPs. This thesis focuses on six BMPs for beef cow operators; Nutrient Management, Rotational Grazing, Filter Strips, Riparian Buffers, Streambank Fencing, and Streambank Bridging/Crossing. The definitions of each of these BMPs are as follows.

- **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.
- **Filter Strips** are vegetative areas used to trap sediment, organic material, nutrients, and chemicals before reaching sensitive environmental areas.
- **Riparian Buffers** are Vegetative areas adjacent to surface water to remove excess amounts of sediment, organic material, nutrients, chemicals, and other pollutants.
- **Streambank Fencing** is the practice of practice of excluding livestock from surface waters through the use of fencing.

- **Streambank Bridging/Crossing** is generally used in conjunction with Streambank fencing so that livestock can move across water with minimal contact.

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 operators. Proactive adoption of surface water pollution abatement BMPs by North Dakota beef cow operators will lessen financial and resource hardships (real or perceived) for beef cow operators due to potential forthcoming surface water pollution regulations. These hardships would be lessened by allowing operators to choose BMPs that best fit their beef cow operation and allowing implementation of BMPs over time. Providing North Dakota beef cow operators 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 operator 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 characteristics (l), awareness of BMPs (a), management characteristics (m), economic characteristics (e), and operator 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 hypothesized to influence adoption rates of BMPs. The probability of adopting BMPs can be expressed as:

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

$$P_i^* = \begin{cases} 1, \text{ if BMP}_i \text{ adopted} \\ 0, \text{ if BMP}_i \text{ not adopted,} \end{cases}$$

where P_i is the binary variable equal to 1 for BMP$_i$ adoption, and 0 for BMP$_i$ 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).

Definitions of the independent variables and economic justifications for each independent variable are provided in Table 1. Table 2 defines the BMPs and their economic justifications. For each of the six BMPs, independent variables were divided into five categories: crop enterprises, livestock characteristics, best management practices, management characteristics, and economic/operator characteristics.

The crop enterprises category included beef cow operation characteristics relating to acres of cropland, acres of pasture land, and pasture season usage. The livestock characteristics category primarily focused on average number of beef cows in herd and any special marketing elements utilized (organic, natural, grassfed, etc.).

The BMP awareness category included operator awareness of regulatory policies and BMP cost share programs. Additionally, BMPs awareness included questions related to surface water (streams, rivers, ponds) access by beef cows and if BMPs were utilized on the beef cow operation. BMP cost share programs included Environmental Quality Incentives Program (EQIP), Livestock Pollution Prevention Program (LP3), and Environmental Services Program (ESP).

Management characteristics included information relating to recordkeeping methods, existence of business plans, and beef cow operation ownership structure. Economic/operator characteristics included information about the principal operator of the beef cow operation (i.e. age, education, years farming experience, contact with extension services) and economic information specific to debt level of beef cow operation.

Table 1. Independent Variable Descriptions and Economic Justification

VARIABLE	DESCRIPTION	DEFINITION	ECONOMIC JUSTIFICATION
Crop Enterprises			
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 perception that BMPs are not necessary
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
PASWNTR	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
Livestock Characteristics			
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
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
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
Best Management Practices Awareness			
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

Table 1. (continued)

VARIABLE	DESCRIPTION	DEFINITION	ECONOMIC JUSTIFICATION
Management Characteristics			
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
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
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
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
Economic/Operator Characteristics			
PRCTDF	Continuous	Debt Free Percent of Farm Operation	BMP adoption increases as debt level percentage of farm operation decreases due to increased financial health
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
PRINAGE	Continuous	Age of Principal Operator	As age of principal operator increases, adoption of BMPs decreases due to perceived cost vs. benefit
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
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
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
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

Table 2. BMP Descriptions and Economic Justification

VARIABLE	DESCRIPTION	DEFINITION	ECONOMIC JUSTIFICATION
NUTRNMANG[1]	Yes = 1, No = 0	Nutrient Management	Use of nutrient management practices increase rotational grazing practices due to increased understanding of benefits relating to appropriate use of manure to minimizing undesirable environmental effects while maximizing crop production
ROTATEGRAZE[2]	Yes = 1, No = 0	Rotational Grazing	Use of rotational grazing practices increases streambank fencing practices due to increased chance of surface water contact as beef cows are moved from one pasture location to another
FILTERSTRIPS[3]	Yes = 1, No = 0	Filterstrips	Use of filterstrips increases nutrient management practices due to increased understanding that filterstrips are a important element to minimize negative environmental effects of runoff
RIPARIANBUFF[4]	Yes = 1, No = 0	Riparian Buffers	Use of riparian buffers increases filterstrip practices due to their similarity in nature and benefits
STRMBNKFENC[5]	Yes = 1, No = 0	Streambank Fencing	Use of streambank fencing practices increases streambank bridging/crossing practices due to the understanding that they are generally used together to maximize benefit of limiting access to surface water
STRMBRDGCROSS	Yes = 1, No = 0	Streambank Bridging/Crossing	

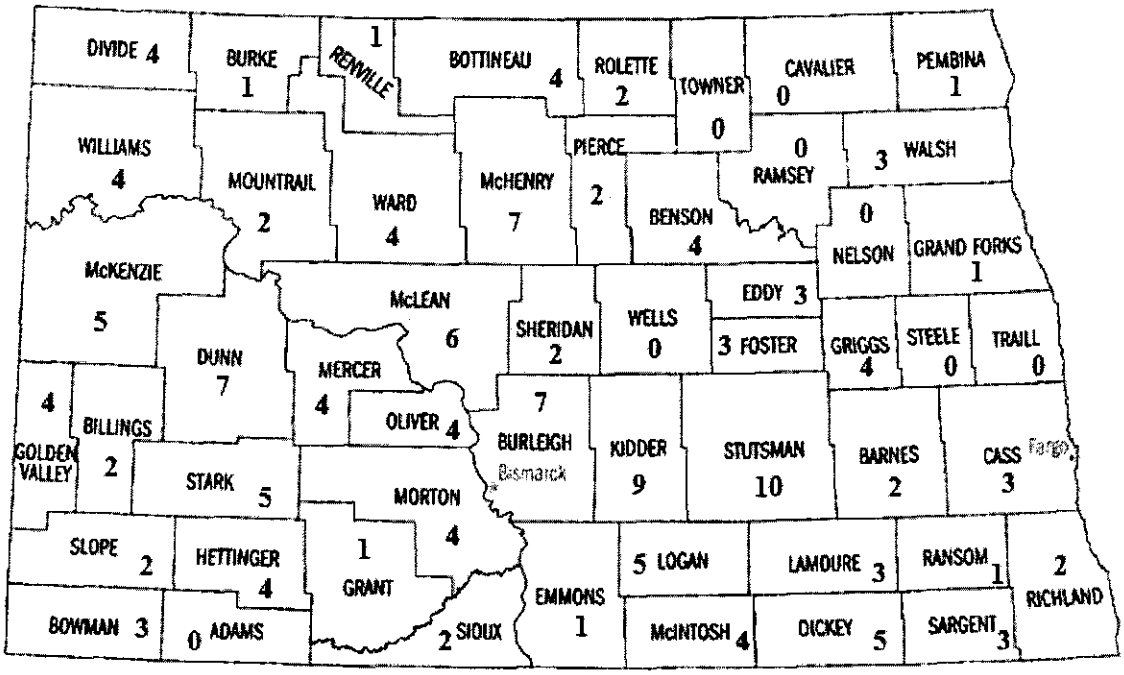
[1]Used as an independent variable in rotational grazing estimation model
[2]Used as an independent variable in streambank fencing estimation model
[3]Used as an independent variable in nutrient management estimation model
[4]Used as an independent variable in filterstrip estimation model
[5]Used as an independent variable in streambank bridging/crossing estimation model

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 in December 2010 to 1,000 North Dakota beef operators randomly selected from the National Agricultural Statistics Service (NASS). A postcard was mailed in January 2011 to the same beef operators as a reminder to complete and return the survey if they had not yet done so. The postcard identified a website which directed the survey recipients to an online version of the survey (http://www.ext.nodak.edu/homepages/aedept/staff/bio_hadrich_j.html). The survey was designed to obtain information facilitating assessment of current operational practices and factors which may affect the adoption of particular production practices by beef cow operators.

Survey questions were grouped into six categories: crop enterprises, livestock characteristics, awareness of BMPs, management characteristics, economic/financial characteristics, and operator characteristics. The six categories were selected by reviewing multiple survey examples (Johnson et al., 2010, Dillman, 2009) and determining categories which best incorporated characteristics relating to beef cow operations and the operators. The categories selected best reflected the grouping of questions that could provide valuable information pertaining to adoption of BMPs in North Dakota by beef cow operators. Survey response rate was 16.8% with 45 of 53 counties represented. Response rate from the 45 counties was fairly evenly distributed. Operators were not required to answer all questions, thus individual question response rates may differ from the overall survey response rate. Figure 1 illustrates the number of returned surveys from each county in North Dakota. Total number of responses was 168; however some returned surveys did not indicate which county the operation was located. This resulted in eight unidentified counties. Figure 1 only illustrates the distribution of the returned 160 surveys which identified county.

Figure 1. North Dakota Country Survey Return Numbers



Map Source: http://www.statetravelmaps.com/North-Dakota, October 2011.

Table 3 presents summary statistics of the data collected and described in the model section of this thesis. Of the respondents who provided answers, the average age of the principal operator was 53 and 97% (145 out of 150) of the principal operators were male. Average cropland acres was 1,200, while average operation pasture acres was 1,772. Principal operators reported extension contact average of two per year.

Table 3. Summary Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Crop Enterprises					
CROPACRES	149	1199	1330	100	8,000
PASACRES	150	1772	1836	100	10,000
PASFALL	146	0.8972	0.3047	0	1
PASSPR	146	0.8082	0.3951	0	1
PASWNTR	146	0.1164	0.3219	0	1
Livestock Characteristics					
AVGBEEFCOWS	152	184.38	123.7	25	750
SURFACCESS	146	0.8219	0.3839	0	1
SPCLMARKT	126	0.7778	0.4174	0	1
Best Management Practices Awareness					
AWAREAFO_CAFO	150	0.4200	0.5086	0	2
AWAREEQIP	151	0.8874	0.3172	0	1
AWAREESP	149	0.4631	0.5003	0	1
AWARELP3	150	0.4133	0.4941	0	1
FILTERSTRIPS	141	0.2766	0.4489	0	1
RIPARIANBUFF	140	0.2214	0.4167	0	1
STRMBNKFENC	140	0.0929	0.2913	0	1
STRMBRDGCROSS	136	0.0514	0.2218	0	1
ROTATEGRAZE	150	0.6933	0.4627	0	1
NUTRNMANG	141	0.4255	0.6463	0	4
Management Characteristics					
RCRDKEEPELEC	144	0.4861	0.5016	0	1
RCRDKEEPMAN	144	0.4722	0.5010	0	1
LTBUSPLAN	144	0.1111	0.3154	0	1
STBUSPLAN	144	0.1667	0.3740	0	1
SOLEPROP	149	0.8188	0.3865	0	1
Economic/Operator Characteristics					
PRCTDF	142	75.28	24.05	0	100
PRINRETIRE	146	0.4863	0.5015	0	1
PRINAGE	151	53.02	11.98	24	71
PRINFRMEXP	149	31.01	6.340	10	35
PRINMALE	150	0.9667	0.1801	0	1
PRINFEMALE	150	0.0333	0.1801	0	1
PRINHS	146	0.3082	0.4633	0	1
PRINSOMECOLL	146	0.1781	0.3839	0	1
PRINCOMM	146	0.2192	0.4151	0	1
PRINBACH	146	0.2808	0.4509	0	1
PRINEXTNCONTCT	146	2.116	1.485	0	4

*Refer to Tables 1 and 2 for complete definitions of variables

As expected, the majority of respondents utilized fall pasture and spring pasture grazing (90% and 81%, respectively); while few (12%) utilized winter grazing. One hundred forty six of the total 168 survey respondents answered the survey question relating to pasture usage. All 146 indicated that summer grazing was utilized. The lack of winter grazing can be logically attributed to the harsh climate of North Dakota which includes significant snow cover with extreme cold temperature and winds.

