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AN ANALYSIS OF FACTORS INFLUENCING ADOPTION OF BMPS AMONG LOUISIANA SUGARCANE PRODUCERS

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ABSTRACT

Multivariate probit analysis of BMP adoption, based on Louisiana sugarcane producer data, indicates that education and cost-sharing programs are effective means of increasing adoption rates. Results also indicate that contemporaneous correlation exists within and between management measures, implying a policy strategy of coordinating education and cost-sharing programs to maximize effectiveness.

PROBLEM STATEMENT

The Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) require that each state participating in the Coastal Zone Management Act submit a Coastal Nonpoint Pollution Control Program (CNPCP) to the Secretary of Commerce and the U.S. Environmental Protection Agency for approval. The program must include Aenforceable policies and mechanisms to implement the applicable requirements of the Coastal Nonpoint Pollution Control Program of the State required by section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990. @

The Clean Water Act, as amended in 1987, requires all States to develop policies and mechanisms to control nonpoint sources of pollution. Section 319 requires that States address nonpoint pollution by assessing nonpoint source pollution problems and causes within the State, adopting management programs to control the nonpoint source pollution, and implementing the management programs.

The State of Louisiana is applying a voluntary approach to the implementation of the Louisiana Coastal Nonpoint Pollution Control Program (CNPCP). The State has developed a statewide comprehensive program that addresses the requirements of both Federal Acts by using enforcement of existing State laws to correct for violations when they occur.

For agriculture, the program includes the establishment of a water quality monitoring system and the voluntary adoption of Best Management Practices (BMPs). The basic position is to emphasize the need to use the so-called ›bad actor= approach. That is, Louisiana proposes to enforce the Louisiana Water Control Law (R.S. 30:2076), and the Water Quality Regulations (LAC 33:IX) whenever a violation exists.

The Louisiana Department of Environmental Quality (LDEQ) considers that Aonce education of producers has occurred, and technical assistance and cost share assistance have been offered, if a farmer/producer still does not implement management measures, then the

subsequent discharges would be intentional and subject to enforcement action or permitting. @ At the same time, educational and technical assistance programs will be developed that will allow the expansion of the area covered by the program as the need arises.

OBJECTIVES

The objectives of this study were to:

1) assess the current rate of BMP adoption among sugarcane producers in Louisiana;

2) determine the level of compliance under current and future scenarios of Federal guidelines for BMP adoption; and

3) and analyze the policy implications of the findings and suggest policy alternatives.

STUDY AREA AND DATA COLLECTION

Sugarcane production in Louisiana is limited to twenty-one parishes in the southern half of the state (Figure 1). The Louisiana Cooperative Extension Service identified 943 sugarcane producers in the study area. Mail surveys were sent to all identified producers during March-April, 1999. A total of 223 completed surveys (24% response rate) were included in the empirical analysis.

