



Groundwater and Agriculture

A report on local solutions to protect both

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INTRODUCTION

Farming and water go hand in hand, and farmers are on the front lines of protecting soil and water resources while continuing to make improvements that improve farm profitability and sustainability. Over the course of the last several months, local farmers, agronomists, and industry professionals came together during a series of workshops to:

- List practices currently being used to protect groundwater
- Discuss practices local farmers are interested in trying and what they'd like their operations to look like in five years
- Identify the barriers in the way of making those changes
- Develop strategies to overcome those barriers and protect agricultural economies and groundwater supply at the same time

This report provides a summary of the conversations that took place in three workshops held in Perham, Parkers Prairie, and Osage that hosted over 90 farmers and other members of the agriculture community as well as from the follow-up meeting held in New York Mills. We developed the report using the notes taken by the workshop participants themselves, and it is a reflection of what we heard from them.

Though the workshops were held in different towns with different groups of people, there are unifying themes across all three: a lot of good work is already happening, there is a strong desire to further improve on fiscal and environmental stewardship, and there are many creative solutions available to help producers make those desired changes. This comes as no surprise to producers or those who work with them, but two other things became clear in these workshops:

- There is a need to capture the work farmers are already doing to protect groundwater and tell that story
- Farmers are facing other structural barriers that will prevent them from doing more good work

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PROCESS DESCRIPTION

Freshwater Society was hired by East Otter Tail (EOT) Soil and Water Conservation District (SWCD) to conduct a series of workshops for the purpose of gathering input from area producers on local strategies to protect agricultural economies and groundwater supply at the same time. Three identical workshops were developed and hosted in three separate locations in the 5-county area in an effort to reach as many producers as possible.

Each of those first three workshops featured small-group conversation, allowing for greater participation from all present. Each table had a note taker from the SWCD or partner organizations to make sure all ideas shared in response to questions were written down.

The first two questions were designed to capture information about practices or strategies already in use locally, and what it was about those activities that made them work for local producers. Those questions were:

- For nutrient and irrigation management, what are the practices that are working in your fields and why?
- What makes the practices you are using in your fields feasible and beneficial to you?

The remaining questions sought to illustrate what further efficiencies were of interest, why they were not already adopted, and what might make it easier for adoption. These questions below begin to paint a picture of how an SWCD response could facilitate further efforts to protect groundwater:

- If time and money were not a factor, what would you like your irrigation and nitrogen management practices to look like in 5 years?
- With a focus on nutrient and irrigation management, what are the barriers to improving efficiencies in your fields?
- What strategies can we use to address these barriers?

Answers to these questions were sorted into categories by participants, and summaries from each table were shared after each question. Participants were also asked to move to different tables for the different questions so as to encourage the development of a shared understanding of the challenges and opportunities farmers face.

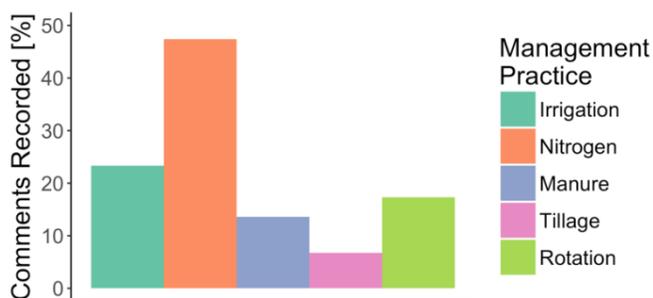
All comments recorded at the different meetings were analyzed by Freshwater and fully inform the content of the narrative contained in this report. To confirm that the stories and input shared by participants were accurately reflected, a fourth workshop was held to present findings and define and prioritize specific strategies that would be most useful to producers.

WHAT'S CURRENTLY WORKING, AND WHY

We heard from farmers throughout this process that they understand they have a responsibility to protect groundwater. While economics constrain which practices are feasible in their fields, farmers are already making sacrifices of time, resources, and money to implement practices that are environmentally beneficial. Many of the practices that are currently working are those that maximize input use efficiency. By aiming to make every ounce of fertilizer and drop of water productive and available for crops, farmers are protecting their bottom line and groundwater. As problem solvers, we heard that farmers are using a variety of different practices on their fields which reflect the unique conditions found on each farm.