The relationship of surface water access of beef cows in grazing lands and the adoption of BMPs by operators to abate surface water pollution provides insight into the awareness level of beef cow operators regarding potential surface water pollution factors. Grazing cattle can have a negative impact on surface water quality due to organic waste directly or indirectly entering the surface water.

Table 4 presents adoption levels of BMPs by operators of ND beef cow operations. A majority of respondents, 120 out of 146 (82.2%), indicated that beef cows have access to surface water; which initially indicates that few operators had adopted any of the six BMPs addressed in this study. Of the survey respondents, 28% adopted filter strips, 22% adopted riparian buffers, 9% adopted Streambank fencing, 5% adopted streambank bridging/crossing, and 37.5% adopted nutrient management. Of the six BMPs discussed in this thesis, only rotational grazing BMPs reported a majority of respondents adopting (70%).

Few operators indicated the existence of either a short-term or long-term business plan for the operation. This could be attributed to the respondents indicating that the majority of beef cow operations were sole proprietorships (82%).

Education level of principal operators was fairly evenly distributed. Thirty-one percent of principal operators responded that the highest level of education they had was a high school diploma, 18% had some college education, 22% had a community college degree, 28% had a bachelor's degree, and 1% had a master's degree or higher degree.

Table 4. Adoption Levels of BMPs

Adoption Level	Nutrient Management	Rotational Grazing	Filterstrips	Riparian Buffers	Streambank Fencing	Streambank Bridging/ Crossing
Yes	52	104	39	31	13	7
No, implementation in 12 months	3	2	3	3	3	3
No, implementation in 5 years	8	5	3	5	3	1
No, implementation not being considered	76	39	96	101	121	125

Table A1 located in Appendix A presents the correlation of the independent variables. General interpretations specify that correlation coefficients between 0.00 and 0.03 are considered weak. Correlation coefficients between 0.03 and 0.07 are moderate. Highly correlated coefficients are designated as having values between 0.70 and 1.00 (Wooldridge, 2009).

Three sets of variables were identified as highly correlated in this study: 1) PASACRES and AVGBEEFCOWS (0.7372), 2) PRINAGE and PRINRETIRE (0.7310), and 3) RCRDKEEPMAN and RCRDKEEPELEC (-0.9022). The positive correlation between PASACRES and AVGBEEFCOWS indicated that as pasture acres (PASACRES) increased the average number of beef cows (AVGBEEFCOWS) increased and vice versa. This is expected, since beef cow operators want optimal grazing conditions, which means as cow numbers increase, pasture acres would need to increase as well. Principal operator's age (PRINAGE) and retirement plans of the principal operator (PRINRETIRE) were highly correlated because of the logical close relationship between the two variables, which was expected. The negative correlation between manual recordkeeping methods (RCRDKEEPMAN) and electronic recordkeeping methods (RCRDKEEPELEC) indicated that if manual recordkeeping methods were used by the beef cow operation, electronic recordkeeping methods were not be used. This indicated that producers do not use two methods for recordkeeping, but rather choose to use one or the other.

It is important to identify these high (but expected) correlations to address the possibility of multicollinearity. While high correlation (or multicollinearity) does not violate the assumption of no perfect collinearity in the estimation, it is better to have less correlation between the independent variables. This is preferred because multicollinearity can lead to large variances. One method to correct for multicollinearity is to drop one of the correlated variables from the estimation. However, if that variable is needed due to theoretical or economic justification, dropping the variable can lead to bias in the estimation (Wooldridge, 2009). In this thesis, the highly correlated variables are needed in the analysis. Therefore, no correction for multicollinearity was made; rather the correlations were explained above and provided in the appendix.

The probit regression estimation uses standard maximum likelihood estimation which is based on the distribution of y given x. Because of this distribution, the heteroscedasticity in Var(y|x) is automatically accounted for (Wooldridge, 2009). If the data was not corrected for the possible presence of heteroscedasticity in the model, then the correlation coefficients reported in this thesis would not be a valid summary of association. While heteroskedasticity does not cause bias or inconsistency in the model estimations, the estimation of the variances would be biased causing invalid construction of confidence intervals and t statistics (Wooldridge, 2009).

RESULTS

Discussed below are the results for the six different BMPs addressed in this thesis. While there is not one specific independent variable which was identified as significant in all of the six BMPs estimations, the results provide a basis for continued research of North Dakota beef cow operators and factors affecting their likelihood of adopting North Dakota specific BMPs.

Nutrient Management

Table 5 presents results from the probit model estimated in equation (2) for BMP_i= nutrient management. Beef cow operations that utilized winter grazing (PASWNTR) were 28% less likely to adopt nutrient management BMPs than if fall grazing is used. This was not surprising since winter pasture was typically described as bale grazing.

Probability of BMPs adoption was estimated to increase by 79% if the principal operator was aware of ESP (AWAREESP) and 30% if the principal operator was aware of EQIP (AWAREEQIP). We would expect adoption of nutrient management plans to increase with awareness of the ESP and EQIP programs due to the cost share benefits of these programs. ESP (Environmental Service Program) is available through the North Dakota Stockman's Association. ESP focuses on assisting livestock operators to make positive environmental contributions while increasing productivity and profitability of the operation. ESP reimburses operators up to 60% of approved BMP implementation cost. EQIP (Environmental Quality Incentives Program) is available through the United States Department of Agriculture. EQIP provides financial and technical assistance for planning and implementation of practices that positively improve natural resources. While awareness of EQIP and ESP had positive effects on nutrient management BMP adoption, awareness of the LP3 (AWARELP3) program decreased the probability of adoption by 40%. This raises the question of why the LP3 program had a negative effect on nutrient management adoption of BMPs. One possible reason for this result could be that when the LP3 program was established in 2000, it was called the Dairy Pollution Prevention Program (DP3) because it served only dairy operators. The program was renamed the Livestock Pollution Prevention Program (LP3) in 2006 as the program mission expanded to include assisting all North Dakota livestock operators (North Dakota Department of Agriculture, 2011). Since the LP3 program initially was only intended for dairy operators, beef cow operators may not be aware that the LP3 is now available to assist all livestock operators.

Adoption of nutrient management BMPs increased by 91% if beef cow operators had already adopted filter strip BMPs. This was expected since operators who already have adopted one BMP to abate surface water pollution were hypothesized to have a greater understanding of the importance of clean surface water and more likely to adopt additional BMPs. This emphasizes the importance of education relating to the cost and benefits of BMP implementation. As a beef cow operation recognized and understood the importance of one type of BMP, this result suggests that the operation is more likely to recognize and understand the importance of additional types of BMPs. It was expected that increased contact with extension services would increase adoption rates of

BMPs. However, in this estimation extension service contact (PRINEXTNCONTCT) was not a significant variable.

The probability of adopting nutrient management BMPs decreased by 33% if beef cow operations had a documented long-term business plan (LTBUSPLAN). Conversely, adoption increased by 95% if the operation had developed a short-term business plan (STBUSPLAN). This discrepancy between positive and negative effects on adoption of nutrient management BMPs could be explained by the possibility that survey respondents interpreted a business plan as a plan for BMP implementation rather than overall goals for the operation. Documented short-term business plans positively increased the adoption of nutrient management BMPs was not surprising since, short-term business plans provide an outline of how to achieve long-term strategic goals for future growth/improvements through day to day operations. Documented short-term business plans may include provisions for potential environmental concerns 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 environmental regulations could potentially become an issue that the beef cow operation must address. Therefore, a short-term business plan for beef cow operations may include provisions for budget management allocated for adoption of BMPs in the future.

Beef cow operators who operated as a sole proprietorship (SOLEPROP) were 44% more likely to adopt nutrient management BMPs than other ownership structures. Ease of decision making in a sole proprietorship structure could explain this result. Of the survey respondents, sole proprietorship comprised 82% of beef cow operations ownership structure.

The less debt a beef cow operation carried (PRCTDF), the more likely the operation would adopt nutrient management BMPs. This was expected since a strong financial position allows for the ability to engage in improvements and investments to the beef cow operation. Of the survey respondents who implemented nutrient management BMPs, 31 provided information regarding how the implementation of nutrient management BMPs was funded. Fifty-eight percent of beef cow operations self-funded nutrient management BMP implementation. Increased awareness of BMP cost share programs may bridge the gap between beef cow operations ability to adopt nutrient management BMPs may not be as financially burdensome as possibly perceived.

Principal operator education levels had a positive impact of operator's probability of adopting BMPs. Operators with some college education compared to a high school education were 83% more likely to adopt nutrient management BMPs. Operators with a community college education compared to a high school education were 61% more likely to adopt nutrient management BMPs.

R-squared was 0.59 for Nutrient Management BMPs. This R-squared indicated that many of the factors that affect adoption of Nutrient Management BMPs are represented in this model. There may be additional factors that increase the goodness-of-fit, but the results of this regression are an effective point of reference for effectively developing policies and educational opportunities in order to increase nutrient management BMP adoption.

Table 5. Marginal Effects of Probit Model for Nutrient Management BMP

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Significance
Crop Enterprises					
CROPACRES	2.64E-05	7.08E-05	0.3792	0.7131	
PASACRES	-1.88E-05	5.66E-05	-0.3472	0.7340	
PASSPR[3]	-0.0172	0.2467	-0.0761	0.9436	
PASWNTR[3]	-0.2767	0.1065	-1.711	0.0881	*
Livestock Characteristics					
AVGBEEFCOWS	0.0008	0.0010	0.8335	0.4062	
SURFACCESS	0.0772	0.1941	0.3597	0.7282	
SPCLMARKT	0.0181	0.1726	0.1365	0.9184	
Best Management Practices Awareness					
AWAREAFO_CAFO	0.1615	0.1487	1.141	0.2540	
AWAREEQIP	0.2974	0.1062	1.899	0.0597	*
AWAREESP	0.7922	0.1899	2.259	0.0249	**
AWARELP3	-0.4035	0.1709	-1.875	0.0620	*
FILTERSTRIPS	0.9071	0.1272	2.626	0.0091	***
Management Characteristics					
RCRDKEEPMAN[4]	-0.0147	0.1699	-0.0977	0.9320	
LTBUSPLAN[1]	-0.3275	0.1003	-1.742	0.0829	*
STBUSPLAN[1]	0.9547	0.0800	2.482	0.0138	**
SOLEPROP[2]	0.4400	0.1172	2.502	0.0133	**
Economic/Operator Characteristics					
PRCTDF	0.0162	0.0052	2.496	0.0136	**
PRINRETIRE	-0.0624	0.1750	-0.3657	0.7292	
PRINFRMEXP	-0.0139	0.0135	-1.019	0.3140	
PRINSOMECOLL[5]	0.8283	0.2236	1.996	0.0477	**
PRINCOMM[5]	0.6148	0.3267	1.617	0.1080	
PRINBACH[5]	0.4403	0.3315	1.356	0.1765	
PRINEXTNCONTCT	0.0275	0.0682	0.4266	0.6870	
R-squared	0.5952				
LR statistic	65.29				
Prob(LR statistic)	4.00E-06				
Obs with Dep=0	51				
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 = fall
[4]Base record keeping type = electronic
[5]Base education level = high school

Rotational Grazing

Table 6 presents results from the model estimated in equation (2) for BMP = rotational grazing adoption. Principal operators with a community college degree (PRINCOMM) were 20% more likely to adopt rotational grazing BMPs than those with a high school education. Only one significant independent variable was found in this estimation even though the majority (61 of 84) of the beef cow operation survey respondents indicated the adoption of rotational grazing BMPs. This result could be explained by the fact that rotational grazing is a widespread practice on beef cow operations in North Dakota.