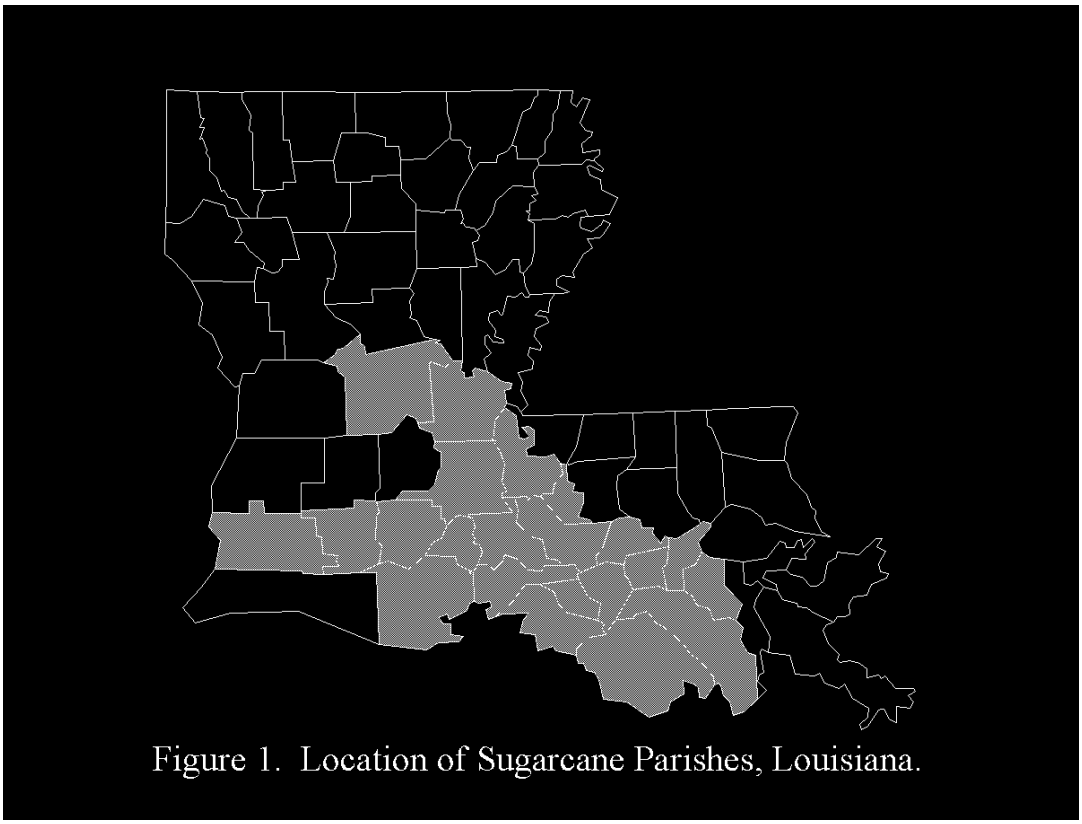

Figure 1. Location of Sugarcane Parishes, Louisiana.

METHOD OF ANALYSIS

Three different types of management measures identified by Federal EPA guidelines were included in the analysis:

1) soil erosion and sediment control;

2) nutrient management; and

3) pesticide management.

Multiple BMP alternatives were also identified within each management measure (shown in Tables 1-3). The principal hypothesis of this study was that the error terms were contemporaneously correlated both within as well as between management measures. Therefore, a multivariate construct was required.

Multivariate probit was the theoretical option of analysis selected. Given the number of dependent variables to be considered, it had the practical obstacle of evaluating higher-order multivariate normal integrals (Greene, 1997). Nevertheless, recent developments have produced methods to obtain accurate estimates of multivariate normal integrals based on simulations by Markov chain Monte Carlo simulations (Chib and Greenberg, 1998) and other numerical techniques (Greene, 1997; Bock and Gibbons, 1996).

Because it was hypothesized that the error terms across the different BMPs to be evaluated were contemporaneously correlated, a multivariate probit approach was undertaken to account for the correlation of the disturbances across equations. The general formulation (Greene, 1998) is:

$$y_{im}^* = \beta_m' \mathbf{X}_{im} + \varepsilon_{im},\ m = 1,...,M$$

$$y_{im} = 1 \text{ if } y_{im}^* > 0, \text{ and 0 otherwise,}$$

where ε_{im}, m = 1,...,M are distributed as multivariate normal with mean vector **0** and covariance matrix **R** with diagonal elements equal to 1. The probabilities that enter the log-likelihood are computed using the GHK (Geweke, Hajivassiliou, Keane) simulation method.

A screening process was implemented through univariate probit models, as the basis to the final development of multivariate probit models both within management measures and between management measures. Four phases were defined in the process of constructing a series of multivariate probit structures for the overall analysis of the present study.

In Phase I, all potential explanatory variables were included in the single-probit (univariate) empirical models for each Best Management Practice. In Phase II, only those regressors that were significant in Phase I, at least at the 25% significance level, were included in the models, to ensure convergence of the multivariate models to be constructed and provide more efficient estimates (Hendry, 1995; Banerjee and Hendry, 1997). Coefficients were evaluated to

ensure that they did not change significantly, and more importantly, that they did not change signs.

All regressors included in the single probit models of Phase II were included in Phase III. Phase III consisted of the construction of Multivariate Probit models for each of the management measures to evaluate the hypothesis that contemporaneous correlation exists among the error terms within each management measure. This would imply that adoption of practices within a measure were related.

