Nutrients in Our Environment; Past, Present, and Beyond
Poster/Booth Abstracts

Minnesota Agricultural Water Resources Coalition

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The Minnesota Agricultural Water Resources Coalition came together to develop and implement a strategic educational, communications and public relations program to inform agricultural producers in Minnesota about water quality issues.

MAWRC members include the Minnesota Soybean Research and Promotion Council, Minnesota Soybean Growers Association, Minnesota Corn Research and Promotion Council, Minnesota Corn Growers Association, Minnesota Farm Bureau Federation, Minnesota Milk Producers Association, Minnesota Pork Board, Minnesota Pork Producers Association, Minnesota Association of Wheat Growers, Minnesota State Cattlemen's Association, Minnesota Farmers Union, Minnesota Turkey Growers Association, Broiler and Egg Association of Minnesota, Minnesota Lamb and Wool Producers Association, and the Irrigators Association of Minnesota.
Primary funding for the MAWRC is provided by the Minnesota Corn Research & Promotion Council and the Minnesota Soybean Research & Promotion Council.

South Central College Agriculture Programs

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South Central College is a Community & Technical College located in North Mankato, Minnesota. The Agribusiness Department is a leader in providing education to prepare the future employees for the agricultural industry in Southern Minnesota. South Central College offers 2-year programs in the areas of Ag Production, Chemical Applicator, Ag Service Technician, Ag Service/Management & Ag Education.

Nutrient Management Initiative Program

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The Nutrient Management Initiative (NMI) program provides a framework for farmers to evaluate economic outcomes from their nutrient management decisions. Farmers receive $1200 for completing program requirements. Program design compares two rates of either nitrogen or phosphorous fertilizer in three replicated strips. Participating farmers are required to work with a certified crop adviser who assists with site design, and validates cropping information, and yield results. Farmers receive an economic evaluation of their site based on their actual fertilizer price and a base corn price.
Funding for the program is through the Environmental Quality Incentives Program (EQIP) and administered by the Minnesota USDA-Natural Resources Conservation Service (NRCS). The Minnesota Department of Agriculture assists through promotion, data collection, and compilation of data for the program.

Nutrient Management Plans

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Olmsted, Winona, Fillmore, Houston and Mower Counties

Having a Nutrient Management Plan for a livestock operation is essential for maximizing the economic value of manure and minimizing environmental risks associated with the storage, handling, and application of manure on the land. A Nutrient Management Plan helps producers budget and supply nutrients for plant production. Helps properly utilize manure or organic byproducts as a plant nutrient source. A Nutrient Management Plan minimizes agricultural nonpoint source pollution of surface and ground water resources. Also a Nutrient Management Plan helps maintain or improve the physical, chemical and biological condition of the soil. Finally manure should not be considered waste product requiring disposal. Instead, it should be collected, stored, handled and applied with the same care given to expensive commercial fertilizers. Manure applied properly can save a landowner in fertilizer costs. However if manure is over-applied nutrients will be wasted and water resources can be negatively impacted. Having a sound Nutrient Management Plan will help not only help the environment, but it will help the producer manage his operation to maximize the value of manure.

Root River Turbidity TMDL

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The Clean Water Act, Section 303(d), requires that states publish a list of waters that do not meet water quality standards and do not support their designated uses every two years. These waters are then considered “impaired,” and a Total Maximum Daily Load (TMDL) must be developed. The Root River Turbidity TMDL encompasses eleven impaired reaches in Southeast MN with the affected use being aquatic life. Turbidity is caused by suspended and dissolved matter including silt, clay, organic matter, and algae which can be detrimental at elevated levels to water quality and habitat. The 2010

monitoring season will be the third and final year in this study and the final report is due by June 30th, 2011. Preliminary data for Total Suspended Solids (TSS), Nitrate + Nitrite, and Total Phosphorus (TP) can be seen for the 2008 and 2009 monitoring seasons. Also included in the poster is an overview and current status of the Root River Turbidity TMDL, and information regarding a new Mississippi River Basin Healthy Watersheds Initiative (MRBI).

Protecting Sensitive Areas and Productive Lands through Prescribed Grazing Within the Root River Watershed

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The Fillmore and Winona County Soil and Water District and Natural Resources Conservation Services have worked in a partnering effort to provide technical and financial assistance to clients to influence the adoption of Rotational Grazing Systems. These systems have helped to improve soil and water resources in the Root River Watershed. Through state and federal cost-share programs, Fillmore and Winona Counties has allocated approximately $ 665,610 to agricultural producers from 2003-2009. The District and NRCS currently has 26 active contracts and has implemented numerous of practices through the Environment Quality Incentive Program (EQIP) and State Cost share programs. The success of the following programs can be measured by the implementation of 255,654 feet of fence, and 173,429 feet of pipeline on 2,849 acres of pasture land. Other practices being implemented through cost share are Heavy Usage Protection for cattle lanes and stationary water tanks to help prevent soil erosion.