Table 6. Marginal Effects of Probit Model for Rotational Grazing BMP

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Significance
Crop Enterprises					
CROPACRES	3.25E-05	0.0001	0.6952	0.4869	
PASACRES	0.0001	0.0001	0.9857	0.3243	
PASSPR[3]	0.0641	0.1386	0.4994	0.6175	
PASWNTR[3]	-0.0112	0.1724	-0.0658	0.9475	
Livestock Characteristics					
AVGBEEFCOWS	0.0001	0.0008	1.221	0.2222	
SURFACCESS	-0.0631	0.1035	-0.5547	0.5791	
SPCLMARKT	0.0793	0.1292	0.6517	0.5146	
Best Management Practices Awareness					
AWAREAFO_CAFO	0.0346	0.1050	0.3344	0.7380	
AWAREEQIP	0.0766	0.1980	0.4350	0.6635	
AWAREESP	-0.1145	0.1645	-0.7089	0.4784	
AWARELP3	0.0163	0.1402	0.1154	0.9082	
NUTRNTMANG	0.1109	0.1140	0.8974	0.3695	
Management Characteristics					
RCRDKEEPMAN[4]	0.1509	0.1021	1.412	0.1580	
LTBUSPLAN[1]	0.1469	0.0826	1.145	0.2523	
STBUSPLAN[1]	0.1142	0.1019	0.9439	0.3452	
SOLEPROP[2]	-0.0606	0.1765	-0.3712	0.7131	
Economic/Operator Characteristics					
PRCTDF	-0.0039	0.0025	-1.523	0.1276	
PRINRETIRE	-0.0052	0.1074	-0.0484	0.9614	
PRINCOMM[5]	0.2016	0.0949	1.932	0.0533	**
PRINBACH[5]	0.1481	0.0935	1.307	0.1912	
PRINEXTNCONTCT	-0.0187	0.0390	-0.4715	0.6373	
R-squared	0.3402				
LR statistic	34.20				
Prob(LR statistic)	0.0345				
Obs with Dep=0	24				
Obs with Dep=1	60				

*** 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 = fall
[4]Base record keeping type = electronic
[5]Base education level = high school

Beef cow operations utilize rotational grazing as a standard practice because of the intense use of pasture as a feedstuff during the spring, summer, and fall. This emphasizes the point that beef cow operations using rotational grazing do so because it is accepted standard practice in the industry, not because it is a potential BMP to abate surface water pollution. Secondly, since this is a standard production practice, there may be limited similarities across beef cow operations, which would result in a low number of significant variables for the model.

R-squared is 0.34 for rotational grazing BMPs. This R-squared indicates that there are still other factors that affect adoption of rotational grazing BMPs. Identification and analysis of these additional factors would result in more accurate and effective development of policy regulations and educational opportunities to increase rotational grazing BMP adoption.

Filterstrips

Table 7 presents results from the model estimated in equation (2) for BMP_i = filterstrip adoption. Spring pasture use (PASSPR) decreased adoption of filterstrip BMPs by 61%. It is possible that beef cow operators believe that the active growing cycle of the pasture grasses help effectively breakdown and filter manure before the manure has the opportunity to run off into surrounding surface water. Conversely, utilization of winter pasture (PASWNTR) grazing increased filterstrip BMP adoption by 75% compared to fall pasture grazing. This increase could be explained by the principal operator's understanding of the effect runoff has on surface water quality. Due to the harsh cold winter climate of North

Dakota, manure generated in the pasture during the winter months is unable to breakdown to be incorporated into the soil. Thus, as winter snow melts manure generated during the winter months from beef cattle in the pasture may be carried by snowmelt runoff into nearby surface water. The quantity of manure carried by the snowmelt runoff in a relative short period of time may result in decreased surface water quality.

Awareness of the EQIP program (AWAREEQIP) decreased filterstrip BMPs adoption rate by 53%. This was not expected. It was expected that greater awareness of cost share programs, such as EQIP, would increase adoption rates of filterstrip BMPs. Of the 39 survey respondents that adopted filterstrip BMPs, 35 were aware of EQIP. This creates questions as to why the estimated probability was negative. EQIP awareness was a positive variable in other BMPs adoption rate, thus this result identifies a potential disconnect between producer awareness and adoption that additional research may answer for filterstrip BMPs specifically.

Adoption of filterstrip BMPs increased by 92% if beef cow operators had already adopted riparian buffers BMPs. This was expected since operators who already have adopted one BMP to abate surface water pollution were hypothesized to have a greater understanding of the importance of BMPs and the positive impact BMPs have on surface water quality.

Manual record keeping (RCRDKEEPMAN) increased filterstrip BMP adoption by 33%. This increase may be attributable to quality management processes of beef cow operations. Three and one-half percent of survey respondents stated no record keeping processes were used by the beef cow operation. The increased rate of adoption of filterstrip BMPs due to manual recordkeeping practices may be explained by the importance beef cow operations have placed on recordkeeping which indicated good management practices.

Operations which have a documented short-term business plan (STBUSPLAN) are 39% more likely to adopt filterstrip BMPs than operations without any type of business plan. As stated previously in this thesis, a short-term business plan identifies processes for day to day operation plans for future growth/improvements to effectively handle potential future regulations. It is important to note that long-term business plan (LTBUSPLAN) was not significant. But, documented short-term business plan (STBUSPLAN) resulted in a positive effect on filterstrip BMP adoption, while documented long-term business plan resulted in negative effect on filterstrip BMP adoption. This discrepancy between positive and negative effects on adoption of BMPs could be explained by the possibility that survey respondents interpreted a business plan as a plan for BMP adoption for the operation instead of overall goals for the operation.

For each additional contact the principal operator had with extension services (PRINEXTNCONTCT) per year, filterstrip BMP adoption increased by 10%. Increased contact between principal operators and extension services may provide principal operators with a greater understanding of the effects grazing cattle can have on potential surface water pollution. Additionally, extension services may provide information regarding cost share assistance programs which are available to the operator to help implement BMPs.

Table 7. Marginal Effects of Probit Model for Filterstrips BMP

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Significance
Crop Enterprises					
CROPACRES	-0.0001	0.0001	-1.720	0.0855	***
PASACRES	-0.0001	0.0001	-1.325	0.1852	
PASSPR[3]	-0.6083	0.1701	-3.069	0.0021	***
PASWNTR[3]	0.7541	0.1543	3.040	0.0024	***
Livestock Characteristics					
AVGBEEFCOWS	0.0008	0.0010	0.8734	0.3824	
Best Management Practices Awareness					
AWAREAFO_CAFO	0.1707	0.1131	1.466	0.1426	
AWAREEQIP	-0.5275	0.2854	-1.783	0.0747	*
AWAREESP	0.0936	0.1787	0.5360	0.5920	
AWARELP3	0.0776	0.2033	0.3883	0.6978	
RIPARIANBUFF	0.9227	0.0639	4.539	0.0000	***
Management Characteristics					
RCRDKEEPMAN[4]	0.3321	0.1417	2.111	0.0348	**
LTBUSPLAN[1]	-0.0651	0.1780	-0.3284	0.7426	
STBUSPLAN[1]	0.3921	0.2499	1.635	0.1021	*
SOLEPROP[2]	-0.1777	0.2143	-0.9057	0.3651	
Economic/Operator Characteristics					
PRCTDF	0.0010	0.0025	0.4222	0.6729	
PRINRETIRE	-0.0753	0.1464	-0.5130	0.6079	
PRINFRMEXP	-0.0162	0.0116	-1.307	0.1911	
PRINSOMECOLL[5]	-0.0997	0.1874	-0.4655	0.6416	
PRINCOMM[5]	0.2947	0.2448	1.250	0.2115	
PRINBACH[5]	0.0642	0.2033	0.3246	0.7455	
PRINEXTNCONTCT	0.1032	0.0519	2.013	0.0441	**
R-squared	0.6022				
LR statistic	79.63				
Prob(LR statistic)	0.0000				
Obs with Dep=0	71				
Obs with Dep=1	34				

*** 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 = fall
[4]Base record keeping type = electronic
[5]Base education level = high school

R-squared is 0.60 for filterstrips BMPs. Although this R-squared indicates a good model fit, there are still some additional factors that have not been identified in this model that may affect adoption of filterstrip 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 filterstrip BMP adoption rate.

Riparian Buffers

Table 8 presents results from the probit model estimated in equation (2) for BMP_i= Riparian Buffers adoption. Awareness of AFO/CAFO (Animal Feeding Operations/Concentrated Animal Feeding Operations) increased adoption rate of riparian buffer BMPs by 17.5%. This increase may be explained by the logic that as principal operators are more aware of regulations affecting the operation, the more likely they are to seek practices to address potential regulation compliance.

Manual record keeping methods (RCRDKEEPMAN) increased adoption rates by 19%. Adopting BMPs to abate surface water pollution requires dedication to good management practices, similar to manual recordkeeping. Both manual recordkeeping practices and riparian buffer BMPs require the operator to be very involved with day to day operation management.

Principal operators who hold at least a bachelor's degree (PRINBACH) increased adoption of riparian buffers BMPs by 38% compared to operators with high school education. This educational result is as expected because it is hypothesized that increased education creates a greater understanding of costs and benefits related to riparian buffer BMPs.

Pasture usage was not a significant determinant in the adoption of riparian buffer BMPs, which was not expected. In other BMP adoption rates, seasonality of pasture usage was a significant variable. Specifically, the utilization of winter pasture was expected to be significant since it was in the adoption of filterstrip

BMPs (Table 7). Filterstrips and riparian buffers are very similar in nature and provide similar benefits. The difference is in the location of the BMPs. Riparian buffers are found along waterways, while filterstrips can be utilized to separate any sensitive areas from potential runoff from another area.

Table 8. Marginal Effects of Probit Model for Riparian Buffers BMP

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Significance
Crop Enterprises					
CROPACRES	3.44E-05	3.04E-05	1.103	0.2702	
PASACRES	7.23E-06	3.30E-05	0.2190	0.8267	
PASSPR[3]	-0.1964	0.1743	-1.2429	0.2139	
PASWNTR[3]	0.1041	0.1783	0.6431	0.5202	
Livestock Characteristics					
AVGBEEFCOWS	0.0002	0.0006	0.3452	0.7300	
SURFACCESS	0.0646	0.1339	0.4305	0.6668	
SPCLMARKT	0.0606	0.1067	0.5323	0.5945	
Best Management Practices Awareness					
AWAREAFO_CAFO	0.1751	0.1031	1.6560	0.0977	*
AWAREESP	-0.1206	0.1610	-0.7155	0.4743	
AWARELP3	0.1127	0.1640	0.7071	0.4795	
Management Characteristics					
RCRDKEEPMAN[4]	0.1873	0.1076	1.6785	0.0933	*
LTBUSPLAN[1]	0.0136	0.2001	0.0691	0.9449	
STBUSPLAN[1]	-0.0907	0.1234	-0.6408	0.5217	
SOLEPROP[2]	0.0261	0.1295	0.1958	0.8448	
Economic/Operator Characteristics					
PRCTDF	-0.0907	0.1235	-0.6243	0.5325	
PRINRETIRE	0.0346	0.1645	0.2128	0.8315	
PRINAGE	-0.0046	0.0075	-0.6439	0.5196	
PRINFRMEXP	0.0039	0.0091	0.4238	0.6717	
PRINCOMM[5]	-0.0319	0.1319	-0.2355	0.8138	
PRINBACH[5]	0.3801	0.1597	2.497	0.0125	***
PRINEXTNCONTCT	-0.0278	0.0386	-0.7050	0.4808	
R-squared	0.2201				
LR statistic	20.41				
Prob(LR statistic)	0.4953				
Obs with Dep=0	65				
Obs with Dep=1	20				

*** 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 = fall
[4]Base record keeping type = electronic
[5]Base education level = high school

Streambank Fencing

Table 9 presents results from the probit model estimated in equation (2) for BMP_i= Streambank Fencing adoption. Of a total of 107 observations, 10 observations indicated that streambank fencing BMPs had been implemented on the beef cow operation.