Finally, Phase IV was developed to evaluate the hypothesis that error terms were correlated across management measures. Two scenarios of compliance were evaluated. As indicated previously, one scenario was constructed assuming that the requirement for compliance demands at least two management practices be implemented for each management measure. The second scenario assumed the possibility of more stringent requirements, meaning that at least three management practices be implemented for each management measure.

Tables 1-3 list the management practices evaluated in this study. The tables also illustrate the developmental relationship between the EPA Guidance, NRCS practices and LSU Agricultural Center recommendations. The LSU recommendations were based on an evaluation of NRCS conservation practices in terms of economic feasibility. NRCS practices, in turn, are the basis for EPA Guidance recommendations.

SUMMARY OF DESCRIPTIVE STATISTICS

Table 4 contains a summary of descriptive statistics for selected variables in the sugarcane producer survey. A brief explanation of the variables follows.

Institutional Variables

Institutional factors that may have an impact on the decision to adopt or not adopt BMPs were evaluated through several different variables. Awareness of legislation related to improving water quality was assessed through two questions. One question asked whether the respondent was aware of the Coastal Nonpoint Pollution Control Program as specified in the Coastal Zone Management Act (ACZMA), to which only 44 percent responded positively, leaving a significant 56 percent unaware of the existence of such legislation. The second question aimed to determine awareness of the Clean Water Act (ACWA), to which 65 percent responded positively.

Respondents were also asked whether they have ever heard the term Best Management Practices (HBMPT), to which 65 percent indicated yes. An interesting result was that out of those who had heard about Best Management Practices, 78 percent indicated that they believed that the use of Best Management Practices for sugarcane would improve the quality of water when compared to conventional production practices (BMPIWQ).

Results of the survey indicated that respondents met with extension service personnel or attended educational programs sponsored by extension service (TMES) an average of 3.38 times

during 1998. Respondents also indicated that they attended an average of 2.57 grower meetings (TAGM) in the same period.

Participation in cost-sharing programs was an important institutional factor, with 63 percent of the respondents indicating that they had participated in cost-sharing programs (PCS) for at least one of the practices that had offered that option in the study area. The following practices have had cost-sharing programs in the past: land smoothing, precision leveling, and/or row arrangement; use of drop pipes or other grade stabilization structures to reduce erosion; use of alternative sources of nutrients (manure, cover crops, sludge, or any other organic matter); and, use of a containment facility for mixing, loading and storing farm chemicals. Use of this variable involved aggregation to measure overall participation (represented as a binary variable for yes or no) in all empirical modeling, under the assumption that cost-sharing participation in at least one practice may have an impact on the adoption of other practices.

One variable in the assessment measured environmental attitudes. The variable asked whether the respondent believes that agriculture reduces the quality of water coming off farmland (ARWQ). Only 38 percent of the respondents think agriculture affects water quality.

Economic and Socio-Economic Variables

The average response for self perception of risk (SPRISK) was 4.17 on a scale of 1 to 10, which indicated a tendency toward risk aversion. Risk attitude, as measured by an investment venture (RISKB), averaged 1.67, where 1 was the level for maximum risk aversion and 4 was the value of least risk aversion or more risk taking. About 30 percent of the respondents indicated that their firm debt level was more than 40 percent of the total estimated value of farm business (DEBTR).

The average AGE of respondents was 48 years. About 95 percent of the respondents were males.

When asked whether they planned to pass the farm operation on to a member of their family (PASS), 68 percent responded yes. The percent of total gross household income from farming (PINOFF) averaged 85 percent. The tenure status, as measured in terms of the ratio of leased acreage over total farm size (TENURE), indicated that 78 percent of the land was leased.

Finally, 30 percent of the respondents were organized as individual operations, 20 percent were organized in partnership (ORG1), 42 percent were family corporations (ORG2), and 8 percent were non-family corporations (ORG3).