In general, the practices that are working now to protect groundwater are focused on the annual management of irrigation and nitrogen to meet the unique conditions for each field, each farmer, and each growing season.

The following are a summary of the practices identified by farmers that are currently working in their fields:



Nitrogen: The practice that we received the most comments on was nitrogen management. We heard from farmers that the 4R Nutrient Management Principles – applying fertilizer at the Right Time, using the Right Rate, in the Right Place, and with the Right Source – are the foundations of the practices that are currently working in their fields. Split-application was the practice most commonly mentioned. Other practices such as fertigation, controlled-release

fertilizers, reducing early season applications, plant tissue sampling, variable-rate applications based on grid sampling and yield monitors, nitrogen stabilizers, and soil nitrate measurements are also being used.

Irrigation: Irrigation was the management practice that received the second highest number of comments. Out of all the practices mentioned, irrigation scheduling was overwhelmingly regarded as a practice that is working. However, irrigation scheduling means different things to different producers. For some, it means the program currently provided by EOT SWCD; for others, it meant irrigation management in general where the goal is to apply no more or no less water than is needed by the crop. We also heard that pivot uniformity testing, tracking water use and adjusting for precipitation with the checkbook method, remote control of irrigation pivots, low pressure nozzles, soil moisture probes, and using imagery to track application problems are practices that are currently working.

Rotations, Tillage, and Manure: We heard that management of rotations, tillage, or manure management practices were important depending on the conditions of a given farm and resources available to a farmer. Cover crops are being incorporated into some rotations, especially those with short-season main crops, primarily for erosion control. In some cases, cover crops are also being used for soil health and to reduce nitrogen losses. Similarly, reduced tillage practices are also gaining ground to reduce erosion and improve soil health. In some areas, we heard that manure management is an effective source of nitrogen and a way to improve soil health.

When farmers talked about *why* these practices they are using are feasible, we heard that resource efficiency, knowledge of local efficacy, and ability to manage the risk of unexpected events were the most important factors. The ability to use a management practice is limited by the physical, capital, or human resources available on a farm, and the most effective management practices are those which make use of existing resources in an efficient manner. Other practices are working well because farmers have evidence that the practice is effective and practical for local conditions. The availability of local information is an important factor of why farmers are choosing to use a given management practice. Effective management practices also work to mitigate risk from

unexpected events like an untimely mega-rain or season-long drought. While farmers can't control the weather, they are choosing practices that reduce the risk of financial losses due to unpredictable events.

We also heard that while some practices are feasible for producers working on a larger scale, they might not be appropriate for farmers working on a smaller scale or who are approaching the end of their career. Farmers participating in these meetings also clarified that because of the vulnerable and variable soil conditions found in north central Minnesota, they have adopted different Best Management Practices (BMP's) for nitrogen than other areas of the state. These BMP's require more time and resources, but are a necessity for farmers to be financially viable in this region. Along with protecting a farmers bottom line these BMP's also work to protect groundwater from being contaminated from nitrogen.

However, the conversations on why the practices being used were feasible repeatedly circled back to the dual importance of fiscal and environmental stewardship. **We heard from participants that both economics and environmental considerations were important components of the decisions farmers are making to manage their fields.** Participants said that they understood agriculture and water go hand-in-hand, and that they are already implementing practices on their fields that reflect this understanding.

WHAT FUTURE PRACTICES COULD LOOK LIKE

We asked participants to imagine what the management practices on their fields could look like in five years. In response, we heard that there is more work to be done to improve financial sustainability and to protect groundwater. In most cases, farmers have a vision for the practices they want to incorporate into their future farming systems. In the next five years, they want to shift their management practices towards those with a long-term perspective in mind: reducing tillage, incorporating cover crops, and adding alternative cropping systems into their rotations. We also repeatedly heard that farmers want to adopt precision irrigation and nitrogen management practices that could drastically improve the efficiency of the inputs they use.