As acres of pasture land (PASACRES) increased, beef cow operations were slightly less likely (0.002%) to adopt streambank BMPs. This could be due the additional cost of fencing related to more pasture land adjacent to open water. Beef cow operations which utilized spring pasture grazing (PASSPR) were 6% less likely to adopt BMPs for streambank fencing than operations which utilized fall grazing.

Operations that used manual recording keeping methods (RCRDKEEPMAN) increased adoption of streambank fencing BMPs by 2.3%. This result again illustrates the relationship between manual recording keeping and adoption of BMPs as an indicator of good management practices explained in a previous BMP discussion of results.

Retirement plans of the principal operator (PRINRETIRE) affected adoption of streambank fencing BMPs negatively. If the principal operator had stated plans to retire, the rate of adoption decreased by 2.9%. This result was expected and seems logical. The closer to retirement, the less likely the principal operator is to take on any additional improvements to the operation since the returns would not be realized by the principal operator prior to retirement. Additionally, implementing streambank fencing BMPs requires a significant time commitment. If the principal operator has plan for retirement, the principal operator may choose to engage in other projects that may not need as much time commitment to complete.

For each additional year of farming experience (PRINFRMEXP) the principal operator had, the adoption rate of streambank fencing BMPs increased by 0.2%. It is possible that increased farming experience increased the knowledge of the importance of streambank fencing BMPs in reducing potential surface water pollution. A principal operator with a community college education (PRINCOMM) was 4.8% more likely to adopt streambank fencing BMPs than an operator with a high school education. This result supports the argument that additional education past high school factors into willingness to adopt BMPs. This could be explained by the hypothesis that higher education provides a greater understanding of the importance of stewardship.

Each additional unit of contact per year the principal operator had with extension services (PRINEXTNCONTCT), streambank fencing BMPs adoption rate increased by 0.9%. It is likely that as contact with extension personnel increased, principal operators gained greater understanding of potential issues relating to surface water pollution and assistance programs which are available to implement streambank fencing BMPs.

R-squared is 0.37 for streambank fencing BMPs. This relatively low R-squared indicates that additional factors exist which may affect adoption rates of streambank fencing BMPs. Those additional factors have not been identified in this model. Additional research to identify and analyze these factors would result in a better fit model for factors affecting adoption rates of Streambank fencing BMPs. The better the fit of the model, the more effective the results will be for policy regulations and educational opportunities to increase the rate of streambank fencing BMPs adoption.

Table 9. Marginal Effects of Probit Model for Riparian Buffers BMP

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Significance
Crop Enterprises					
PASACRES	-1.49E-05	1.63E-05	-1.645	0.0999	*
PASSPR[3]	-0.0569	0.0655	-1.642	0.1006	*
PASWNTR[3]	0.1110	0.1441	1.542	0.1230	
Livestock Characteristics					
AVGBEEFCOWS	0.0001	0.0002	1.546	0.1221	
Best Management Practices Awareness					
AWAREESP	-0.0184	0.0270	-1.068	0.2853	
AWARELP3	0.0042	0.0188	0.2450	0.8064	
ROTATEGRAZE	0.0109	0.0166	0.9923	0.3211	
Management Characteristics					
RCRDKEEPMAN[4]	0.0231	0.0294	1.8245	0.0681	*
LTBUSPLAN[1]	-0.0043	0.0103	-0.3480	0.7278	
STBUSPLAN[1]	0.0043	0.0196	0.2629	0.7927	
Economic/Operator Characteristics					
PRCTDF	-0.0003	0.0004	-1.335	0.1817	
PRINRETIRE	-0.0287	0.0314	-1.803	0.0713	*
PRINFRMEXP	0.0020	0.0026	2.068	0.0386	**
PRINSOMECOLL[5]	-0.0191	0.0232	-1.510	0.1310	
PRINCOMM[5]	0.0477	0.0488	1.757	0.0789	*
PRINEXTNCONTCT	0.0086	0.0106	1.650	0.0990	*

R-squared	0.3656
LR statistic	24.29
Prob(LR statistic)	0.0833
Obs with Dep=0	97
Obs with Dep=1	10

*** 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 = fall
[4]Base record keeping type = electronic
[5]Base education level = high school

The limitation of this model results from the few number of survey respondents who indicated that streambank fencing BMPs had been adopted on the operation. However, while only 10 survey respondents indicated adoption of streambank fencing BMPs, commonality demonstrated across the variables resulted in seven significant results for the estimation. This provides a good understanding of operators who are adopting streambank fencing.

Streambank Bridging/Crossing

Table 10 presents results from the probit model estimated in equation (2) for BMP= Streambank Bridging/Crossing. Of a total of 115 observations, 7 observations indicated streambank bridging/crossing BMPs had been implemented on beef cow operations.

Increased average head of cattle (AVGBEEFCOWS) decreased the probability of adopting streambank bridging/crossing BMPs. Principal operator awareness of the ESP program (AWAREESP) increased adoption by 0.3%. However, awareness of the LP3 program (AWARELP3) decreased adoption by 0.06%.

Adoption rates of streambank bridging/crossing (STRMBRDGCROSS) BMPs on beef cow operations increased 2.2% if the operation had implemented streambank fencing (STRMBNKFENC). This was expected and is logical since streambank bridging/crossing is generally used in conjunction with streambank fencing.

R-squared is 0.57 for streambank bridging/crossing BMPs. Additional research to identify and analyze additional variables which effect adoption of streambank bridging/crossing would increase the overall fit of this model. Increased model fit results in more targeted and effective policy regulations and educational opportunities to increase the level of streambank bridging/crossing BMPs adoption. As with the probit model estimation for streambank fencing, the limitation of this model estimation results from the low number of survey respondents which indicated adoption of streambank bridging/crossing BMPs. However, while only 7 survey respondents indicated adoption of streambridging/crossing BMP on the beef cow operations, commonality of variables provides a good understanding of operators who are adopting streambank bridging/crossing BMPs.

Table 10. Marginal Effects of Probit Model for Streambank Bridging/Crossing BMP

Variable	Coefficient	Std. Error	z-Statistic	Prob.	Significance
Crop Enterprises					
PASACRES	6.91E-09	4.31E-08	0.8015	0.4228	
Livestock Characteristics					
AVGBEEFCOWS	-4.29E-07	2.67E-06	-1.722	0.0850	*
Best Management Practices Awareness					
AWAREESP	0.0030	0.0096	1.970	0.0489	**
AWARELP3	-0.0006	0.0027	-2.501	0.0124	*
STRMBNKFENC	0.0223	0.0578	2.066	0.0389	**
Economic/Operator Characteristics					
PRCTDF	-1.73E-06	1.07E-05	-2.030	0.0424	**
PRINRETIRE	8.97E-07	4.65E-05	0.0200	0.9840	
PRINAGE	2.42E-06	1.50E-05	0.9104	0.3626	
PRINFRMEXP	4.12E-06	2.53E-05	0.9694	0.3324	
PRINSOMECOLL[5]	1.86E-05	0.0002	0.2456	0.8060	
PRINCOMM[5]	-6.50E-05	0.0004	-1.408	0.1590	
PRINBACH[5]	3.70E-05	0.0002	0.7264	0.4676	
PRINEXTNCONTCT	1.03E-05	0.0001	1.207	0.2276	
R-squared	0.5693				
LR statistic	30.03				
Prob(LR statistic)	0.0047				
Obs with Dep=0	108				
Obs with Dep=1	7				

*** 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 = fall
[4]Base record keeping type = electronic
[5]Base education level = high school

Comparison of BMP Adoption Factors

Table 11 presents a summary of the independent variables used in the estimation models including the effect significant variables have on the rate of adoption of the six BMPs discussed in this thesis.

Crop and pasture acres were expected to be significant variables in all BMP estimation models. This was not the result. Crop acres were only significant in the filterstrip estimation model while pasture acres were only significant in the streambank fencing estimation model. These results could be explained by the number of acres (crop or pasture) rented versus owned by the North Dakota beef cow operator. Additional analysis of rented versus owned acres may provide insight as to why crop and pasture acres was not found to be significant across all six BMP estimation models.

Awareness of cost-share programs available to assist North Dakota beef cow operators with BMP implementation returned mixed results. Only three estimation models returned awareness of cost-share programs as a significant variable. Among the three estimation models that returned cost-share program awareness as a significant variable, there was no consistency between positive or negative effects on adoption rates of BMPs by North Dakota beef cow operators. This result could be explained due to North Dakota beef cow operators lack of awareness of the three cost-share programs discussed in this thesis. Table 12 presents the level of awareness of the three cost-share programs as indicated by the survey respondents. Increased promotion and education opportunities of these three cost-share programs in North Dakota would likely improve the consistency of the results and improve BMP adoption rates by North Dakota beef cow operators.

Table 11. Summary Statistics of Significant Independent Variables

	Nutrient Management	Rotational Grazing	Filter strips	Riparian Buffers	Streambank Fencing	Streambank Bridging / Crossing
Crop Enterprises						
CROPACRES	NS	NS	-	NS		
PASACRES	NS	NS	NS	NS	-	NS
PASSPR	NS	NS	-	NS	-	
PASWNTR	-	NS	+	NS	NS	
Livestock Characteristics						
AVGBEEFCOWS	NS	NS	NS	NS	NS	-
SURFACCESS	NS	NS		NS		
SPCLMARKT	NS	NS		NS		
Best Management Practices Awareness						
AWAREAFO_CAFO	NS	NS	NS	+		
AWAREEQIP	+	NS	-			
AWAREESP	+	NS	NS	NS	NS	+
AWARELP3	-	NS	NS	NS	NS	-
NUTRNMANG		NS				
ROTATEGRAZE					NS	
FILTERSTRIPS	+					
RIPARIANBUFF			+			
STRMBNKFENC						+
STRMBRDGCROSS						
Management Characteristics						
RCRDKEEPMAN	NS	NS	+	+	+	
LTBUSPLAN	-	NS	NS	NS	NS	
STBUSPLAN	+	NS	+	NS	NS	
SOLEPROP	+	NS	NS	NS		
Economic/Operator Characteristics						
PRCTDF	+	NS	NS	NS	NS	-
PRINRETIRE	NS	NS	NS	NS	-	NS
PRINAGE				NS		NS
PRINFRMEXP	NS		NS	NS	+	NS
PRINSOMECOLL	+		NS		NS	NS
PRINCOMM	NS	+	NS	NS	+	NS
PRINBACH	NS	NS	NS	+		NS
PRINEXTNCONTCT	NS	NS	NS	NS	+	NS

*NS indicates variable not significant in estimation model
**Blank cells indicate variable not used in estimation model

Education was not a significant variable in all of the estimation models. This was not the expected result. Education was a significant variable in four of the six estimation models. However, even in the four estimation models (nutrient management, rotational grazing, riparian buffers, and streambank fencing) in which education was significant, the level of education was not consistent between the models. More comprehensive research on beef cow operator's education may provide additional information to better understand the role of education in their adoption rate of BMPs. Location of achieved education (rural/urban), category of higher education (Associates Degree, B.A, M.S, PHD), course of study (crop/animal sciences, business, marketing, etc.) and academic performance may be influential factors in the adoption of BMPs by North Dakota beef cow operators.