CURRENT RATE OF BMP ADOPTION AND COMPLIANCE UNDER ALTERNATIVE SCENARIOS

Current adoption rates, based on survey results, are shown in Table 5. The current EPA Guidance indicates that a producer would be in compliance if he/she adopted at least one BMP. The survey indicates that Louisiana sugarcane producers would likely be in compliance under

this criteria, with over 90 percent of respondents adopting at least one of the indicated BMPs in each management measure.

However, as environmental policy evolves, it is likely that higher compliance requirements would be imposed in the future. A requirement of adopting at least two BMPs per management measure reduces the percent in compliance slightly for sediment control and pesticide management, and a significant drop to 68 percent for the nutrient management measure.

Increasing the compliance requirement to three BMPs per management measure reduces compliance to about half the producers in the sediment control and pesticide management measures. Only 12 percent of the producers adopted all three nutrient management measures in the study.

The management practices, listed in Tables 1-3, served as the binary dependent variables in the probit models included in the study. The independent variables considered in the models, along with their expected sign, are shown in Table 6.

RESULTS WITHIN MANAGEMENT MEASURES

Phase III of the analysis looked for relationships between practices within each of the management measures. Table 7 presents the results of this analysis, listing the statistically significant independent variables for models of each management practice as the dependent variable. The results, by management measure, are briefly discussed below.

Soil Erosion and Sediment Control

The signs of all significant variables were as expected, with the exception of awareness of the NPS program under the Coastal Zone Management Act (ACZMA) in S3.

The correlation coefficients (not shown in Table 7) were all positive, with significant contemporaneous correlation of the error terms between S1 and S3, and S1 and S4, at the five percent significance level. The correlation coefficient for practices S2 and S4 was significant at the ten percent level.

Nutrient Management

The signs of all significant variables were as expected.

The error terms were highly correlated between N1 and N2 at the one percent significance level. This supports the hypothesis of contemporaneous correlation among the management practices within the nutrient management measure.

Pesticide Management

The risk, debt, and age variables all had incorrect signs. The sign for the variable in P4 for the ratio of leased to owned land (TENURE) was also incorrect.

The correlation coefficient for the error terms of practices P1 and P3 were significant at the one percent level. The correlation coefficient for practices P1 and P4 was significant at the five percent level.

RESULTS BETWEEN MANAGEMENT MEASURES

The analysis also looked for relationships between the management measures. Tables 8 and 9 present the results of this analysis, listing the statistically significant independent variables for models of each management measure as the dependent variable.

The analysis included two scenarios: 1) a requirement of at least two management practices per management measure (Table 8) and 2) a requirement of at least three management practices per management measure (Table 9). These scenarios represent increasing levels of future compliance.

Two Management Practices Per Management Measure (Table 8)

The signs of all significant variables were as expected, with the exception of the firm's debt level (DEBTR).

Contemporaneous correlation (not shown in Table 8) between Sediment Control and Nutrient Management, and between Sediment Control and Pesticide Management, were significant at the 1 percent level. The correlation coefficient for the error term between Nutrient Management and Pesticide Management was significant at the 5 percent level.

This suggests that the analytical framework proposed was the correct one, and that policy alternatives to improve adoption of BMPs should be treated accordingly.

Three Management Practices Per Management Measure (Table 9)

The signs of all significant variables were as expected, with the exception the firm's debt level (DEBTR) and the age of the respondent (AGE).

There was a positive contemporaneous correlation (not shown in Table 9) of the error terms between the Sediment Control and Nutrient Management measures, significant at the 5 percent level. This suggests the need to analyze and treat management measures simultaneously, rather that independently.

SUMMARY OF RESULTS

- More than 90 percent of the responding producers were implementing at least one best management practice for each of the best management measures.

- Results indicate that the decision to adopt BMPs was significantly influenced by the number of times producers met with extension service personnel and the number of grower meetings attended in the previous year.

- Producers who participated in cost sharing were more likely to implement management practices for which cost sharing did not exist.

- Risk of yield loss was not a factor in the adoption of the BMPs included in the study.

- The hypothesis that the error terms were contemporaneously correlated both within as well as between management measures was supported by the results of the multivariate probit analysis. This supports the contention that education programs designed to increase BMP adoption should consider the benefits within and across management measures to maximize effectiveness.