The following is a summary of the practices that farmers want to adopt in the next 5 years:



Rotations and Tillage: Compared to their comments on what is working now, there was a significant increase in the number of comments received mentioning changes in rotation and tillage management practices when farmers were talking about the practices they wanted to adopt in five years. Both cover crops and reduced tillage practices were frequently mentioned as practices farmers want to incorporate in the future. These practices were identified by farmers for their soil health

and sustainability benefits, and we heard from farmers their desire to shift their management practices away from annual management of inputs towards a system with a longer-term perspective. Farmers understand that increasing organic matter, water holding capacity, and soil biological activity while decreasing erosion is good for their bottom line and for the environment. In the short-term, however, these changes will need to be accompanied by changes in nitrogen and irrigation management to adjust for the lower yields associated with the transition period. In addition, we heard from farmers a desire to increase the diversity and duration of their rotations (including the use of non-traditional crops), and remove marginal acres from production. Farmers also recognize that changes in tillage and rotation management practices have a longer-term return on investment (ROI), there is a consensus that adopting these practices will eventually result in better financial and environmental outcomes as well as more sustainable farming operation.

Nitrogen and Irrigation: As two of the most important inputs for farms in this region, there was a lot of discussion regarding the future of nitrogen and irrigation management practices. For nitrogen, we heard that farmers want to reduce the total rate of nitrogen applied and improve the efficiency of their fertilizer applications. This could be accomplished through conventional means such as using slow release fertilizer or applying N stabilizers, expanding their acres with fertigation, using new equipment for sidedress applications such as y-drops, or adding in soil biological amendments to their fertility management plan. For irrigation, we heard that farmers also want to reduce the total rate of water applied and improve efficiency by transitioning irrigators to low pressure systems, upgrading gearboxes to allow for faster applications, installing GPS nozzles and remotely controlled systems, irrigating field corners, and having weather stations at each of their fields. For both irrigation and nitrogen, we also heard that farmers are interested in precision management tools such as variable-rate applications based on yield maps or grid soil sampling, or drones and other sensors to scout fields and to determine where and when to apply in-season nitrogen and irrigation. We heard active discussion on a future where the combination of robots and sensors could provide each plant with exactly the amount of fertilizer and water needed to maximize crop growth and minimize input losses. Farmers are very interested in adopting precision agriculture practices in their fields as soon as these technologies are available, reliable, and have been proven to work. Farmers also said that they are counting on their changes in rotation and tillage management to assist with their nitrogen and irrigation management in the future. Improving soil health is an important part of how farmers in this region want to manage soil fertility and soil water availability in the future.

We posed the discussion of future management practice as a hypothetical, as if time or money were not limiting factors. The answers we heard from farmers varied based on the practices that farmers had already adopted and what is feasible for a given field. The scale of the farming operation and the life stage of the farmer are also important determinants of what future management practices will look like. Major changes aren't likely possible for farmers who are nearing retirement or farmers working on a small scale.

During this discussion, a common theme emerged: **there is a strong desire to shift towards a system that incorporates longer-term management practices that produce a more sustainable farming operation and better environmental outcomes.** This desire alone is not enough, however; we heard from farmers that even above and beyond the limitations of time and money, other barriers could still limit what is possible in the future. This means that **unless solutions to these structural barriers can be found, interest and effort by farmers alone will not be enough to get more practices adopted that will protect groundwater.** We heard from farmers that they have been working hard to protect groundwater and want to do more good work in the future. Adopting new management practices will not happen as quickly as needed without some outside interventions to help farmers overcome the barriers in their way.

BARRIERS TO PROGRESS

In these meetings, farmers identified the structural barriers that would prevent them from doing more good work on their fields to protect groundwater and improve the sustainability of their farms. Some of these barriers are obvious. For example, there is never enough money or time to do everything that is desired. However, other less obvious barriers exist and addressing them is equally as important to achieving the vision farmers have for their fields in the future.

The following is a summary of the barriers identified by farmers:

Negative public perception: The general understanding shared by farmers is that the public believes that farmers don't care about the environment and aren't doing anything at all to protect groundwater. This is evidenced by media reports over the past few years painting farmers in a negative light with respect to groundwater and the environment. While this characterization is itself inaccurate and in need of correction, this misperception also impedes the adoption of more good work by farmers, as success stories that could help inform business decisions are not shared. If the public believes that the solution to our groundwater problems is educating farmers on the basic principles of conservation, they are only creating another barrier for farmers to overcome. Farmers are not asking for education as to why protecting groundwater is important or on the basic strategies that can be used to protect groundwater. They already understand that they have a responsibility to protect groundwater and many have been working hard for years to adopt more environmentally friendly practices. Incorrect public perception of farming was the issue most commonly mentioned by participants.