Contact with extension services/personnel was shown to be significant only in the streambank fencing estimation model. This was not the expected result. The result could be due to lack of educational programs or opportunities directed to beef cow operators which specifically address BMP options and benefits related to adoption BMPs.

Additional study and research of North Dakota beef cow operators may provide clarification of the results discussed above and thus provide a better understanding of how to most effectively assist North Dakota beef cow operators proactively address potential non-point source surface water regulations.

Table 12. Awareness Statistics of Survey Respondents

Awareness Level	AFO/CAFO Regulations	EQIP	LP3	ESP
Yes	61			
No	88	17	88	80
Yes, Not applied		75	61	67
Yes, Applied, Not Approved		9	1	1
Yes, Received Cost-share		50	0	1

RECOMMENDATIONS

Based on analysis of the survey data of North Dakota beef cow operators, the primary recommendation is to address the lack of awareness of BMPs cost share programs available to assist North Dakota beef cow operators. Educating beef cow operators about these programs could lead to significant increases in adoption rates of BMPs, thus proactively addressing any potential non-point source surface water pollution issues. As potential regulatory enforcement focusing on surface water pollution moves into North Dakota, proactive measures to abate this pollution will provide greater benefits to North Dakota as a whole. Proactively addressing potential issues, such as non-point source surface water pollution, results in increased feasibility and effectiveness of BMPs as addressed previously in this thesis.

The process of educating North Dakota beef cow operators can be addressed in multiple methods including focused mailings and increased general public marketing campaigns. Another method is to develop new and/or reassess current educational programs and the individual cost-share parent organizations to increase cost share awareness levels of North Dakota beef cow operators. As a majority of beef cow operations in North Dakota are educated regarding cost share programs, additional analysis should be done to determine the next step in abating potential non-point sources of pollution in North Dakota.

CONCLUSIONS

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 operators to comply with this regulation or face potential consequences. This thesis identified and analyzed factors that affect the adoption of six pollution abatement practices (BMPs) in use in North Dakota, Nutrient Management, Rotational Grazing, Filter Strips, Riparian Buffers, Streambank Fencing, and Streambank Bridging/Crossing.

The results of this thesis suggest that the number of pasture and crop acres, awareness of cost share programs, regulatory measures, documented business plans, ownership structure, retirement plans, farm experience, contact with extension services, operation debt level, grazing practices, education level, and previous implementation of BMPs are factors that affect beef cow operator's rate of adoption of BMPs. The analysis of the survey data indicate opportunities for educational and policy enhancement. Education of available cost share programs is needed in North Dakota. Many beef cow operators indicated awareness of EQIP, however less than half of the survey respondents were aware of the ESP or LP3 programs. Table 12 summarizes the number of beef cow operators who were aware of each of these programs. Table 12 also identified the number of survey respondents who applied for each cost share program, the number who received cost share assistance, and the number who did not receive cost share payments.

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

Proactive efforts addressing potential pollution regulations would be in the best interest of North Dakota beef cow operators, as these proactive efforts preserves operator control of farm operations. This control allows operators to select pollution abatement practices that best fit the needs of the individual operators, while complying with potential environmental regulations.

Limitations of this research should be mentioned. There is limited data available on BMPs in North Dakota. Additionally, the survey did not address financial costs of BMPs. However, beef cow operators 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 thesis has regional implications as well due to the dynamic nature of water and the economic activity across borders.

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APPENDIX A

Table A 1. Correlation of Variables

	AVGBEEF COWS	AWARE AFO_CAFO	AWAREEQIP	AWAREESP	AWARELP3	CROPACRES	LTBUSPLAN
AVGBEEFCOWS	1.000	0.1231	0.3176	0.3535	0.0376	0.1004	0.0534
AWAREAFO_CAFO	0.1231	1.0000	0.2855	0.4524	0.2417	-0.0049	-0.0175
AWAREEQIP	0.3176	0.2855	1.000	0.3258	0.2030	0.1792	0.1463
AWAREESP	0.3535	0.4524	0.3258	1.000	0.6114	0.2039	0.1529
AWARELP3	0.0376	0.2417	0.2030	0.6114	1.000	0.1458	0.1340
CROPACRES	0.1004	-0.0049	0.1792	0.2039	0.1458	1.000	0.2044
LTBUSPLAN	0.0534	-0.0175	0.1463	0.1529	0.1340	0.2044	1.000
NUTRNTMANG	0.2108	0.3888	0.1786	0.2939	-0.0289	0.1856	0.0202
PASACRES	0.7372	0.1218	0.2197	0.3557	0.1011	0.0015	0.0430
PASFALL	0.0572	0.2030	0.2464	0.0838	-0.0444	0.0937	0.0310
PASSPR	0.1426	0.1852	0.0274	0.0478	-0.0823	-0.0294	-0.1761
PASWNTR	0.1249	0.1698	0.1385	0.1166	0.0121	0.1343	-0.0452
PRCTDF	-0.0217	-0.0596	-0.0640	-0.0125	0.1048	0.0250	0.0061
PRINAGE	-0.0845	-0.0137	-0.0841	0.1245	0.2617	-0.0959	-0.1486
PRINBACH	0.1896	0.2331	0.1287	0.2660	0.2331	-0.0064	-0.0799
PRINCOMM	-0.0344	0.0089	-0.1185	-0.0746	-0.1067	-0.0701	-0.0197
PRINEXTNCONTCT	0.1547	0.1910	0.1396	0.2606	0.2451	0.2969	0.2093
PRINFEMALE	-0.0159	-0.1838	-0.2799	-0.0929	-0.0643	-0.0771	0.0728
PRINFRMEXP	-0.0410	-0.0420	-0.0799	0.0856	0.1680	-0.0274	0.0636
PRINHS	-0.2306	-0.2228	0.0283	-0.1756	-0.1021	-0.0438	0.1839
PRINMALE	0.0159	0.1838	0.2799	0.0929	0.0643	0.0771	-0.0728
PRINMASTER	-0.1002	0.1442	0.0412	0.1263	0.1442	-0.0870	0.2813
PRINRETIRE	-0.1557	0.0041	-0.1987	0.1101	0.2195	0.0531	-0.1785
PRINSOMECOLL	0.1169	-0.0707	-0.0538	-0.0576	-0.0707	0.1710	-0.1812
RCRDKEEPELEC	0.1026	0.0815	0.1645	0.0153	0.1345	-0.0666	0.1529
RCRDKEEPMAN	-0.0356	-0.1054	-0.0401	0.0258	-0.1054	0.1402	-0.1105
RIPARIANBUFF	-0.0181	0.2210	0.1907	0.1481	0.1571	0.1678	-0.0355
ROTATEGRAZE	0.3341	0.1067	0.2065	0.1312	-0.0667	0.1110	0.1812
SOLEPROP	-0.3626	0.0100	0.1147	-0.0524	0.1406	-0.0378	0.1146
SPCLMARKT	-0.0143	-0.0186	-0.0283	-0.1196	-0.0789	-0.1282	0.0692
STBUSPLAN	0.0824	0.0048	0.1026	0.1788	-0.0577	0.1772	0.4775
STRMBNKFENC	-0.0059	0.1206	0.1134	-0.0127	0.0284	-0.1121	0.1305
STRMBRDGCROSS	-0.0523	0.2530	0.0722	0.0876	-0.0211	0.0414	-0.0810
SURFACCESS	0.0950	0.1910	0.1797	0.1704	0.1180	-0.1279	-0.0314

Table A 1. (continued)

	NUTRNTMANG	PASACRES	PASFALL	PASSPR	PASWNTR	PRCTDF	PRINAGE
AVGBEEFCOWS	0.2108	0.7372	0.0572	0.1426	0.1249	-0.0217	-0.0845
AWAREAFO_CAFO	0.3888	0.1218	0.2030	0.1852	0.1698	-0.0596	-0.0137
AWAREEQIP	0.1786	0.2197	0.2464	0.0274	0.1385	-0.0640	-0.0841
AWAREESP	0.2939	0.3557	0.0838	0.0478	0.1166	-0.0125	0.1245
AWARELP3	-0.0289	0.1011	-0.0444	-0.0823	0.0121	0.1048	0.2617
CROPACRES	0.1856	0.0015	0.0937	-0.0294	0.1343	0.0250	-0.0959
LTBUSPLAN	0.0202	0.0430	0.0310	-0.1761	-0.0452	0.0061	-0.1486
NUTRNTMANG	1.000	0.1020	0.1150	0.0179	0.0468	0.0916	-0.1398
PASACRES	0.1020	1.000	0.0305	0.0994	0.2572	0.0457	0.0364
PASFALL	0.1150	0.0305	1.000	0.5365	0.1385	0.1864	-0.0841
PASSPR	0.0179	0.0994	0.5365	1.000	0.1871	-0.0284	-0.0179
PASWNTR	0.0468	0.2572	0.1385	0.1871	1.000	0.1192	0.1477
PRCTDF	0.0916	0.0457	0.1864	-0.0284	0.1192	1.000	0.2977
PRINAGE	-0.1398	0.0364	-0.0841	-0.0179	0.1477	0.2977	1.000
PRINBACH	0.0511	0.2056	0.0383	0.0762	0.1131	0.0173	0.0754
PRINCOMM	-0.0771	0.0081	-0.1185	0.1015	-0.0798	-0.2113	-0.2003
PRINEXTNCONTCT	0.2212	0.0888	-0.0116	-0.0900	0.0882	-0.0353	-0.0416
PRINFEMALE	-0.0638	0.0649	-0.0980	0.1134	-0.0892	-0.0883	0.0571
PRINFRMEXP	-0.0243	0.0175	-0.0160	-0.0907	0.0713	0.3650	0.5147
PRINHS	-0.1146	-0.2482	0.0283	-0.1605	-0.0495	0.1694	0.1203
PRINMALE	0.0638	-0.0649	0.0980	-0.1134	0.0892	0.0883	-0.0571
PRINMASTER	-0.0764	-0.0601	0.0412	0.0556	-0.0437	-0.2338	-0.0978
PRINRETIRE	-0.1709	-0.0738	-0.0347	-0.0026	0.0804	0.2139	0.7310
PRINSOMECOLL	0.1909	0.0542	0.0538	-0.0436	0.0343	0.1099	0.0439
RCRDKEEPELEC	-0.1147	0.0295	0.0838	-0.0830	0.0395	-0.0010	0.0107
RCRDKEEPMAN	0.1423	0.0254	-0.0401	0.0976	0.0000	0.0286	-0.0358
RIPARIANBUFF	0.2367	0.1030	0.1907	0.0212	0.0762	0.0243	0.0198
ROTATEGRAZE	0.1663	0.2623	0.1185	0.1125	0.0798	-0.2273	-0.2961
SOLEPROP	0.0387	-0.2923	-0.1835	-0.1673	0.0049	-0.1041	-0.0160
SPCLMARKT	-0.0716	0.0159	-0.0283	0.0860	0.0495	-0.1040	0.0569
STBUSPLAN	0.2115	0.0923	0.0073	-0.1960	0.1540	-0.1064	-0.1164
STRMBNKFENC	0.1450	0.0071	-0.1674	-0.0744	0.1479	-0.0243	-0.0270
STRMBRDGCROSS	0.0772	0.0030	0.0722	0.0976	0.1227	-0.0834	0.0686
SURFACCESS	0.0043	0.1872	-0.0428	0.0624	0.0572	-0.1547	0.0810