POLICY RECOMMENDATIONS

Based on the outcomes from the current study, the following general recommendations are made:

- More intensive education programs to inform producers of the existence and implications of federal and state laws and regulations affecting production decisions.

- Develop educational programs that focus on explaining how agriculture affects water quality, and how BMPs can have a positive impact on water quality.

- Education programs that explain when it is appropriate to adopt specific BMPs. Emphasis should be placed on the costs and benefits of implementing BMPs.

- Continue to utilize the Louisiana Cooperative Extension Service and grower organizations as primary sources of educational information.

- Investigate opportunities to cost share the adoption of BMPs, where feasible.

- Study the relationship between capital investment in BMPs and rate adoption. Focus on the financial appropriateness of such investment.

- Study the relationship between leased land and implementation of BMPs. What influence can land owners have on BMP adoption on leased land?

REFERENCES

Banerjee, A.and D. Hendry. *The Econometrics of Economic Policy*. Blackwell Publishers, Oxford, 1997.

Bock, R. D., and R. D. Gibbons. "High Dimensional Multivariate Probit Analysis." *Biometrics.* 52(1996):1183-1194.

Chib, S. and E. Greenberg. "Analysis of Multivariate Probit Models." *Biometrika.* 85(1998):347-361.

Greene, W. *Econometric Analysis.* New Jersey: Prentice Hall, 1997.

Hendry, D. *Dynamic Econometrics*, Oxford University Press, Oxford, 1995.

Table 1. Selected BMPs for Erosion and Sediment Control Management Measure, Sugarcane.			
Agricultural Practice	EPA's Guidance Management Pracice(s)	NRCS Practice Name (Number)	LSU Ag. Center BMP Recommnedation
S1 – Do you use any of the following practices to control runoff: land smoothing, precision leveling, and/or row arrangement?		1) Land smoothing (466) 2) Precision land forming (462) 3) Row arrangement (557)	1) Land smoothing 2) Precision land forming 3) Row arrangement
S2 – Do you occupy the fallow period with either succession planted sugar cane or a cover crop such as wheat, soybeans or others?	1) Conservation cropping sequence 2) Cover and green manure crop	1) Conservation cropping sequence (328) 2) Cover and green manure crop (340)	1) Conservation cropping sequence 2) Cover and green manure crop
S3 – Do you delay stubble breakout and maintain crop residue (30% or more) through the winter months?	1) Delayed seed bed preparation 2) Crop residue use	1) Delayed seed bed preparation (354) 2) Crop residue use (344)	1) Crop residue use
S4 – Do you use drop pipes or other structures to reduce bank erosion?	1) Grade stabilization structure	1) Grade stabilization structure (410)	1) Grade stabilization structure

Table 2. Selected BMPs for Nutrient Management Measure, Sugarcane.			
Agricultural Practice	EPA's Guidance Management Pracice(s)	NRCS Practice Name (Number)	LSU Ag. Center BMP Recommnedation
N1 – Do you determine fertilizer applications based on soil testing and expected yields?	1) Soil testing for pH, phosphorous, potassium, and nitrogen. 2) Use of producer-documented yield history and other relevant information to determine realistic crop yield expectations	1) Nutrient management (590)	1) Nutrient management
N2 – Do you use any of the following fertilization practices: split application of nutrients, banded application, slow-release fertilizers?	1) Use of proper timing, formulation, and application methods for nutrients	1) Nutrient management (590)	1) Nutrient management
N3 – Do you utilize alternate sources of nutrients (manure, cover crops, sludge, or any other organic matter)?	1) Manure, sludge, mortality compost, and effluent testing 2) Cover and green manure crop	1) Nutrient management (590) 2) Cover and green manure crop (340) 3) Waste utilization (633)	1) Nutrient management 2) Cover and green manure crop 3) Waste utilization

