The Long and Short of Groundwater Education for Michigan Farmers

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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. MGSP collaborates with local, state, and federal agencies to provide confidential information, assessment tools, and technical assistance to farmers. The Farm*A*Syst program is based on environmental education and adult learning theories. This article describes four different evaluation studies investigating program effectiveness. The evaluations focused on the MGSP program objectives and behavioral change theories and utilized mail surveys. The results suggest that Farm*A*Syst has been a successful intervention for promoting farm environmental 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.

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).

Other educational principles to consider when working with adult learners, which are based on Knowles' theory of andragogy (1984), are: a) adult learners need to be involved in the planning and evaluation of their instruction, b) adult learners' past experience provides the basis for learning, c) adult learners want to learn information that has immediate relevance to their life or job, and d) adult learning is problem-based.

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 several years of research and program evaluation done to track the effectiveness of the MGSP.

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), Michigan Conservation Districts (CDs) 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.[1]

Groundwater Education Approach

Since 1995, groundwater technicians have conducted Farm*A*Syst assessments on over 10,000 of Michigan's farms (MGSP, 1999). Through these voluntary and confidential assessments, technicians provide farmers with a workbook that contains worksheets for calculating various risks to groundwater and an Improvement Action Plan. It is the goal of Extension that the FAS workbook serves 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 workbook and to

[1] Editor's Note: The Farm*A*Syst (Farm Assessment System) and Home*A*Syst (Home Assessment System) programs pioneered the development of a voluntary, confidential environmental risk assessment for farmers, ranchers homeowners. Information is available at, http://www.uwex.edu/farmasyst/ (accessed June 2004).

empower farmers to assess their own groundwater risk factors now and in the future. The Action Plan includes a timeline for addressing high risks on the farm, in addition to the technical assistance or financial assistance needed to help make the change. Both the farmer and technician sign the Action Plan.

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 four 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 has been the 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 from 1998-2003. Though the methodology for this annual survey has varied over the course of this article, the results obtained have been consistent for the past 3 years. In the past three years, a mail survey was sent to FAS participants three to six months after they had a FAS conducted on their farm. The mail surveys followed Dillman’s Total Design Method (1978) and the response rates ranged from 53-58%.

A third study was a follow-up survey with 2001 FAS participants who had high risks to groundwater on their farm; however, they had not made changes to the high risks (Farrell, 2001). Again, the Dillman survey method was followed and a 44.7% response rate was obtained.

A fourth study was conducted in 2002 with Michigan Certified Pesticide Applicators (Farrell, 2002). A stratified random sample was created by MDA based on the seven MDA regions. The survey instrument comprised of two pages and included a question on

whether or not an applicator had participated in a FAS, farm demographic questions, and farm environmental stewardship management practices. The response rate was 62.4%.

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.
- Most respondents applied for program cost-share dollars in order to make changes (78%) (Holsman, Heyboer, Geisler, & Campo, 2000).
- The most frequently reported stewardship practices included emergency farm planning (56.1%), closing abandoned wells (79.8%), enacting safeguards in pesticide storage and handling (37.6%%), testing well water (52.2%), and creating drift management plans (52.7%) (Farrell, 2003).

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 (see 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 2000	95.4 94.5	2.3 4.6	2.3 1.0
Irrigation and lawn watering can affect the amount of water leaching into the ground. (True)	1996 2000	88.4 90.7	7.4 7.9	4.1 1.4
Groundwater in Michigan provides water to lakes and streams. (True)	1996 2000	81.5 79.6	13.4 13.5	5.1 6.9
Groundwater in Michigan can best be described as an interconnected series of rivers, streams, and caverns. (False)	1996 2000	72.1 65.1	13.5 19.5	14.4 15.3
Groundwater in Michigan can best be described as a wet sponge where water fills the spaces between soil	1996 2000	68.8 64.5	14.1 16.4	17.2 19.2