Table A 1. (continued)

	PRINBACH	PRINCOMM	PRINEXTN CONTCT	PRINFEMALE	PRINFRMEXP	PRINHS	PRINMALE
AVGBEEFCOWS	0.1896	-0.0344	0.1547	-0.0159	-0.0410	-0.2306	0.0159
AWAREAFO_CAFO	0.2331	0.0089	0.1910	-0.1838	-0.0420	-0.2228	0.1838
AWAREEQIP	0.1287	-0.1185	0.1396	-0.2799	-0.0799	0.0283	0.2799
AWAREESP	0.2660	-0.0746	0.2606	-0.0929	0.0856	-0.1756	0.0929
AWARELP3	0.2331	-0.1067	0.2451	-0.0643	0.1680	-0.1021	0.0643
CROPACRES	-0.0064	-0.0701	0.2969	-0.0771	-0.0274	-0.0438	0.0771
LTBUSPLAN	-0.0799	-0.0197	0.2093	0.0728	0.0636	0.1839	-0.0728
NUTRNTMANG	0.0511	-0.0771	0.2212	-0.0638	-0.0243	-0.1146	0.0638
PASACRES	0.2056	0.0081	0.0888	0.0649	0.0175	-0.2482	-0.0649
PASFALL	0.0383	-0.1185	-0.0116	-0.0980	-0.0160	0.0283	0.0980
PASSPR	0.0762	0.1015	-0.0900	0.1134	-0.0907	-0.1605	-0.1134
PASWNTR	0.1131	-0.0798	0.0882	-0.0892	0.0713	-0.0495	0.0892
PRCTDF	0.0173	-0.2113	-0.0353	-0.0883	0.3650	0.1694	0.0883
PRINAGE	0.0754	-0.2003	-0.0416	0.0571	0.5147	0.1203	-0.0571
PRINBACH	1.000	-0.3925	0.1813	-0.0101	-0.0115	-0.3564	0.0101
PRINCOMM	-0.3925	1.000	-0.3173	0.1046	-0.1531	-0.3797	-0.1046
PRINEXTNCONTCT	0.1813	-0.3173	1.000	-0.2890	0.0152	0.0346	0.2890
PRINFEMALE	-0.0101	0.1046	-0.2890	1.000	-0.0309	-0.0034	-1.0000
PRINFRMEXP	-0.0115	-0.1531	0.0152	-0.0309	1.000	0.1560	0.0309
PRINHS	-0.3564	-0.3797	0.0346	-0.0034	0.1560	1.000	0.0034
PRINMALE	0.0101	-0.1046	0.2890	-1.0000	0.0309	0.0034	1.000
PRINMASTER	-0.0692	-0.0737	0.1511	-0.0265	-0.1968	-0.0669	0.0265
PRINRETIRE	0.0386	-0.0081	-0.0446	0.0487	0.4558	0.0031	-0.0487
PRINSOMECOLL	-0.2714	-0.2892	0.0864	-0.1040	0.0777	-0.2626	0.1040
RCRDKEEPELEC	0.2079	0.0384	-0.0131	0.0240	-0.0993	-0.1756	-0.0240
RCRDKEEPMAN	-0.1445	-0.0843	0.0791	0.0000	0.1532	0.1762	0.0000
RIPARIANBUFF	0.3797	-0.1371	0.1577	0.0180	0.0536	-0.0966	-0.0180
ROTATEGRAZE	0.0756	0.2332	0.0188	0.0229	-0.1830	-0.1354	-0.0229
SOLEPROP	-0.0496	0.1196	0.1093	-0.1698	0.0422	-0.0653	0.1698
SPCLMARKT	-0.1069	-0.0066	-0.2558	0.1365	0.0312	0.2103	-0.1365
STBUSPLAN	0.0106	-0.0205	0.1740	0.0106	0.0000	0.0965	-0.0106
STRMBNKFENC	0.0117	0.0921	0.1091	-0.0730	0.1370	0.0211	0.0730
STRMBRDGCROSS	0.1792	-0.1293	0.1967	-0.0465	0.0797	-0.1174	0.0465
SURFACCESS	0.1787	0.1199	0.1161	-0.0620	-0.0849	-0.0751	0.0620

Table A 1. (continued)

	PRINMASTER	PRINRETIRE	PRINSOMECOLL	RCRDKEEP ELEC	RCRDKEEP MAN	RIPARIANBUFF
AVGBEEFCOWS	-0.1002	-0.1557	0.1169	0.1026	-0.0356	-0.0181
AWAREAFO_CAFO	0.1442	0.0041	-0.0707	0.0815	-0.1054	0.2210
AWAREEQIP	0.0412	-0.1987	-0.0538	0.1645	-0.0401	0.1907
AWAREESP	0.1263	0.1101	-0.0576	0.0153	0.0258	0.1481
AWARELP3	0.1442	0.2195	-0.0707	0.1345	-0.1054	0.1571
CROPACRES	-0.0870	0.0531	0.1710	-0.0666	0.1402	0.1678
LTBUSPLAN	0.2813	-0.1785	-0.1812	0.1529	-0.1105	-0.0355
NUTRNTMANG	-0.0764	-0.1709	0.1909	-0.1147	0.1423	0.2367
PASACRES	-0.0601	-0.0738	0.0542	0.0295	0.0254	0.1030
PASFALL	0.0412	-0.0347	0.0538	0.0838	-0.0401	0.1907
PASSPR	0.0556	-0.0026	-0.0436	-0.0830	0.0976	0.0212
PASWNTR	-0.0437	0.0804	0.0343	0.0395	0.0000	0.0762
PRCTDF	-0.2338	0.2139	0.1099	-0.0010	0.0286	0.0243
PRINAGE	-0.0978	0.7310	0.0439	0.0107	-0.0358	0.0198
PRINBACH	-0.0692	0.0386	-0.2714	0.2079	-0.1445	0.3797
PRINCOMM	-0.0737	-0.0081	-0.2892	0.0384	-0.0843	-0.1371
PRINEXTNCONTCT	0.1511	-0.0446	0.0864	-0.0131	0.0791	0.1577
PRINFEMALE	-0.0265	0.0487	-0.1040	0.0240	0.0000	0.0180
PRINFRMEXP	-0.1968	0.4558	0.0777	-0.0993	0.1532	0.0536
PRINHS	-0.0669	0.0031	-0.2626	-0.1756	0.1762	-0.0966
PRINMALE	0.0265	-0.0487	0.1040	-0.0240	0.0000	-0.0180
PRINMASTER	1.000	-0.0926	-0.0510	0.1263	-0.1140	-0.0602
PRINRETIRE	-0.0926	1.000	-0.0117	0.0047	-0.0262	0.0789
PRINSOMECOLL	-0.0510	-0.0117	1.000	-0.1268	0.1032	-0.1528
RCRDKEEPELEC	0.1263	0.0047	-0.1268	1.000	-0.9022	-0.0392
RCRDKEEPMAN	-0.1140	-0.0262	0.1032	-0.9022	1.000	0.0932
RIPARIANBUFF	-0.0602	0.0789	-0.1528	-0.0392	0.0932	1.000
ROTATEGRAZE	-0.1762	-0.2217	-0.1635	0.0181	0.0281	0.1371
SOLEPROP	0.0579	0.0233	-0.0284	0.0115	0.0000	0.0375
SPCLMARKT	0.0669	-0.0031	-0.1313	-0.0015	0.0000	0.0255
STBUSPLAN	0.2081	-0.0717	-0.1633	0.0565	0.0000	0.0057
STRMBNKFENC	-0.0358	-0.1633	-0.1404	-0.1029	0.1346	0.1602
STRMBRDGCROSS	-0.0228	0.1100	0.0894	-0.1804	0.2000	0.2174
SURFACCESS	0.0486	-0.0168	-0.2860	-0.0440	0.0000	0.1390

Table A 1. (continued)

	ROTATE GRAZE	SOLEPROP	SPCLMARKT	STBUSPLAN	STRMBNK FENC	STRMBRDG CROSS	SURFACCESS
AVGBEEFCOWS	0.3341	-0.3626	-0.0143	0.0824	-0.0059	-0.0523	0.0950
AWAREAFO_CAFO	0.1067	0.0100	-0.0186	0.0048	0.1206	0.2530	0.1910
AWAREEQIP	0.2065	0.1147	-0.0283	0.1026	0.1134	0.0722	0.1797
AWAREESP	0.1312	-0.0524	-0.1196	0.1788	-0.0127	0.0876	0.1704
AWARELP3	-0.0667	0.1406	-0.0789	-0.0577	0.0284	-0.0211	0.1180
CROPACRES	0.1110	-0.0378	-0.1282	0.1772	-0.1121	0.0414	-0.1279
LTBUSPLAN	0.1812	0.1146	0.0692	0.4775	0.1305	-0.0810	-0.0314
NUTRNTMANG	0.1663	0.0387	-0.0716	0.2115	0.1450	0.0772	0.0043
PASACRES	0.2623	-0.2923	0.0159	0.0923	0.0071	0.0030	0.1872
PASFALL	0.1185	-0.1835	-0.0283	0.0073	-0.1674	0.0722	-0.0428
PASSPR	0.1125	-0.1673	0.0860	-0.1960	-0.0744	0.0976	0.0624
PASWNTR	0.0798	0.0049	0.0495	0.1540	0.1479	0.1227	0.0572
PRCTDF	-0.2273	-0.1041	-0.1040	-0.1064	-0.0243	-0.0834	-0.1547
PRINAGE	-0.2961	-0.0160	0.0569	-0.1164	-0.0270	0.0686	0.0810
PRINBACH	0.0756	-0.0496	-0.1069	0.0106	0.0117	0.1792	0.1787
PRINCOMM	0.2332	0.1196	-0.0066	-0.0205	0.0921	-0.1293	0.1199
PRINEXTNCONTCT	0.0188	0.1093	-0.2558	0.1740	0.1091	0.1967	0.1161
PRINFEMALE	0.0229	-0.1698	0.1365	0.0106	-0.0730	-0.0465	-0.0620
PRINFRMEXP	-0.1830	0.0422	0.0312	0.0000	0.1370	0.0797	-0.0849
PRINHS	-0.1354	-0.0653	0.2103	0.0965	0.0211	-0.1174	-0.0751
PRINMALE	-0.0229	0.1698	-0.1365	-0.0106	0.0730	0.0465	0.0620
PRINMASTER	-0.1762	0.0579	0.0669	0.2081	-0.0358	-0.0228	0.0486
PRINRETIRE	-0.2217	0.0233	-0.0031	-0.0717	-0.1633	0.1100	-0.0168
PRINSOMECOLL	-0.1635	-0.0284	-0.1313	-0.1633	-0.1404	0.0894	-0.2860
RCRDKEEPELEC	0.0181	0.0115	-0.0015	0.0565	-0.1029	-0.1804	-0.0440
RCRDKEEPMAN	0.0281	0.0000	0.0000	0.0000	0.1346	0.2000	0.0000
RIPARIANBUFF	0.1371	0.0375	0.0255	0.0057	0.1602	0.2174	0.1390
ROTATEGRAZE	1.000	-0.0500	0.0710	0.2207	0.2031	-0.0169	0.0360
SOLEPROP	-0.0500	1.000	-0.1529	0.0522	0.1595	0.1016	0.1354
SPCLMARKT	0.0710	-0.1529	1.000	0.0429	0.0817	-0.1879	-0.0063
STBUSPLAN	0.2207	0.0522	0.0429	1.000	0.1474	0.0487	-0.0195
STRMBNKFENC	0.2031	0.1595	0.0817	0.1474	1.000	0.1705	0.1339
STRMBRDGCROSS	-0.0169	0.1016	-0.1879	0.0487	0.1705	1.000	0.0853
SURFACCESS	0.0360	0.1354	-0.0063	-0.0195	0.1339	0.0853	1.000

APPENDIX B

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December 3, 2010

Dear Valued North Dakota Beef Producer:

Enclosed with this letter you will find a survey designed to identify factors that influence North Dakota beef producer production practices and management decisions. This research is being conducted by Joleen C. Hadrich (NDSU Department of Agribusiness & Applied Economics) and Andrea VanWinkle (NDSU graduate student) in collaboration with Chris Augustin (NDSU Carrington Research Extension Station) and Scott Ressler (North Dakota Stockmen's Association). We place a high value on your input as it helps us conduct the best research and draw appropriate conclusions regarding ND beef producers. A summary of this project's research findings will be reported in an Ag Econ report and results will be released to agricultural media.

