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# The Long and Short of Groundwater Education for Michigan Farmers

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PREVIOUS ARTICLE | ISSUE CONTENTS | NEXT ARTICLE

# The Long and Short of Groundwater Education for Michigan Farmers

**Abstract**
The Michigan Groundwater Stewardship Program (MGSP) has pursued a variety of educational strategies to educate farmers about groundwater risks associated with pesticide and fertilizer use. This article describes a 4-year study investigating program effectiveness. The results suggest that Farm*A*Syst has been a successful intervention for promoting farm management practices. Yet, despite the apparent changes in some farm management practices, little impact on groundwater literacy has been achieved. We suspect adoption of these practices may be driven by financial incentives, rather than an improved understanding of the need to assess and evaluate risks to their local groundwater supplies.

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## Introduction

We all hope that Extension education programs empower learners to make lasting changes that improve their lives. Empowerment is especially desirable when addressing issues that directly affect an individual's quality of life via health and safety concerns. One prime example relates to efforts to educate the public about steps they can take to protect their drinking water.

Agriculture poses particular risks to groundwater because of the widespread use of pesticides and liquid fertilizer in concentrated quantities (Moody, 1990). In agricultural states, farmers play an especially key role in land use to protect groundwater supplies that often provide drinking water to many communities.

Though most Americans express a strong concern for water quality, they are not well informed about water quality issues, sources of pollution, and ways to prevent it (National Environmental Education and Training Foundation, 1999; Marketing Horizons, Inc., 1997). Jones and Jackson (1990, p.236) determined in their study of Wisconsin farmers that they "lacked the means to evaluate their farms' potential pollution sources, including management activities and to draw conclusions on the possible effects and options to reduce risks." Some of the risky practices they discovered included the improper storage and handling of fertilizers and pesticides. The need to educate and promote behavior changes in farm management and promote safer groundwater practices among farmers was apparent.

## Theories of Behavior Change

Research has overturned the long-standing and naive assumption that there is a direct and linear

relationship between providing information to individuals and changing the behaviors of those clients (Hungerford & Volk, 1990; Newhouse, 1990). Knowledge of groundwater and its sources of contamination may be only one factor among many antecedents that influence farmer behavior. Other important psychological variables include attitudes toward the behavior(s), perceived self efficacy, social norms, and knowledge of and perceived competencies with behavior strategies (Azjen & Fishbein, 1980; Hungerford & Volk, 1990).

Risk perceptions are likely another important criteria that has an impact on decision-making (Slovic, 1987). Raedeke, Nilon, and Rikoon (2001) found that farmers' who believed their land uses had impacts on the local watershed were more interested in participating in conservation programs. Yet it has been shown that even farmers who express higher levels of environmental concern are just as likely to perceive high risks of adopting new technologies aimed at addressing soil and water conservation problems (Napier, Camboni, & Thraen, 1986).

In order to accomplish lasting impacts, educational strategies need to emphasize skills that empower learners in order to increase the likelihood that knowledge gains will lead to permanent adoption of new practices or ways of living. Dwyer, Leeming, Cobern, Jackson, and Porter (1993) termed the behavior change strategies alluded to here as "antecedent strategies" because they attempt to bring about changes in the attitudinal determinants of behavior. They also described "consequence" strategies that focus on rewards and punishments as a to way influence behavior. Economic incentives for taking (or not taking) some action are an example of a consequence strategy.

## Program Background

Since 1995, The Michigan Groundwater Stewardship Program (MGSP) has pursued a variety of educational strategies to educate pesticide and fertilizer users about risks to groundwater and suggest ways to minimize those risks. This article describes results of a 4-year research evaluation done to track the effectiveness of the MGSP in Michigan.

In an effort to be proactive in preventing pollution, the Michigan legislature created a special funding mechanism—a tax on pesticide and fertilizers users—earmarked for education about the wise use of these products. This initiative led to the creation of the Michigan Groundwater Stewardship Program, housed in and administered by the Michigan Department of Agriculture (MDA) in cooperation with Michigan State University Extension (MSUE) and the USDA Natural Resource Conservation Service (NRCS). Since its inception, the focus of MGSP has been to provide voluntary, confidential risk assessments, education and demonstration projects, technical assistance, and cost-share money to promote the adoption of farm management practices that minimize risks to groundwater.

