# DETERMINANTS OF THE ADOPTION OF MANURE MANAGEMENT PRACTICES IN THE MIDWEST

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**ABSTRACT.** *Four manure management practices--soil nutrient testing, manure nutrient testing, land application based on phosphorus need, and injection--were examined to determine the factors that affect their adoption. Data, from a mail survey, were analyzed using logistic regressions. For most of the practices examined, off-farm income, location, perceived profitability and perceived complexity are significant variables. Other significant variables include the use of public information, land tenure, water quality perceptions and discomfort, in terms of odor.*

***Keywords.*** *Manure management, nutrient management, adoption.*

## INTRODUCTION

The purpose of this study is to identify factors affecting the adoption of manure management practices by livestock farmers in order to improve and target environmental policies and extension programs. Various practices associated with land application of manure were examined, including soil testing, manure testing, application based on phosphorus need, and injection of manure into the soil during application. Data regarding whether or not farmers perform the above-mentioned practices as well as farmer characteristics, farm characteristics and perceptions of the practices were obtained through a mail survey of 1500 farmers in Missouri and Iowa.

## CONCEPTUAL MODEL

Since the objective of this research is to determine factors affecting the adoption of manure management practices, the dependent variables are whether or not a practice is performed while the independent variables are farmer and farm characteristics as well as perceptions of the practice. The

purpose of the analysis is to determine a probability associated with manure management practice adoption based on the independent variables. Therefore, a binary logit model for each practice is used to test the hypotheses. Below is a mathematical representation of the models.

$$\log\left[P_u/\left(1-P_u\right)\right] = \alpha + \sum_{i=1}^{n}\beta_i X_i + \sum_{j=1}^{m}\beta_j X_j + \sum_{k=1}^{l}\beta_k X_k$$

where $P_u$ = Probability of performing the manure management practice

$(1-P_u)$ = Probability of not performing the manure management practice

$X_i$ = Farm characteristics

$X_j$ = Farmer characteristics

$X_k$ = Perceptions of the manure management practice

The statistical hypotheses used are $H_0$: $\beta = 0$ and $H_a$: otherwise. If it is found that $\beta$ is significantly greater or less than zero, the null hypothesis, $H_0$: $\beta = 0$, can be rejected and it can be concluded that the variable impacts the adoption decision. A positive (negative) parameter estimate ($\beta$) suggests a higher (lower) likelihood of performing the practice.

## RESULTS

The overall survey response rate was approximately 51%, although only the subset of livestock farmers was used for the analysis. The results from each logit model, as well as the variables used, are described in the Appendix.

### SOIL TESTING

Ribaudo, *et al.* indicate that more land is needed for manure application based on nutrient need; therefore, it is important that farmers not only know the nutrient content of their manure but also the soil nutrient content. Approximately 63% of 217 respondents indicated that they test soil nutrient content at least every two years.

The logit results indicate that off-farm income, expectation to continue farming, perceptions of profitability, perceptions of water quality, and perceptions of complexity are significant in determining

which farmers test the soil. The results suggest that farmers with $25,000 to $49,999 of off-farm income are less likely than those in the base group with $10,000 to $24,999 to test soil at least every two years. Also, farmers who plan to continue farming are less likely to practice soil testing.

As Rogers indicates, perceptions play an important role in the adoption decision. Results suggest that farmers who perceive soil testing to be profitable are more likely to soil test, while those who perceive it to be complicated are less likely to do it. Similar to past studies, which indicate that environmental empathy can impact the adoption of agricultural conservation technologies (Nowak), farmers who are both concerned about water quality and believe that soil testing can help improve water quality are more likely to practice soil testing.

## MANURE TESTING

For the practice of manure testing, the sub-sample consisting of those who said they applied manure was used. Thus, there are 151 observations in this sample, of which about 21% said they tested the manure for nutrient content before applying it.

Results indicate that off-farm income and use of public information are important farmer characteristics affecting the adoption of manure testing. Those farmers with $100,000 or more of off-farm income are more likely than the base group of $10,000 to $24,999 to test manure before application. Likewise, those who use public information (from extension or Natural Resource Conservation Service staff) and find it important are more likely to test manure.

Land tenure and location are important farm characteristics affecting whether or not a farmer tests manure. Land tenure is measured in terms of percent of total acres rented. Interestingly, it is found that the higher the proportion of rented land, the more likely they are to test manure. Also, farmers in Iowa are more likely than those in Missouri to test manure.

Perceptions of profitability, water quality and complexity are also important determinants of manure testing. Those who perceive manure testing to be profitable are more likely to do it than those who perceive it as unprofitable. Likewise, when a farmer is both concerned about water quality and

believes that testing manure will help improve water quality, he or she is more likely to test manure. Finally, those who perceive manure testing to be complicated are less likely to do it.

### APPLY BASED ON PHOSPHORUS NEED

Application based on phosphorus need is recommended since phosphorus build-up is occurring. Again, the sub-sample of respondents who applied manure to land was used as the basis for the analysis. Because some farmers did not respond to this particular set of questions, the number of observations is 146, of which approximately 49% responded that they apply manure based on phosphorus need.

Results indicate that those with at least some college education are more likely to apply manure based on phosphorus need. Also, those with off-farm income of $25,000 to $49,999 are less likely than the base group ($10,000 to $24,999) to apply manure based on phosphorus need. Those renting a greater proportion of their land are less likely to adopt this practice. Those farmers with farm sales less than the base category of $100,000 to $249,999 are less likely to apply manure based on phosphorus while those with higher farm sales are more likely to do it. Also, it is found that Iowa farmers are more likely to adopt this practice than those in Missouri. Again, it is found that those who perceive it to be a profitable practice are more likely to do it than others.