Table 3. Selected BMPs for Pesticide Management Measure, Sugarcane.			
Agricultural Practice	EPA's Guidance Management Pracice(s)	NRCS Practice Name (Number)	LSU Ag. Center BMP Recommnedation
P1 – Do you base chemical applications (insecticides, Herbicides) on economic thresholds as determined by field scouting?	1) Use of IPM strategies to minimize the amount of pesticides applied	1) Pest management (595 A)	1) Pest Management
P2 - Do you use a containment facility for mixing, loading and storage of farm chemicals?	1) Consider the soil and physical characteristics of the site including mixing, loading, and storage areas for potential for the leaching and/or runoff of pesticides	1) Pest management (595 A)	1) Pest management 2) Pesticide containment facility
P3 - Do you calibrate spray equipment before each use?	1) Recalibrate spray equipment each spray season and use anti-backflow devices on hoses used for filling tank mixtures	1) Pest management (595 A)	1) Pest management
P4 - Do you use any of the following for precise application of chemicals: computer sensing to control flow rates, radar speed determination, electrostatic applicators?	1) Integrated crop management system	1) Pest management (595 A)	1) Pest management

Table 4. Summary Statistics for Selected Variables, Louisiana Sugarcane Best Management Practice Adoption Study.						
Variable	Explanation	Mean	Standard Dev.	Minimum	Maximum	Observations
ACZMA	Awareness of the Coastal Nonpoint Pollution Control Program as specified in the Coastal Zone Management Act.	0.44	0.50	0	1	223
ACWA	Awareness of efforts to control nonpoint sources of water pollution through the Clean Water Act.	0.65	0.48	0	1	223
HBMPT	Have heard the term Best Management Practices (BMPs).	0.65	0.48	0	1	223
BMPIWQ	Thinks the use of BMPs would improve the quality of water.	0.78	0.41	0	1	148
TMES	Number of times farm operator met with extension service personnel or attended educational programs sponsored by the extension service during the last year.	3.38	4.29	0	36	223
TAGM	Number of times farm operator attended grower meetings during the last year.	2.57	1.90	0	15	223
ARWQ	Thinks agriculture reduces the quality of water coming off farmland.	0.38	0.49	0	1	223
PCS	Participation in cost-sharing programs for any of the agricultural practices that have had this option.	0.63	0.48	0	1	223
SPRISK	A continuous variable for self perception of risk attitude.	4.17	2.26	1	10	222
RISKB	Risk attitude as measured by an investment venture.	1.67	0.67	1	4	222

Table 4. Continued.						
Variable	Explanation	Mean	Standard Dev.	Minimum	Maximum	Observations
FSIZE	Total farm size in acres.	1433.21	1279.29	7	12000	223
ORG1	Binary variable equal to 1 if the farm is a partnership 0 otherwise (The basis is individual operation).	0.20	0.40	0	1	223
ORG2	Binary variable equal to 1 if the farm is a family corporation 0 otherwise (The basis is individual operation).	0.42	0.49	0	1	223
ORG3	Binary variable equal to 1 if the farm is non-family corporation, 0 otherwise (The basis is individual operation).	0.08	0.27	0	1	223
PASS	Whether the farm operator plans to pass this farming operation on to a member of his/her family.	0.68	0.47	0	1	223
DEBTR	Whether the firm debt level is more than 40% of the total estimated value of the farm business.	0.29	0.46	0	1	223
AGE	Age in years.	48.08	11.70	21	86	223
SEX	Binary variable for sex.(1=male, 0=female).	0.95	0.22	0	1	223
PINOFF	Percent of total gross household income from farming.	85.16	22.40	1	100	223
TENURE	Ratio of leased acreage over total farm size	0.78	0.35	0	1	223

Table 5. Percent of Respondents Implementing Selected BMPs.					
Management Measure	Management Practice	Percent Adoption	Percent Compliance with at least 1 Practice	Percent Compliance with at least 2 Practices	Percent Compliance with at least 3 Practices
Soil Erosion and Sediment Control	S1	75	92	82	53
	S2	28			
	S3	72			
	S4	67			
Nutrient Management	N1	88	92	69	12
	N2	72			
	N3	13			
Pesticide Management	P1	85	95	86	48
	P2	37			
	P3	90			
	P4	28			