We want to emphasize that your participation in this survey is ***entirely voluntary and highly encouraged***. It is estimated that the survey will take approximately 20 minutes of your time to complete. Your individual responses will be kept in strict confidence. Although we would like you to answer all of the questions (note there are questions on both sides of each page), you may choose to skip any question. You may choose not to participate or quit participating at any time without penalty or loss of benefits to which you are already entitled.

We appreciate your assistance with this research project and look forward to receiving your completed survey. After completion, please mail us your survey using the enclosed, postage-paid envelope. If you have any questions, comments, or concerns regarding this survey, please feel free to contact Dr. Joleen C. Hadrich via email at joleen.hadrich@ndsu.edu or phone 701-231-5721.

If you have questions regarding research subjects' rights or to file a complaint regarding the research please contact the NDSU Human Research Protection Office via email at ndsu.irb@ndsu.edu or phone at 701-231-8908.

Sincerely,

Joleen C. Hadrich	Andrea VanWinkle	Chris Augustin	Scott Ressler
NDSU	NDSU	NDSU	ND Stockmen's Association
Assistant Professor	Research Assistant	Nutrient Management	Environmental Services Dir.

NDSU is an equal opportunity institution.

SURVEY – NORTH DAKOTA BEEF COW PRODUCERS

Your participation in this survey is voluntary. You may choose to participate by completing and returning this survey. Your individual responses will be kept confidential. Please answer all questions to the best of your knowledge. Any information provided will be used to assess overall beef producer characteristics in North Dakota. The objective of this survey is to collect and analyze information in order to improve policies and programs that serve North Dakota beef cow producers. Information gathered will be used for educational and policy recommendation purposes.

Farm location: County______________________________

Are you currently involved in **beef cow** operations?

- ☐ Yes
- ☐ No. Please check all that apply
  - ☐ Still farming, but sold beef cow herd
  - ☐ Retired from farming, sold beef cow herd
  - ☐ Retired from farming, sold farm including beef cow herd
  - ☐ Other, please list___________________________

This survey is primary interested in active beef cow producers. If *'NO'* was answered in the above question, no additional information is needed, please return this survey and thank you for your cooperation. If *'YES'* was answered in the above question, please continue answering the following questions. If the farm is not a sole proprietorship (individual owner), please answer all questions as they relate to the entire operation, not just your share.

A. CROP ENTERPRISES

A1 How many **cropland** acres were farmed as of January 1, 2010?

☐ 1-199	☐ 2,000-3,999
☐ 200-499	☐ 4,000-5,999
☐ 500-999	☐ 6,000-9,999
☐ 1,000-1,999	☐ 10,000 +

A2 Please check the crops typically grown on the farm.

☐ Alfalfa	☐ Peas/Lentils
☐ Barley	☐ Potatoes
☐ Canola	☐ Soybeans
☐ Corn	☐ Spring Wheat
☐ Dry Edibles	☐ Sugarbeets
☐ Durum	☐ Sunflowers
☐ Hay	☐ Other________________

A3 How many acres of **pasture** were in use as of January 1, 2010?

- ☐ 1-199
- ☐ 200-499
- ☐ 500-999
- ☐ 1,000-1,999
- ☐ 2,000-3,999
- ☐ 4,000-5,999
- ☐ 6,000-9,999
- ☐ 10,000 +

A4 Of the total acres in operation, how many acres were:

- ☐ Owned ________
- ☐ Rented from private entity ________
- ☐ Rented from government entity ________
- ☐ Rented Out ________

A5 What pasture systems are used by the farm? Please check all that apply.

- ☐ Continuous (one or two main pastures)
- ☐ Rotational (multiple pastures used to rotate livestock as necessary to allow vegetation re-growth)
- ☐ Controlled (strip grazing with new pasture area every 12 to 48 hours)
- ☐ Other, please list________________________________

A6 If a pasture system is used on the farm, what time period(s) are cattle allowed to graze? Please check all that apply.

- ☐ Spring
- ☐ Summer
- ☐ Fall
- ☐ Winter (bale grazing/swath grazing)
- ☐ No pasture

B. LIVESTOCK ENTERPRISES

B1 What was the average number of beef cows in the herd during the 2010 grazing season?

- ☐ 1-49
- ☐ 50-99
- ☐ 100-249
- ☐ 250-500
- ☐ 501-750
- ☐ 751 +

B2 What breed of beef cows were in the farm herd as of January 1, 2010? Please check all that apply.

- ☐ Angus
- ☐ Charolais
- ☐ Gelbvieh
- ☐ Hereford
- ☐ Maine-Anjou
- ☐ Red Angus
- ☐ Shorthorn
- ☐ Simmental
- ☐ Tarentaise
- ☐ Cross-bred
- ☐ Other, please list________________

B3 What marketing element(s) does the farm utilize with regard to beef cows?

- ☐ Branded Beef Program
- ☐ Farm direct to consumer
- ☐ Grassfed
- ☐ Organic
- ☐ No hormones or antibiotics/Natural
- ☐ Other, please list______________________

B4 How many head of other livestock were present on the farm as of January 1, 2010? Please check all that apply.

		Number
☐	Bison	________
☐	Goats	________
☐	Horses	________
☐	Pigs	________
☐	Sheep	________
☐	Other, please list______________________	________
☐	None	

B. BEST MANAGEMENT PRACTICES (BMPs)

Best Management Practices (BMPs) are recommended farming practices which have been found to be the most effective and practical methods to prevent and/or reduce potential agricultural pollution.

C1 Are you aware of any *AFO/CAFO* (Animal Feeding Operations/Concentrated Animal Feeding Operations) regulations that may affect your farm operation?

- ☐ Yes
- ☐ No

C2 Are you aware of the *Environmental Quality Incentives Program* (*EQIP*) available through the United States Department of Agriculture? *EQIP* is a program that allows producers to apply for cost share payments and/or incentive payments to facilitate in implementing pollution abatement practices.

- ☐ Yes, aware of program but have not applied
- ☐ Yes, applied but cost share incentives not approved
- ☐ Yes, applied and received cost shares/incentives
- ☐ No

C3 Are you aware of the *Livestock Pollution Prevention Program (LP3)* available through the North Dakota Department of Agriculture? *LP3* assists livestock producers meet environmental compliance regulations and increase productivity and profitability of livestock operations. This program reimburses producers up to 60 percent of the approved expenses.

- ☐ Yes, aware of program but have not applied
- ☐ Yes, applied but expenses not approved
- ☐ Yes, applied and received reimbursement
- ☐ No

C4 Are you aware of the *Environmental Services Program (ESP)* available through the North Dakota Stockmen's Association's? *ESP* assists livestock producers make positive environmental contributions while increasing productivity and profitability of livestock operations. This program reimburses producers up to 60 percent of the approved expenses.

- ☐ Yes, aware of program but have not applied
- ☐ Yes, applied but expenses not approved
- ☐ Yes, applied and received reimbursement
- ☐ No

C5 What type(s) of runoff control system(s) for *pasture manure* is currently used by the farm? Please check all that apply.

- ☐ None
- ☐ Vegetative buffer strips
- ☐ Holding pond
- ☐ Containment pond
- ☐ Clean water diversion
- ☐ Other, please list____________________________________

C6 What type(s) of runoff control system(s) for *manure application on cropland* is currently used by the farm? Please check all that apply.

- ☐ None
- ☐ Vegetative buffer strips
- ☐ Holding pond
- ☐ Containment pond
- ☐ Clean water diversion
- ☐ Other, please list____________________________________

C7 What type(s) of runoff control system(s) for *feedlot manure collection* is currently used by the farm? Please check all that apply.

- ☐ None
- ☐ Vegetative buffer strips
- ☐ Holding pond
- ☐ Containment pond
- ☐ Clean water diversion
- ☐ Other, please list____________________________________

C8 Do beef cows have access to streams, rivers, or ponds (surface water)? If "No", please skip to question C10.

☐ Yes
☐ No

C9 If cattle have access to surface water, is there a method/system in place which restricts access to the surface water? If yes, please check all restriction methods that apply.

☐ Yes. Livestock are completely restricted from water.
☐ Yes. Beef cows use trough or tank for water.
☐ Yes. Fencing is used to allow only limited access.
☐ Other, please list______________________________
☐ No. Restricted water access methods not used.

C10 **Filter Strips** are vegetative areas used to trap sediment, organic material, nutrients, and chemicals before reaching sensitive environmental areas through surface runoff and wastewater. Is this practice utilized on the farm?

☐ Yes
☐ No, implementation planned in the next 12 months
☐ No, implementation planned in the next 5 years
☐ No, implementation not being considered at this time

C11 **Riparian Buffers** are vegetative areas adjacent to surface water to remove excess amounts of sediment, organic material, nutrients, chemicals, and other pollutants in surface water. Is this practice utilized on the farm?

☐ Yes
☐ No, implementation is planned in the next 12 months
☐ No, implementation planned in the next 5 years
☐ No, implementation not being considered at this time

C12 **Streambank Fencing** is the practice of excluding livestock from surface waters though the use of fencing. Is this practice utilized on the farm?

☐ Yes
☐ No, implementation is planned in the next 12 months
☐ No, implementation planned in the next 5 years
☐ No, implementation not being considered at this time

C13 **Stream Bridging/Crossing** is generally used in conjunction with streambank fencing so that livestock can move across the stream/river with minimal contact to the water. Is this practice utilized on the farm?

☐ Yes
☐ No, implementation is planned in the next 12 months
☐ No, implementation planned in the next 5 years
☐ No, implementation not being considered at this time

C14 **Rotational Grazing** is the practice of dividing pastures into sections. Each section is grazed for a short period of time and then rested from grazing until vegetation in that section has recovered. Is this practice utilized on the farm?

- ☐ Yes
- ☐ No, implementation is planned in the next 12 months
- ☐ No, implementation planned in the next 5 years
- ☐ No, implementation not being considered at this time

C15 **Nutrient Management** (manure utilization) is the practice of using organic wastes from agricultural/farm operations in an environmentally sound manner by following recommended application rates. Does the farm operation have a nutrient management plan?

- ☐ Yes, please list ______________________________
- ☐ No, implementation is planned in the next 12 months
- ☐ No, implementation planned in the next 5 years
- ☐ No, implementation not being considered at this time

C16 Other than the above **Bolded** identified practices, what other practices does the farm utilize to abate possible contamination of surface water? Please list:

____

____

____

C17 If manure is collected, what collection system is used?

	Solid	Semi-solid
Scraper	☐	☐
Box scraper	☐	☐
Blades	☐	☐
Front end loader	☐	☐
Other please list ____________	☐	☐

C18 How long do you store manure?

Solid	0-3 months	3-6 months	6-12 months	12+ months
Stock pile	☐	☐	☐	☐
Other please list ____________	☐	☐	☐	☐

Semi-solid	0-3 months	3-6 months	6-12 months	12+ months
Earthen basin	☐	☐	☐	☐
Concrete basin	☐	☐	☐	☐
Other please list ____________	☐	☐	☐	☐

C19 If manure is applied to crop land, when is applied?