### INJECT MANURE

A sample based on farmers who have liquid manure systems, or in other words injectable manure, was used for the practice of injecting manure into the soil. Due to some missing responses, this sample only has 58 observations of which approximately 38% responded that they inject manure. In addition, the smaller sample size required that the lowest two farm sales categories be grouped together to create a category of farm sales from $0 to $99,999. Also, there were no farmers in this sample with off-farm income of $100,000 or more; these categories are thus blank in the table.

It was found that farmers with off-farm income of $50,000 to $99,999 are less likely than the base group to inject manure, which would indicate that opportunity cost of time may be a factor. In

addition, those who perceive the practice to be profitable and not complicated are more likely to practice it than others. Those who responded that the smell of manure bothers them are also more likely to inject manure than others. This may indicate that a utility, rather than a profitability framework is needed.

## CONCLUSION

Farmer and farm characteristics as well as perceptions are all important in determining the adoption of manure management practices. Understanding the barriers to adoption of best management practices will allow improved design of technologies, policies and educational programs. Further research is needed on how off-farm income affects the adoption decision. Complexity is a limiting factor so research on more user-friendly technologies is warranted. Lowering costs or increasing benefits involved with the practices is another obvious need. Finally, odor has not previously been included in adoption studies and warrants further research.

## REFERENCES

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# Appendix

**Table 1. Results of Logit Models for manure management practices.**

| Variable | Description | Soil Test n = 217 | Manure Test n = 151 | P app n = 146 | Inject n = 58 |
|---|---|---|---|---|---|
| Intercept | | 0.53 | -5.98 | 1.37 | -0.54 |
| **Farmer Characteristics** | | | | | |
| Age | Age in years | 0.01 | -0.03 | -0.03 | -0.02 |
| Education | Dummy; Some college = 1, otherwise = 0 | 0.37 | -0.62 | 0.85* | -3.55 |
| Off farm income (0) | No off-farm income (compared to base category--$10,000 to $24,999) | 0.08 | -1.07 | -0.06 | -0.53 |
| Off farm income (0-9.9) | $0 to $9,999 household off-farm income (compared to base category) | 0.10 | 0.59 | 0.77 | 3.65 |
| Off farm income (25-49.9) | $25,000 to $49,999 off-farm income (compared to base category) | -0.62* | -1.42* | -1.16** | 2.38 |
| Off farm income (50-99.9) | $50,000 to $99,999 off-farm income (compared to base category) | -0.55 | -0.16 | -0.83 | -5.02* |
| Off farm income (100+) | $100,000 or more of off-farm income (compared to base category) | 1.35 | 3.09** | 1.64 | --- |
| Public Information Use & Importance | Use and find information from NRCS & extension agents important | 0.44 | 2.17*** | 0.74 | 1.89 |
| **Farm Characteristics** | | | | | |
| Total Acres | Total number of acres | 0.00 | 0.00 | 0.00 | 0.00 |
| Percent Rented | Percent of total acres rented | 0.60 | 3.13** | -1.55* | 2.24 |
| AU | Animal Units | 0.00 | 0.00 | 0.00 | 0.00 |
| Farm Sales (0-9.9) | $0 to $9,999 annual farm sales (compared to base--$100,000 to $249,999) | 0.52 | 0.78 | -1.67* | --- |
| Farm Sales (10-99.9) | $10,000 to $99,999 annual farm sales (compared to base category) | -0.50 | 0.92 | -0.60 | 4.29[a] |
| Farm Sales (250-499.9) | $250,000 to $499,999 annual farm sales (compared to base category) | 0.21 | -0.52 | 2.38*** | -3.98 |
| Farm Sales (500+) | $500,000 or more of annual farm sales (compared to base category) | -0.77 | -0.68 | -0.13 | 2.28 |
| Location | Dummy; Iowa = 1, Missouri = 0 | 0.43 | 2.39** | 1.40** | 1.90 |
| Type of Manure | Dummy; liquid manure = 1, otherwise = 0 | 0.01 | 1.26 | 0.48 | --- |
| Continue Farming | Dummy; plan to continue farming in 5 years = 1, otherwise = 0 | -1.41** | -1.18 | 1.18 | 7.41 |
| **Perceptions** | | | | | |
| Profitable | Perceive practice as profitable (Likert; 1 = agree, 5 = disagree) | -1.26*** | -1.94*** | -1.20*** | -4.56* |
| Improves WQ * WQ concern | Interaction variable. Practice improves water quality & respondent is concerned about water quality in his/her county (Likert; 1 = agree) | 0.16* | 0.25* | 0.05 | -1.90 |
| Time Consuming | Practice is perceived as time consuming (Likert; 1 = agree, 5 = disagree) | 0.28 | 0.26 | -0.25 | -2.70 |
| Complicated | Practice is perceived as complicated (Likert; 1 = agree, 5 = disagree) | 0.40** | 1.43*** | 0.21 | 5.61* |
| Smell | Smell of manure bothers respondent (Likert; 1 = agree, 5 = disagree) | --- | --- | --- | -3.19* |
| Goodness-of-fit Statistics: | Model Chi-square (p-value) | 100.01 (<0.001) | 85.98 (<0.001) | 79.61 (<0.001) | 52.73 (<0.001) |
| | Pseudo (McFadden) $R^2$ | 0.3693 | 0.4341 | 0.4203 | 0.5971 |

Notes: ***, **, and * indicate that the variable is significant at the 0.001 level, 0.05 level, and 0.10 level respectively.

a) Farm sales of $0 to $99,999 was used for this model due to low levels of variability when using both categories