Locally appropriate knowledge: Farmers make decisions on which management practices to use based on locally appropriate information of the benefits and tradeoffs associated with a given practice. Because changes in management practices, whether major or minor, carry some level of risk, farmers are not likely to make changes without evidence that the practice will be beneficial on their fields. University research is often conducted under soil and climate conditions that are not directly transferable to the conditions found locally. Similarly, there is no simple way for a farmer to get access to a centralized information database on all the research conducted that would be appropriate for their fields. Farmers trust management practices that have been demonstrated on fields they know and by peers they trust. However, there is currently no formal way for farmers to share information with other farmers on which practices are working in their fields. The lack of locally appropriate knowledge was one of the most significant barriers identified in this process.

Long return on investment period for new practices: Both changes in tillage and rotation management practices, as well as adoption of precision irrigation and nitrogen management, have high upfront costs and a long return on investment (ROI) period. While these practices make sense in the long-term, the transition period and costs in the short-term make them difficult to adopt. The environmental benefits of these practices may also have a shorter ROI period compared to the ROI for the economic benefits. For example, upgrading an irrigation system with GPS nozzles for variable-rate irrigation is an expensive investment that will take years to pay off with the modest decreases in the total volume of irrigation applied. However, it may have immediate environmental benefits by limiting irrigation applications in areas that are highly vulnerable to nitrate leaching. In a similar way, cover crops can immediately reduce nitrate leaching once planted but may take many years to improve soil health to the point that cover crops are an economically beneficial practice.

Lack of technical expertise and actionable information: While there is an abundance of new precision management technologies which generate massive amounts of on-farm data, farmers are lacking the resources needed to use this technology to its full potential. Although these tools have the promise to give plants the ability to communicate their exact nutrient and water needs, the tools are not yet easy to use for all farmers. On-farm technology is changing very rapidly. While farmers with lower technological literacy will obviously be challenged, in some cases, even the savviest producers will have a hard time keeping up with the rapid pace of change. At the

same time, the data generated by these tools is almost useless without accompanying support systems to interpret the data or provide actionable information. Without the knowledge to operate new technologies or the ability to make decisions based on the data generated, farmers will be spending time and money on technology that is not fully useful to them.

Absence of markets for alternative crops and improved inputs: In some cases, the management practices that farmers want to use are not aligned with the products provided by or the crops purchased by the market. Without markets aligned to farmer needs, certain practices will not be feasible. For example, some farmers expressed interest in growing alternative crops such as canola, oats, peas, hemp, alfalfa or anything besides corn and soybeans; however, they also identified that there is no market to sell these crops. In the case of cover crops, there has not yet been a cover crop developed that is well suited for the climate and shorter growing season of north central Minnesota. Other inputs, such as advanced precision agriculture technologies, have either not yet been developed or are not yet commercially available for farmers in this area.

Unpredictable and variable environmental conditions: Farmers work in systems that are defined by their unpredictable and variable conditions. Unexpected or extreme weather events, volatility in crop prices, and soil conditions that change dramatically over just a few feet can impede or even derail the best-laid plans. Farmers are largely unable to control major factors that determine whether their farm is financially viable or if negative environmental impacts will occur. This lack of control means that farmers are limited in their choices of management practices because of the need to mitigate and manage the risk of unexpected events happening and account for the variability in their fields.

Restrictions from landowners, bankers, and government: Farmer decisions on which management practices to use are limited by outside interest groups such as landowners, bankers, and government agencies. A landlord may restrict a farmer's ability to change their tillage or rotation management practices. A banker may limit financing options on farmers when crop prices are low. Government agencies have restrictions and regulations for conservation programs, crop insurance, and water appropriation permits. There is also a maze of paperwork required for the different government programs and permitting. Together, these three groups currently limit the flexibility of farmers to implement new practices that could have a positive impact on groundwater.