The implementation of these groundwater education and outreach efforts is conducted by a network of trained groundwater technicians who are employed by local grantee organizations (usually Conservation Districts) but whose activities are directed through partnerships with regional Extension offices. The keystone in MGSP's approach to education and outreach with farmers has been the deployment of the Farmstead Assessment System (Farm*A*Syst or FAS), a nationally developed risk assessment tool.

## Groundwater Education Approach

Since 1995, groundwater technicians have conducted Farm*A*Systs on 8,600 of Michigan's farms (MGSP, 1999). Through these voluntary and confidential assessments, technicians provide farmers with a three-ring binder that contains fact sheets and worksheets for calculating various risks to groundwater. It is the goal of Extension that the FAS workbook serve to expand farmer knowledge regarding groundwater and the risks presented by common farming practices involving the storage and use of pesticides and fertilizers. These individualized educational interventions are designed for the technician to train the farmers in use of the FAS reference book and to empower farmers to assess their own groundwater risk factors now and in the future.

The on-site visit also provides technicians an opportunity to share additional information with farmers regarding cost-share opportunities available through MDA grants, local stewardship activities, or other additional programs that provide technical assistance or services that encourage groundwater stewardship behaviors. In addition, all program participants are eligible to apply for cost-share through the MGSP. The types of practices eligible vary based on funding availability and local priorities.

## Evaluation Methods

In order to assess the effectiveness of the program, we drew upon the results of two separate studies. First, we employed a statewide baseline mail survey in 1996 that was sent to a randomly selected sample of 400 Michigan farmers drawn from the Michigan Agricultural Statistics Service's database. The mail survey measured groundwater knowledge, risk perceptions posed by various materials and land uses to groundwater contamination, and awareness related to groundwater education and technical assistance programs.

In 2000, the baseline survey was repeated with another sample of 400 Michigan farmers drawn

from the same source to assess changes in knowledge and attitudes. The same survey instrument was used, with an additional set of seven questions added, targeting groundwater stewardship farm practices. Response rates for the survey in 1996 and 2000 were 53% and 51%, respectively.

The second study was an annual survey of farmers who participated in the FAS program. The evaluation survey tracked the self-reported behavior changes and program satisfaction levels of FAS participants. This program participant data was collected each year between 1998-2000. Though the methodology for this annual survey has varied over the course of the study, the results obtained have been consistent for the past 3 years. The self-administered FAS evaluations were sent in by farmers following on-site assessments conducted by local groundwater technicians. Response rates on the annual evaluations have ranged from 35-50%.

## Results of the FAS Evaluation

Results of annual evaluations by program participants indicate strong levels of satisfaction with the program and with the technical assistance provided by technicians. In addition, the evaluations have revealed numerous behavior changes following completion of an on-site FAS. Highlights of the most recent findings include the following:

- Nearly four out of five (78.9%) respondents made at least one management change to protect groundwater.
- The majority of respondents changed more than one farm management practice as a result of program participation.
- The most frequently reported stewardship practices included emergency farm planning (48.1%), closing abandoned wells (45.2%), and enacting safeguards in pesticide storage and handling (45%).
- Most respondents applied for program cost-share dollars in order to make changes (78%).
- Only a quarter (24%) of the respondents said they read the fact-sheets dealing with the substantive knowledge of each groundwater topic before completing the risk assessment worksheets (Holsman, Heyboer, Geisler, & Campo, 1999).

Meanwhile, the longitudinal study of Michigan farmers' knowledge, attitudes, and groundwater behaviors indicates that groundwater literacy scores are low and remained unchanged on all 12 groundwater knowledge items over the 4-year period (Table 1). On average, farmers scored 55% correct on the knowledge section in 2000. There was not a significant difference in the overall score between 1996 and 2000.