Table 6. Independent Variables and Expected Signs.		
Variable	Description	Expected Sign
ACZMA	Awareness of the Coastal Nonpoint Pollution Control Program as specified in the Coastal Zone Management Act (1=yes, 0=no).	+
ACWA	Awareness of efforts to control nonpoint sources of water pollution through the Clean Water Act (1=yes, 0=no).	+
HBMPT	Have heard the term Best Management Practices (BMPs) (1=yes, 0=no).	+
TMES	Number of times farm operator met with extension service personnel or attended educational programs sponsored by the extension service during the last year.	+
TAGM	Number of times farm operator attended grower meetings during the last year.	+
ARWQ	Thinks agriculture reduces the quality of water coming off farmland (1=yes, 0=no).	+
PCS	Participation in cost-sharing programs for any of the agricultural practices that have had this option (1=yes, 0=no).	+
SPRISK	A continuous variable for self perception of risk attitude.	+
RISKB	Risk attitude as measured by facing the respondent to investing in a specific farm venture.	+
FSIZE	Farm size in acres.	+

Table 6. Continued.

Variable	Description	Expected Sign
ORG1	Binary variable equal to 1 if the farm is a partnership 0 otherwise (The basis is individual operation)	+/-
ORG2	Binary variable equal to 1 if the farm is a family corporation 0 otherwise (The basis is individual operation)	+/-
ORG3	Binary variable equal to 1 if the farm is non-family corporation 0 otherwise (The basis is individual operation)	+/-
PASS	Whether the farm operator plans to pass this farming operation on to a member of his/her family (1=yes, 0=no).	+
DEBTR	Whether the firm=s debt level is more than 40% of the total estimated value of the farm business (1=yes, 0=no).	-
AGE	Age of respondent in years.	-
SEX	Binary variable for sex of respondent (1=male, 0=female).	-
EDU	Years of education completed by respondent.	+
PINOFF	Percent of total gross household income off farm.	+/-
TENURE	Ratio of lease acreage over total farm size	-

Table 7. Significant Variables, Model Analysis Within Management Measures (Phase III).											
Variable	S1	S2	S3	S4	N1	N2	N3	P1	P2	P3	P4
ACZMA			(-) **								
TMES	+ **				+ ***		+ ***	+ ***			+ ***
TAGM		+ *				+ ***	+ **				
ARWQ			+ *		+ **	+ **		+ *			
PCS	+ *		+ **	+ *							
SPRISK								(-) ***			
FSIZE		+ **			+ *			+ ***			
ORG1									+ ***		
ORG2				+ ***							
DEBTR									(+) *		
AGE					- ***						(+) **
SEX		- **								+ *	
EDU	+ **	+ **		+ ***							+ *
TENURE									- *		(+) ***

Significance Levels: 1 Percent*, 5 Percent**, 10 Percent***

+ and – Indicate Sign Of The Estimated Coefficient

( ) indicates Incorrect Sign of Estimated Coefficient

Table 8. Significant Variables, Model Analysis Between Management Measures, Requiring Two Management Practices Per Management Measure (Phase IV).			
Variable	Soil and Sediment Control	Nutrient Management	Pesticide Management
TMES	+ ***		+ **
TAGM		+ *	
ARWQ		+ ***	+ **
PCS	+ *		
FSIZE		+ **	
DEBTR		(+) ***	(+) ***
EDU	+ *		
Significance Levels: 1 Percent*, 5 Percent**, 10 Percent***			
+ and – Indicate Sign Of The Estimated Coefficient			
( ) indicates Incorrect Sign of Estimated Coefficient			

Table 9. Significant Variables, Model Analysis Between Management Measures, Requiring Three Management Practices Per Management Measure (Phase IV).

Variable	Soil and Sediment Control	Nutrient Management	Pesticide Management
TMES	+ **	+ **	
TAGM		+ ***	
PCS	+ *		
FSIZE		+ ***	+ ***
DEBTR	(+) **		(+) *
AGE			(+) ***
EDU	+ **		
TENURE	- ***		- ***

Significance Levels: 1 Percent*, 5 Percent**, 10 Percent***

+ and – Indicate Sign Of The Estimated Coefficient

( ) indicates Incorrect Sign of Estimated Coefficient