The adoption of more groundwater-friendly management practices is limited primarily by systemic barriers rather than by a lack of knowledge or interest on the part of farmers. Farmers have a vision of the management practices they want to implement in their fields in the next 5 years in addition to the things they are already doing to protect groundwater. In order to accomplish their goals of decreasing their environmental impact and increasing the sustainability of their operations, farmers are asking for help from the SWCD to overcome the barriers they have identified.

STRATEGIES FOR SUCCESS

In the final meeting of the workshop series, participants from the first three meetings had the opportunity to review the content of this report and provide feedback to make sure the story shared in these pages truly reflected the conversation from those workshops. Of the initial group of 90 participants, more than 30 participants returned to continue this conversation. We have incorporated the comments from this meeting throughout the report. Additionally, during the final session participants were asked specifically to identify strategies that would make the biggest difference to them in overcoming barriers they face in adopting new management practices.

The following is a summary of the solutions identified by farmers:

Shift the public narrative: This was clearly the strategy most strongly championed by attendees at the fourth meeting. Farmers want to see changes in the public narrative because it does not accurately reflect the work they are doing to protect groundwater. While shifting the narrative alone won't remove the barriers to improving efficiencies, it will help to focus funding on efficient and effective strategies, encourage further participation in conservation practices as farmers learn about successful work in their area, and remove a negative stigma associated with farmers and farming. The stories being told about farmers do not accurately reflect their lives and their communities. While changing dominant public opinion will be difficult, there is an abundance of stories of the good work that farmers are doing that could be publicized. These are the public relations strategies suggested by farmers:

- Tell better stories of good work farmers are doing and of how farming practices have improved over time
- Provide education on agricultural systems to those outside of the agriculture community
- Connect members of the public with farmers to build relationships

Promote improved regulations: Whether in the form of government rules or restrictions by bankers and landlords, farmers are asking for common sense regulations that let them do more good work to protect groundwater and improve their bottom line. Farmers prioritized changes in regulations as one of their top priorities. While this is a difficult component of a system to change, farmers have a clear picture of what changes to regulations they would like to see, including these strategies suggested by participants:

- Regulations should be rooted in common sense and locally controlled
- Government conservation program should have increased flexibility and reduced paperwork
- All levels of government should be working together

Facilitate local information exchange: Farmers are looking for more sources of locally relevant information to evaluate the performance of management practices on fields like their own. The practices for which the impacts are widely understood are the same practices that have already been widely adopted. For example, farmers in this region have knowledge that split-application of nitrogen is a locally appropriate management practice to improve nitrogen use efficiency. This is an important reason why this practice has been adopted by so many farmers. Information can be exchanged formally or informally between farmers, agronomists and crop consultants, university researchers, and SWCD staff. During these workshops, farmers expressed that there was a lot of value in hearing from their peers on which management practices are working and why. These are the programs to exchange locally appropriate information suggested by participants:

- Regular publication of locally appropriate research results
- Conducting university research in the local area
- Formal sharing of information between farmers on practices that are working on their fields
- Networking for farmers with agronomists, researchers, SWCD staff, and other farmers

- Increased number of local field days and on-farm demonstrations

Develop assistance programs: Direct assistance from outside entities is needed to overcome certain barriers. Assistance does not mean that farmers are giving up control over their fields or asking someone to manage their farm for them. However, in some situations there are certain resources or expertise that when provided by someone else can overcome a time, cost, logistical, or expertise barrier faced by a farmer. For example, irrigation scheduling provides actionable information that farmers can use while the time, technology, labor, and expertise is provided by the SWCD. This model works well and can be built on. Here are assistance programs suggested by participants:

- In-season nitrogen management program, including tissue and soil nitrate testing
- Training in new technologies, including how to use sensors and software
- Translating precision agriculture data into actionable information
- Application assistance for conservation programs

Foster financial support: While having more money is always nice and would alleviate some of the barriers farmers face, targeted financial assistance could increase the adoption rate of management practices with a long-term ROI or high upfront cost. Reducing the upfront cost of equipment upgrades or finding creative ways to spread out transition costs over time can help remove this barrier. For example, cost-share programs already exist for some conservation programs. By expanding these programs to the new practices that farmers want to adopt, more work to protect groundwater could occur. Programs providing financial support are especially important now in this period with very narrow profit margins. These are the programs to provide financial support suggested by participants:

- Incentives for adopting costly management practices with environmental benefits, such as cover crops
- Cost-share or lower interest rate loans for investments with long-term ROI or high upfront cost, such as variable-rate irrigation
- Opportunity to “try out” or rent equipment, such as equipment for reduced tillage, before buying

Encourage development of local markets: Having access to local markets is essential for farmers who want to make major changes to their cropping systems. There is a clear interest in having more options for crops to grow that could diversify existing rotations. Beyond crops, farmers also want inputs that make their systems more efficient. Developing new markets is a large task, but demonstrated demand by farmers is an important component of overcoming this systemic barrier. These are the strategies to develop local markets suggested by participants:

- Invest in local mills and end producers to support alternative cropping systems
- Provide access to improved inputs such as climate hardy cover crops, precision agriculture technologies, manure, and nitrogen stabilizer products that are less difficult to apply

A prioritization of strategies is important because, like producers, the SWCD has limited time and resources and cannot simultaneously pursue all recommendations. By following the guidance provided by participants in these workshops, the SWCD can most effectively provide support to farmers as they work to implement new practices to protect groundwater.

FINAL THOUGHTS

This series of workshops provided important insights into the work farmers are already doing to protect groundwater and the role the SWCD can play in helping farmers adopt more environmentally beneficial management practices. Based on these conversations, we heard again and again that farmers strongly feel a responsibility to protect groundwater and want to do more. **Although there is more work still to be done, it appears that this region is on the right track to protect groundwater.** The SWCD can facilitate early movement on adopting some of the strategies identified in this report through these suggested next steps:

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| Shift the narrative | Collect success stories and case studies from local farmers, and share those with local media, community groups, and others to begin shifting the narrative. |
| Promote improved regulations | Help regulators better understand agricultural contexts and the impacts of proposed regulations. Additionally, as the SWCD works with other government agencies, such as in One Watershed One Plan, highlight the need for common sense and flexibility |
| Facilitate local information exchange | Coordinate field days with area farmers, and host networking opportunities and conversations like those that led to this report. Additionally, contact local colleges and schools to both promote new local research and collect relevant research already done that could be of interest to area farmers. |
| Develop assistance programs | Provide or coordinate training opportunities, including field-specific opportunities, and assist with application requirements for conservation programs. Additionally, consider developing an in-season nitrogen management program like the irrigation scheduling program. |
| Foster financial support | Raise money to support locally-specific incentive and cost share programs, and work with others in the agriculture industry to develop a program that would allow farmers to try out equipment and technology before making significant investments. |
| Encourage development of local markets | Work with providers to increase access to improved inputs, and highlight the need to invest in local mills and other end producers to support alternative cropping systems. |

While addressing the systemic barriers facing farmers will be an uphill challenge, there are opportunities for the SWCD to help the farmers they serve. Assistance programs, local information exchanges, and reframing the public perception of agriculture are all within the reach of the SWCD and accomplishing them could help farmers get more good work done. Other approaches such as improving regulations, developing local markets, and providing financial support are outside of the direct control of the SWCD – however, using these findings as a guide, the SWCD could advocate for the action of other stakeholders to make changes in these areas.

Groundwater and Agriculture Summary Findings

Farming and water go hand in hand. Farmers are on the front lines of protecting soil and water resources while continuing to make improvements that increase farm profitability and sustainability. Over the course of the last several months, local farmers, agronomists, and industry professionals came together to:

- List practices currently being used to improve efficiencies
- Discuss practices local farmers are interested in trying and what they'd like their operations to look like in five years
- Identify the barriers in the way of making those changes
- Develop strategies to overcome those barriers and protect agricultural economies and groundwater supply at the same time

Workshops hosting over 90 farmers and other members of the agriculture community were held in Perham, Parkers Prairie, and Osage with a follow-up meeting in New York Mills. Across all meetings, there were some unifying themes: a lot of good work is already happening, there is a strong desire to further improve on fiscal and environmental stewardship, and there are many creative solutions available to help producers make those desired changes. This comes as no surprise to producers or those who work with them, but two other things became clear in these workshops:

- There is a need to capture the work farmers are already doing to protect groundwater and tell that story
- Farmers are facing other structural barriers that prevent will prevent them from doing more good work

What's currently working, and why

We heard from farmers throughout this process that they understand they have a responsibility to protect groundwater. While economics, farm size and scale, farmer life stage, as well as vulnerable and variable soil conditions constrain which practices are feasible in their fields, farmers are already making sacrifices of time, resources, and money to implement practices that are environmentally beneficial. Many of the practices that are currently working are those that maximize input use efficiency – by aiming to make every ounce of fertilizer and drop of water productive and available for crops, farmers are protecting their bottom line and groundwater. In general, the practices that are working now to protect groundwater are focused on the annual management of irrigation and nitrogen to meet the unique conditions for each field, each farmer, and each growing season. **We heard from participants that both economics and environmental considerations were important components of the decisions farmers are making to manage their fields.** Participants said that they understood agriculture and water go hand-in-hand, and that they are already implementing practices on their fields that reflect this understanding.

What future practices could look like

Farmers already have a vision of the practices they want to incorporate into their fields over the next five years. **We heard that there is a strong desire by farmers to shift towards a system that incorporates longer-term management practices that produce a more sustainable farming operation and better environmental outcomes.** This includes reducing tillage, incorporating cover crops, and adding alternative cropping systems into their rotations. We also heard that farmers are interested in adopting precision irrigation and nitrogen management practices that could drastically improve the efficiency of the inputs they use.

Barriers to progress

In these meetings, farmers identified the following structural barriers impeding their desire to do more good work on their fields to protect groundwater and improve the sustainability of their farms: negative public perception; lack of

locally appropriate knowledge; long return on investment period for new practices; lack of technical expertise and actionable information; absence of markets for alternative crops and improved inputs; unpredictable and variable environmental conditions; restrictions from landowners, bankers, and government

Above and beyond the limitations of time and money, other barriers can still limit what is possible in the future for farmers. This means that **unless solutions to these structural barriers can be found, interest and effort by farmers alone will not be enough to get more practices adopted that will protect groundwater.** Farmers are asking for help from outside groups, such as the SWCD, to realize their vision of how they want their fields to be managed.

Strategies for success

To overcome the identified barriers to progress, workshop participants suggested using the following strategies:

Shift the public narrative: Farmers want to see changes in the public narrative because it does not accurately reflect the work they are doing to protect groundwater. These are the public relations strategies suggested:

- Tell better stories of good work farmers are doing and of how farming practices have improved over time
- Provide education on agricultural systems to those outside of the agriculture community
- Connect members of the public with farmers to build relationships

Promote improved regulations: Farmers are asking for common sense regulations that let them do more good work to protect groundwater and improve their bottom line – here are suggested strategies to do so:

- Regulations should be rooted in common sense and locally controlled
- Government conservation program should have increased flexibility and reduced paperwork
- All levels of government should be working together

Facilitate local information exchange: Farmers are looking for more sources of locally relevant information to evaluate the performance of management practices on fields like their own:

- Regular publication of locally appropriate research results
- Formal sharing of information between farmers on practices that are working their fields
- Increased number of local field days and on-farm demonstrations

Develop assistance programs: In some situations, there are certain resources or expertise that when provided by someone else can overcome a time, cost, or expertise barrier faced by a farmer. Suggested programs include:

- In-season nitrogen management program, including tissue and soil nitrate testing
- Training in new technologies, including how to use sensors and software
- Application assistance for conservation programs

Foster financial support: Targeted financial assistance could increase the adoption rate of management practices with a long-term ROI or high upfront cost. These are the programs to suggested by participants:

- Incentives for adopting costly management practices with environmental benefits, such as cover crops
- Cost-share for investments with long-term ROI or high upfront cost, such as variable-rate irrigation
- Opportunity to “try out” or rent equipment, such as equipment for reduced tillage, before buying

Encourage development of local markets: Developing new markets is a large task, but demonstrated demand by farmers is an important component of overcoming this systemic barrier – these are the suggested strategies:

- Invest in local mills and end producers to support alternative cropping systems
- Provide access to inputs such as climate hardy cover crops and precision agriculture technologies