**Table 1**
Frequency of Farmer Responses to Groundwater Knowledge Questions on the Longitudinal Statewide Survey 1996-2000

| Groundwater Knowledge Items | Year | % Agree | % Disagree | % Don't Know |
|---|---|---|---|---|
| It is more cost effective to prevent pollution of groundwater than to pay for the cleanup. (True) | 1996 | 95.4 | 2.3 | 2.3 |
| | 2000 | 94.5 | 4.6 | 1.0 |
| Irrigation and lawn watering can affect the amount of water leaching into the ground. (True) | 1996 | 88.4 | 7.4 | 4.1 |
| | 2000 | 90.7 | 7.9 | 1.4 |
| Groundwater in Michigan provides water to lakes and streams. (True) | 1996 | 81.5 | 13.4 | 5.1 |
| | 2000 | 79.6 | 13.5 | 6.9 |
| Groundwater in Michigan can best be described as an interconnected series of rivers, streams, and caverns. (False) | 1996 | 72.1 | 13.5 | 14.4 |
| | 2000 | 65.1 | 19.5 | 15.3 |
| Groundwater in Michigan can best be described as a wet sponge where water fills the spaces between soil particles. (True) | 1996 | 68.8 | 14.1 | 17.2 |
| | 2000 | 64.5 | 16.4 | 19.2 |
| Approximately 50% of Michigan's population relies on groundwater for drinking purposes. (True) | 1996 | 61.2 | 10.7 | 28.1 |

| | | | | |
|---|---|---|---|---|
| | 2000 | 54.4 | 13.4 | 32.3 |
| An average American uses 50 gallons of water each day. (False) | 1996 | 56.7 | 17.7 | 25.6 |
| | 2000 | 59.1 | 11.2 | 29.8 |
| Groundwater generally follows the contours of the land surface. (True) | 1996 | 56.6 | 35.2 | 8.3 |
| | 2000 | 55.8 | 37.7 | 6.5 |
| Less than 1% of the earth's water is available for drinking. (True) | 1996 | 45.1 | 11.2 | 43.7 |
| | 2000 | 48.8 | 7.0 | 44.2 |
| Just like surface water, groundwater flows downhill. (True) | 1996 | 43.7 | 39.9 | 16.4 |
| | 2000 | 42.5 | 37.4 | 20.1 |
| Once it reaches the water table, groundwater does not move, unless pumped. (False) | 1996 | 6.6 | 84.3 | 9.3 |
| | 2000 | 9.7 | 82.5 | 7.8 |
| Water that looks clear and tastes good is safe to drink. (False) | 1996 | 3.7 | 85.6 | 10.6 |
| | 2000 | 6.9 | 84.3 | 8.8 |

(No significant changes were found on any item.)

The results indicate that most farmers/respondents knew that:

- Groundwater provides water to lakes and streams;
- It is more cost effective to prevent pollution than to pay for cleanup;
- Irrigation and lawn watering can affect the amount of water leaching into the ground; and
- Water that looks clear and tastes good is not necessarily safe to drink.

Conversely, less than a majority of farmers understand what groundwater is by definition. The fact that most respondents agreed with both definitions provided (the correct and the incorrect one) indicates confusion over the concept. Farmers also do not fully understand the relative scarcity of groundwater as a global resource or have any idea how much American's use in a day (Holsman et al., 2000).

On the statewide survey in 2000, farmers also were asked if they had ever participated in a Farm*A*Syst. One-quarter of the respondents indicated that they had gone through the program (n=47). Knowledge scores of these farmers were compared with farmers who had not participated in the program. No significant differences were observed on any of these items.

However, Farm*A*Syst program participants were more likely than non-participants to engage in four out of seven farm practices that have direct implications for groundwater protection or contamination (Figure. 1). Three of the differences showed increased frequency of the desired stewardship behaviors promoted by the FAS program and suggest that the program is influencing farmers to make positive changes.

These changes mean that more farmers are participating in pre-side dress nitrate testing (PSNT), pesticide container recycling, and drinking water monitoring. Curiously, program participants also reported more frequent levels of one type of practice that presents a risk to groundwater—rinsing away pesticide spills with water.

There were no differences in the frequency of stewardship practiced with regard to petroleum storage safety, use of mix/load pads to contain spills, or in on-farm dumping of trash (a groundwater hazard few respondents practice).