- ☐ Spring
- ☐ Fall
- ☐ Spring & Fall

C20 If manure is applied to crop land, what application method is used?

Solid

- ☐ Broadcast spreaders
- ☐ Other, please list ________________

Semi-solid

- ☐ Broadcast spreaders
- ☐ Dragline/Draghose
- ☐ Other, please list ________________

C21 Is manure application on field/cropland supplemented with commercial fertilizer application?

- ☐ Yes
- ☐ No, field/crop land fertilized with farm manure only
- ☐ No, field/crop land fertilized with commercial fertilizer only

C22 Of the field/crop land fertilized with manure, please check all that apply to describe field/crop land.

- ☐ Tiled crop land
- ☐ No-till (surface application)
- ☐ Traditional till (incorporated application)
- ☐ Other, please list ___________

C23 Is manure tested for nutrient analysis before applications?

- ☐ Yes
- ☐ No

C24 If *Best Management Practices (BMPs)* are not currently used on the farm, what is the primary reason(s)? Please check all that apply.

	Initial Material Cost	Initial Labor Cost	Initial Labor Hours	Maintenance Cost
Filter Strips	☐	☐	☐	☐
Riparian Buffers	☐	☐	☐	☐
Streambank Fencing	☐	☐	☐	☐
Streambank Bridging/Crossing	☐	☐	☐	☐
Rotational Grazing	☐	☐	☐	☐
Nutrient Management	☐	☐	☐	☐

C25 If *BMPs* were implemented by the farm, how was the project financed? Please check all that apply.

	Self-Funded	EQIP	LP3	ESP	NA
Filter Strips	☐	☐	☐	☐	☐
Riparian Buffers	☐	☐	☐	☐	☐
Streambank Fencing	☐	☐	☐	☐	☐
Streambank Bridging/Crossing	☐	☐	☐	☐	☐
Rotational Grazing	☐	☐	☐	☐	☐
Nutrient Management	☐	☐	☐	☐	☐

C26 If 100% subsidy is not available, what is the minimum percentage cost share needed by the farm to adopt *BMPs*?

	0-14	15-29	30-44	45-75	76+
Filter Strips	☐	☐	☐	☐	☐
Riparian Buffers	☐	☐	☐	☐	☐
Streambank Fencing	☐	☐	☐	☐	☐
Streambank Bridging/Crossing	☐	☐	☐	☐	☐
Rotational Grazing	☐	☐	☐	☐	☐
Nutrient Management	☐	☐	☐	☐	☐

D. MANAGEMENT CHARACTERISTICS

D1 What record keeping system is utilized in farm operations?

- ☐ Easy-Farm
- ☐ FarmLogic
- ☐ Farm Notes
- ☐ Farm Works
- ☐ Paper Record Book
- ☐ Quicken
- ☐ Quickbooks
- ☐ Redwing
- ☐ Spreadsheet
- ☐ None

D2 How often are receipt and expense information entered into the farm record system?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Quarterly
- ☐ Other, please list________________

D3 How important are the following in the consideration to adopt a *BMP*?

	Very Important		Neutral		Not Important
Reduce Labor Cost	1	2	3	4	5
Reduce Labor Hours	1	2	3	4	5

D4 How important is generating adequate farm income so that non-farm income is not necessary?

	Very Important		Neutral		Not Important
Generating non-farm income	1	2	3	4	5

D5 Does the farm operation have a short term (less than 3 years) written business plan which clearly identifies current farm focus?

☐ Yes
☐ No

D6 Does the farm have a long term (10 years or more) written business plan which clearly identifies future focus of the farm?

☐ Yes
☐ No

D7 Does the Principal operator plan to retire in the next 10 years?

☐ Yes
☐ No

D8 If yes, have plans been made for transfer of farm to the next generation?

☐ Yes, next generation will continue
☐ Yes, secondary operator will become primary operator
☐ No, next generation is not interested
☐ No, sell livestock
☐ No, sell complete farm operation
☐ No, have not discussed farm transfer

E. ECONOMIC/FINANCIAL CHARACTERISTICS

E1 What is the ownership arrangement of the farm operation?

☐ Sole Proprietorship (Individual owner)
☐ General Partnership
☐ Limited Partnership
☐ Limited Liability Company (LLC)
☐ C-Corporation
☐ S-Corporation
☐ Other, please list ______________________________

E2 What was the farm operation revenue in 2009?

- ☐ Less than $5,000
- ☐ $5,000-$9,999
- ☐ $10,000-$14,999
- ☐ $15,000-$19,999
- ☐ $20,000-$39,999
- ☐ $40,000-$59,999
- ☐ $60,000-$79,999
- ☐ $80,000 or more

E3 What was the amount of farm operation revenue (estimated) in 2009 that was generated by beef cow operations?

- ☐ None
- ☐ Less than $5,000
- ☐ $5,000-$9,999
- ☐ $10,000-$14,999
- ☐ $15,000-$19,999
- ☐ $20,000-$39,999
- ☐ $40,000-$59,999
- ☐ $60,000-$79,999
- ☐ $80,000 or more

E4 If you sold the complete farm operation (including all land and assests) what percentage of the sale amount would you retain after all debts had been paid, ignoring taxes?

- ☐ 100% - currently debt free
- ☐ 90 – 99%
- ☐ 80 – 89%
- ☐ 70 – 79%
- ☐ 60 – 69%
- ☐ 50 – 59%
- ☐ 40 – 49%
- ☐ 30 – 39%
- ☐ 20 – 29%
- ☐ 10 – 19%
- ☐ 0 - 9%
- ☐ Less than 0%

Operators are defined as any individual who has a financial interest and is involved with decision making situations for the farm operation. Operators can be a spouse, siblings, children, hired employees, etc.

E5 How much non-farm income (estimated) was earned in 2009?

	Principal Operator	2nd Operator	3rd Operator	4th Operator
None	☐	☐	☐	☐
Less than $5,000	☐	☐	☐	☐
$5,000-$9,999	☐	☐	☐	☐
$10,000-$14,999	☐	☐	☐	☐
$15,000-$19,999	☐	☐	☐	☐
$20,000-$39,999	☐	☐	☐	☐
$40,000-$59,999	☐	☐	☐	☐
$60,000-$79,999	☐	☐	☐	☐
$80,000 or more	☐	☐	☐	☐

F. PRODUCER CHARACTERISTICS

F1 What is the age of each farm operator?

	Principal Operator	2nd Operator	3rd Operator	4th Operator
18-29	☐	☐	☐	☐
30-54	☐	☐	☐	☐
55-70	☐	☐	☐	☐
71+	☐	☐	☐	☐

F2 How many years of farming experience does each operator have?

	Principal Operator	2nd Operator	3rd Operator	4th Operator
0-4	☐	☐	☐	☐
5-14	☐	☐	☐	☐
15-24	☐	☐	☐	☐
25-34	☐	☐	☐	☐
35+	☐	☐	☐	☐

F3 How many years has the primary farm operator worked as a principal operator in beef cow operations?

☐ 0-4
☐ 5-14
☐ 15-24
☐ 25-34
☐ 35+

F4 What is the gender of each operator?

	Principal Operator	2nd Operator	3rd Operator	4th Operator
Male	☐	☐	☐	☐
Female	☐	☐	☐	☐

F5 What is the highest level of education earned by each operator?

	Principal Operator	2nd Operator	3rd Operator	4th Operator
High School	☐	☐	☐	☐
Some College	☐	☐	☐	☐
Technical/Community College Graduate	☐	☐	☐	☐
Bachelors Degree	☐	☐	☐	☐
Masters Degree or greater	☐	☐	☐	☐

F6 If Bachelors, Masters or greater degree was earned, what was the major course of study?

	Principal Operator	2nd Operator	3rd Operator	4th Operator
Ag Econ/Ag Business	☐	☐	☐	☐
Animal Science	☐	☐	☐	☐
Business	☐	☐	☐	☐
Crop and Weed Science	☐	☐	☐	☐
Soil Science	☐	☐	☐	☐
Other please list	☐	☐	☐	☐

F7 Does the farm hire seasonal help?

- ☐ Yes, full-time
- ☐ Yes, part-time
- ☐ No

F8 How many times per year do the operators have contact with the NDSU Extension Service?

	Principal Operator	2nd Operator	3rd Operator	4th Operator
0	☐	☐	☐	☐
1	☐	☐	☐	☐
2-3	☐	☐	☐	☐
4+	☐	☐	☐	☐

F9 What is your interaction with Extension Service programming?

	Principal Operator	2nd Operator	3rd Operator	4th Operator
Group meetings	☐	☐	☐	☐
Internet based	☐	☐	☐	☐
One-on-one consultations	☐	☐	☐	☐
Workshops/tours	☐	☐	☐	☐
None	☐	☐	☐	☐

F10 How many industry-related organizations are you a member of?

	Principal Operator	2nd Operator	3rd Operator	4th Operator
0	☐	☐	☐	☐
1	☐	☐	☐	☐
2	☐	☐	☐	☐
3+	☐	☐	☐	☐

F11 Please list the industry-related organizations of which operators are a member of.

____

____

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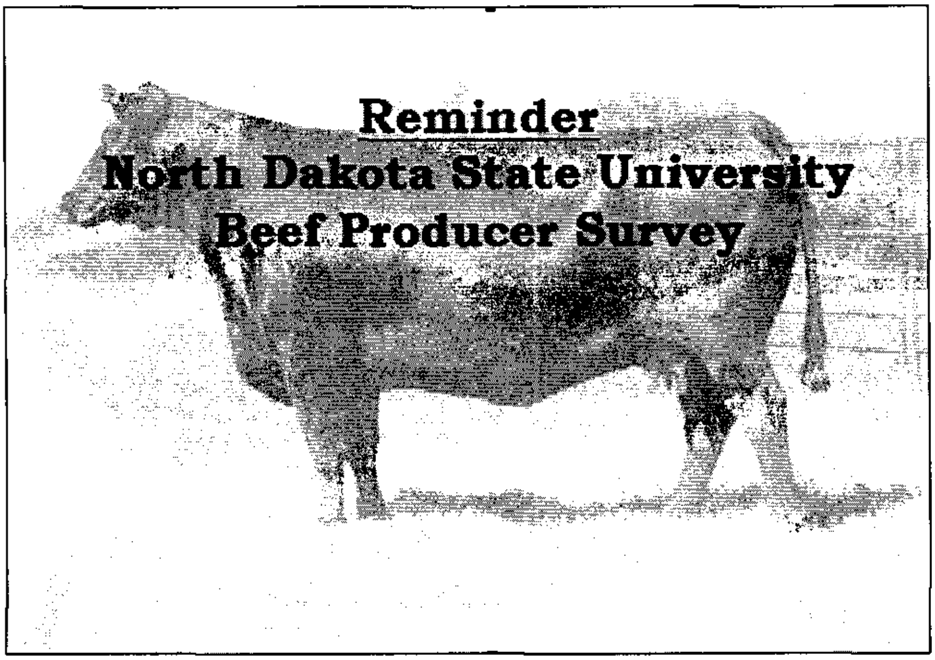

Dear North Dakota Beef Producer:

Thank you if you have already completed the ND Beef Producer survey you recently received. This is a reminder that surveys are requested back by Jan 1st, 2011.

If you need another survey, you may obtain one at:
http://www.ext.nodak.edu/homepages/aedept/staff/bio_hadrich_j.html

For more information, contact Dr. Joleen C. Hadrich by email: joleen.hadrich@ndsu.edu or phone: 701.231.5721

NDSU