Improving soil health and water quality on tile drained lands

Project Summary

Between 2017 and 2020, Discovery Farms programs in Minnesota and Wisconsin worked with farmers to evaluate tile drainage monitoring approaches and relationships with soil health measurements. Funded by a Natural Resources Conservation Service (NRCS) Conservation Innovation Grant, the project worked with 24 farms in Wisconsin and 24 farms in Minnesota to collect water quality and soil health data, offer educational events, and create resources for farmers to address soil health and water quality challenges.

Impact

Collecting data on tile drained fields. This project collected and analyzed three years of tile water quality data along with agronomic information and soil health assessments at 48 sites throughout Minnesota and Wisconsin.

Increasing awareness. During the life of the project, Discovery Farms programs hosted 150 events across Minnesota and Wisconsin with over 9,000 people in attendance where the project was introduced and results were presented. A final project webinar was viewed by more than 400 people.

Providing resources. Data was provided to the participating farmers on an annual basis to evaluate agronomic and soil health impacts on tile water quality. The final report summarizes the findings of the project and provides resources and links for more information.

Data Collection Highlights

Tile monitoring approaches. This project analyzed three tiers of tile water quality monitoring; intensive, intermediate, and basic. Intensive sites utilized automated sampling equipment and a flow based sampling approach. Intermediate sites included continuous flow monitoring and bi-weekly water sampling. Basic sites included bi-weekly flow monitoring and water sampling. If measuring flow is a necessity, the intensive and intermediate approaches would produce reliable results. The intermediate and basic sampling approach produced reliable nitrate concentration values, but underestimated sediment and phosphorus. If reliable sediment and phosphorus concentrations are needed, an automated flow based approach is essential.

Differences in tile and surface water. Sediment and phosphorus sample concentrations are generally much higher for surface runoff and more of a concern for surface runoff than tile drainage. Nitrate, on the other hand, is generally much higher for tile drainage and more of a concern for tile drainage.

Agronomic impacts of tile nitrate levels. Nitrate levels were higher for corn and soybean crops compared with dry bean, wheat, and alfalfa. The previous crop also impacted tile nitrate levels for corn fields with corn following corn and corn following soybean having higher tile nitrate levels than corn following alfalfa. In general, as application rate increased, so did tile nitrate concentration. This became more clear when the sites were grouped by crop and previous crop. Cover crops had an impact on tile nitrate levels. Fields that had cover crops had lower median values of tile nitrate when grouped by crop type and nitrogen application rate.

Tile flow dynamics in Minnesota and Wisconsin. Wisconsin tile sites flowed more consistently throughout the year. The average flow frequency for Wisconsin tile sites was 82% compared with only 43% for Minnesota tile sites. Wisconsin tile sites had a large portion of flow during frozen ground winter conditions in December through March. Minnesota tile sites had little overwinter tile flow with most of the tile flow occurring from April through June. Wisconsin also had some tile sites where the amount of tile flow was greater than the amount of precipitation, indicating that the tile system was intercepting shallow groundwater from a larger regional source. In these instances it was difficult to determine farming system impacts as regional groundwater interception dilutes water draining from the fields, lowering nutrient and sediment concentrations.

Soil health measurements and comparison to water quality and agricultural practices. Soil health measurements were impacted by region likely due to the soils present in the area. Differences of soil health measurements were also observed when grouping the sites by soil type. Soil health increased as soil particle sizes decreased. Sands had lower measured soil health metrics than loams and clays. Differences due to tillage, manure application, and cropping rotation were not as clear, likely because of the type of soil and regional differences observed. These factors highlight an important consideration for soil health measurements and comparisons. Site to site comparisons are difficult as not all locations and soils are going to have the soil health potential.

No direct correlation was found between soil health measurements and water quality. Soil health measurements have a more subtle impact on tile water quality compared to agronomic practices and weather conditions. It is likely that there weren't enough sites in this project to find a subtle correlation.

Challenges and Lessons Learned

Tile monitoring challenges. Flooding and freezing were the biggest monitoring challenges. During these conditions, flow had to be estimated and water samples could not be collected. Sites chosen for monitoring need to be considered carefully to minimize flooding and freezing risks.

Soil health measurement challenges. When this project was initiated, there was little guidance on the methods of collecting soil health samples. Specifically when to take the samples, what depth to take the soil samples, how many subsamples to include, and how to transport and store the samples. For this project, samples were taken in June as this is the time of most biological activity, at a depth of 6 inches, and one composite sample was analyzed per monitoring site. More guidance in this emerging area of research is needed.

Next Steps

Focus on tile nitrate. Nitrate is the nutrient of most concern with tile drainage systems and agronomic practices can impact the level of nitrate measured in tile. Bi-weekly grab sampling of tile flow can provide a high quality measurement of average annual nitrate concentration and assessing nitrate concentration in farmers’ tiles can be an excellent way to gauge the success of in-field nitrogen management practices. Increasing farmer understanding and value of tile nitrate measurement in regards to nitrogen management and farming systems would be an excellent next step in improving farming practices and protecting water quality resources.