particles. (True)				
Approximately 50% of Michigan's population relies on groundwater for drinking purposes. (True)	1996 2000	61.2 54.4	10.7 13.4	28.1 32.3
An average American uses 50 gallons of water each day. (False)	1996 2000	56.7 59.1	17.7 11.2	25.6 29.8
Groundwater generally follows the contours of the land surface. (True)	1996 2000	56.6 55.8	35.2 37.7	8.3 6.5
Less than 1% of the earth's water is available for drinking. (True)	1996 2000	45.1 48.8	11.2 7.0	43.7 44.2
Just like surface water, groundwater flows downhill. (True)	1996 2000	43.7 42.5	39.9 37.4	16.4 20.1
Once it reaches the water table, groundwater does not move, unless pumped. (False)	1996 2000	6.6 9.7	84.3 82.5	9.3 7.8
Water that looks clear and tastes good is safe to drink. (False)	1996 2000	3.7 6.9	85.6 84.3	10.6 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.

In 2001, six months after the annual FAS evaluation, a follow-up study was conducted with farmers who had high risks on their farms but who had not made changes to those high risks. According to responses on the FAS annual evaluation, approximately 42 percent had made changes to all of the high risks on their farms. The study found that 57 percent of the farmers made changes, including:

- 75.9% closed abandoned well(s)
- 68.0% created emergency plans
- 62.1% changed pesticide storage and handling practices
- 46.2% changed fertilizer storage and handling practices

The findings from the follow-up study introduced changes to how FAS process occurred between the groundwater technician and farmer. In addition, a farm improvement action plan was made part of the FAS. Together, the technician and farmer create a plan on how the high risks on the farm would be addressed, including timeline and implementation strategies.

The findings provided MGSP with reasons why participants had not made changes to their high risks:

- 29.4% waiting for cost-share funding
- 28.8% encountered financial constraints
- 22.9% did not know how to complete changes

Lastly, in 2002 a study was conducted with Certified Pesticide Applicators within Michigan. Approximately 24% of the respondents had had a FAS conducted on their operation. The findings indicate that MGSP and FAS are having an impact on farmers' environmental stewardship management practices (see Table 2).

Table 2
Stewardship Practices between FAS and non-FAS participants

Stewardship Practice	**% *Yes*— F*A*S Participants**	**% *Yes*— Non-F*A*S Participants**
Pesticide containers are triple or power rinsed and recycled.	85.1	85.9
Air-gap or anti-backflow device(s) are installed on well(s).	64.6	51.3
All unused wells are "properly" closed.	83.3	68.6
Drinking water is tested annually.	50.0*	28.2
Farm fuel tanks are being monitored for leaks.	91.7	80.0
Pesticides are stored in a fenced or locked separate facility away from all other farm equipment.	68.8**	48.7
Pesticides are mixed on a mixing and loading pad.	21.3	26.4
Pesticides are mixed in different locations in the field each time.	56.3	42.8

Stewardship Practice	% *Yes*— F*A*S Participants	% *Yes*— Non-F*A*S Participants
Used oil is recycled.	79.2	80.1
A written emergency response plan has been developed.	57.4*	20.6
Home septic system has been pumped out within the last five years.	66.7	66.4
A spill kit and fire extinguisher is available at the pesticide storage area.	72.9	55.8
Extremely hazardous pesticides and fertilizers have been reported to the local emergency planning committee.	41.7*	15.4
A written drift management plan has been developed.	43.8*	16.1
All liquid fertilizer is stored within secondary containment.	20.8	10.9
Pesticide treated seed bags are returned to dealer.	16.7	13.5

* Stewardship Practice found to be significant at < .01

** Stewardship Practice found to be significant at < .05

Discussion

The results of the 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 article 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. In 2004, a new FAS was created for technicians to use that included an Action Improvement Plan. The plan includes high risks, timeline, and what is needed for the high risk to be lowered. This plan requires that the technician to follow-up with the FAS participant regarding the Improvement Plan. In addition, technician grants are now focused on deliverables, including number of high risks lowered and if a FAS participant proceeds to farmstead system verification (Michigan Agriculture Environmental Assurance Program-MAEAP, 2004). But, will these program changes have impact on environmental stewardship ownership or empowerment? Future evaluation studies will be critical to learning if behavioral changes are occurring from participating in the FAS program.

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.

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 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 (Thörgeson, 1996; Dwyer et al., 1993).

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 may be one important factor in farmer's willingness to seek information (Raedeke et al., 2001).

In the meantime, we caution 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.

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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