**Figure 1.**
Significant Differences in the Frequency of Groundwater Practices Based on Participation in Groundwater Education and Training in Michigan

## Discussion

The results of the two studies taken together suggest that Farm*A*Syst is a successful intervention for promoting certain farm management practices in Michigan. Yet, despite the apparent shift in several types of farm management practices indicated by the FAS evaluation survey and the

differences in frequency of adoption rates between participants and non-participants, the program appears to be having little impact on groundwater literacy.

At the beginning of this particle we acknowledged that knowledge change alone is not an effective predictor of behavior change. At first glance, these results suggest that knowledge change may not even be necessary in order to shift behaviors. Before jumping to such conclusions, more information and monitoring of the actual implementation of the program's educational delivery may be necessary.

From informal interviews with groundwater technicians (the educators) and from re-evaluating the survey results, we offer the post-hoc hypothesis that behavior changes are being manipulated through cost-share incentives rather than through "education" offered during or after the Farm*A*Syst program. In other words, we suspect "consequence" strategies are having more influence than the "antecedent" strategy of using the FAS workbook to build knowledge and skills.

For example, we know from the data described here that few farmers are utilizing the written education material provided during training. This material represents a substantial investment of money and time by Extension educators, yet it appears it is not being used to its potential.

We also know from speaking with technicians that they are more likely to complete the risk assessment on behalf of the farmers rather than assisting them to build their own skills in risk assessment and evaluation. Finally, an examination of the types of behavior changes reported by farmers shows a strong correlation to those for which the MGSP has offered cost-share dollars.

For instance, the program has prioritized cost share for PSNT and well closures, yet far fewer cost-share dollars have been set aside for purchasing mix/load pads or for constructing locked, diked, petroleum storage facilities. These latter two practices are relatively expensive, and it does not appear many farmers are deciding to adopt such practices in the absence of financial incentives.

In conclusion, we suspect that adoption of groundwater stewardship practices may be driven by short-term financial incentives, rather than an improved understanding by farmers of the need to assess and evaluate risks to their local groundwater supplies. Some may argue that the question is moot as long as farmers are taking positive action. However, in the absence of developing this technical understanding among farmers, current implementation of the FAS program may be missing an opportunity to create long-term change in groundwater management practices.

It is often difficult to reach adult audiences with educational messages, especially when those messages pose threats to their current habits or practices. Farmers can be an especially challenging audience because of their skepticism toward government agencies. While cost-share incentives can provide a great way to market Extension programming by providing a "hook" to get farmers to participate, there are notable drawbacks to the approach. Other researchers have found that conservation behaviors adopted through financial incentives are often discontinued by individuals once those incentives are discontinued (Th�rgeson, 1996; Dwyer et al., 1993).

There is also a risk that information designed to have an impact on knowledge, attitude, and skills may get lost or disregarded when provided in the same channel as information on cost-share. Given these findings, it is recommended that MSUE refocus training of groundwater technicians to emphasize instruction on on-farm risk assessment by farmers rather than completing it for them. We also recommend deferring recommendations about cost-share practices until farmers complete their risk assessment and have reviewed strategies for mitigating high-risk management practices.

In the case of the MGSP and FAS, changes like well closures provide the farmers and local communities with lasting benefits, but many other groundwater practices (e.g., pesticide application, water testing, etc.) represent annual, if not daily choices on the part of the farmer. Further research is needed to investigate the long-term impact of program participation on farmers' management decisions regarding groundwater stewardship practices. There is also a need to identify the importance of groundwater knowledge as a mediating variable on the farmers' awareness of risk and willingness to take action. Increased knowledge maybe one important factor in farmer's willingness to seek information (Raedeke et al., 2001).

In the meantime, we caution Extension educators to specify precise cognitive, affective, and behavioral objectives with programs. Long-term behavior change, whether for groundwater stewardship or other health and safety issues, is likely a complex process that requires interventions designed to affect multiple determinants of an individual's decision-making process.

Extension educators need specific strategies and messages to affect all determinants of behavior. Just as it is often possible to fail to detect the long-term changes of learners who have received an intervention of short duration, it may also be possible to mistake "education" for manipulation of behavior via rewards.

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