Agronomic Responses of Continuous Corn to Tillage, Stover Removal, and Nitrogen Fertilization

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Corn stover is being targeted as a major feedstock for bioenergy production. However, the amount of stover removed from a field can affect the yield of a following corn crop and its response to nitrogen (N) fertilizer. Stover removal may also influence the optimal tillage system with regard to yield and N-use efficiency. In southern Minnesota, concern about yield reductions due to cool and wet soil conditions, high residue amounts, and poorly-drained soils has limited the adoption of reduced tillage systems for continuous corn. When Minnesota producers are presented with the opportunity to sell corn stover for bioenergy production, they need to be aware of how this influences best management practices for N fertilization and tillage. In 2008, a high-yield continuous corn study was established at the University of Minnesota Research and Outreach Center at Waseca on a Nicollet clay loam soil to investigate the effects of stover removal, tillage, and N fertilization on corn growth and yield. Stover removal increased grain yield. Chopping, raking, and baling corn stalks resulted in a yield of 173 bu/acre while yield with no removal was 147 bu/acre when averaged across three tillage systems and six N fertilizer rates. Tillage did not significantly affect grain yield, with yields of 158, 158, and 163 bu/acre for chisel, no-till, and strip-till, respectively, when averaged across all stover management and N fertilizer treatments. Neither stover removal nor tillage system affected the response of grain yield to N fertilization. When averaged across stover management and tillage systems, the economically optimum N fertilizer rate was greater than 200 lb N/acre for a corn price of $3.50/bu and a fertilizer price of $0.28/lb N. While stover removal increased yield in the short-term and did not affect corn response to N, long-term stover removal, even under high fertility conditions, could potentially reduce long-term soil productivity and yield potential.

Validating Top-dressed K Fertilizer Recommendations in an Alfalfa-Corn Rotation

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Potassium (K) fertilizer prices are higher than average and may reduce bottom line returns for alfalfa growers. Potassium supports plant stress tolerance and plays a critical role in alfalfa yield by moving sugars from shoots to roots. Current University of Minnesota recommendations are to apply between 100 and 140 lb K_20/acre for a 6 ton/acre yield goal in fields with medium testing soils (between 81 and 120 ppm K). These recommendations do not change with the age of the alfalfa stand. In 2008 and 2009, K fertilizer recommendations for last-year alfalfa in its third or fourth full year of production were tested on 10 farms with medium soil-test K levels. Alfalfa yield was not improved by top-dressed potash in the early spring or after the first harvest, and no differences were found in overall forage quality. Relative feed quality (RFQ) averaged 200 across all potash rates, farms, and harvests in 2008. Neutral detergent fiber digestibility (NDFD) increased from an average of 44.7% to 47.7% as potash application increased from 0 to 200 lb/acre in 2008. End of season plant density was not affected by soil test K level before or after potash application. Based on these results, there is no apparent benefit from applying potash in the last year of alfalfa production when exchangeable K is greater than 80 ppm at the beginning of that growing season.

Select a Certified Soil and Manure Testing Laboratory

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If you are going to the trouble and expense of sampling crop nutrients in soil or manure, you want to make sure you receive an accurate laboratory analysis. The Minnesota Department of Agriculture (MDA) certifies both soil and manure testing laboratories. In fact, the MDA program for manure testing laboratories is the only certification program in North America. MDA provides manure proficiency samples to about 65 labs, and about 45 of these labs typically meet our certification requirements for manure testing. MDA also collaborates with two different soil proficiency providers to assess the accuracy of about 25 Midwestern laboratories for soil testing. Before investing in laboratory analysis, make sure the laboratory you select has demonstrated their ability to provide accurate results.

Maximizing the Economic Benefits of Manure to Reduce Nutrient Loading

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We present details of the ongoing research & outreach project to maximize the economic benefits of manure, coordinated by the Water Resources Center at the U of MN. The goal of this project is to promote the precise use of manure nutrients to achieve economic and environmental benefits. The goal will be met by (1) presenting small-group educational workshops around the Minnesota to assist producers and agricultural professionals in determining the value of manure, and (2) conducting on-farm research addressing the timing of manure applications. We will discuss current agronomic, economic, and environmental aspects of manure and nutrient management. We will also demonstrate the use of an spreadsheet to readily determine the value of manure under a range of application rates, methods, and fertilizer price regimes.

Nutrient Management Planner for Minnesota Version 3.0

Jose Hernandez jahernan@umn.edu (612) 625-4731
www.mn.nrcs.usda.gov/technical/ecs/nutrient/plant%20nutrient/NMPflyer.pdf
Nutrient Management Planner V. 3 will help you:

- Develop annual field-specific nutrient management plans, providing guidance on location, rate, timing, form, and application method.
- Create long-range strategic nutrient management plans including Comprehensive Nutrient Management Plans (CNMPs).
- Quickly access current University of Minnesota fertilizer recommendations for each field, including the new nitrogen recommendations for corn.
- Get recommendations consistent with the USDA-NRCS-Minnesota 590 (Nutrient Management) Standard and Minnesota State 7020 Feedlot Rules.
- Keep records of past practices.
- Easily generate reports that meet NRCS requirements.
- Determine how many acres you need for manure applications

Optimum Swine Manure Rate on Corn

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Swine manure can be used as one of the renewable nutrient resources due to higher nitrogen (N) and phosphorus (P) contents. However, the required ratio of N and P for plant growth is different than the ratio in the swine manure. Therefore, optimizing swine manure rate can play an important role not only to maximize corn yield but also to help reduce environmental pollution issues. Strip trial study was conducted in 2003, 2005, and 2007 for corn at Christensen farm, Brown County, MN. Swine manure was applied (1750 gal, 3500gal, 5250gal, 7000gal, 1750gal+45N, 1750gal+ 90N, 1750gal+135N, and university of Minnesota recommendation rate (UR)). 5250 gal of swine manure had 191 and 224 lbs of N in 2004 and 2006 and 117 and 110 lbs of P_2O_5 in 2004 and 2006. Each strip was 30 feet wide and 800 feet long. Soil samples were collected from 0-6 inch and 0-2ft in the fall of 2001, 2003, 2005, and 2007 and analyzed for pH, Bray and Olsen P, and inorganic N (ammonium and nitrate). Corn grain samples were measured at physiological maturity and analyzed grain yield and grain quality (oil, protein, and starch). Increased swine manure rate at 5250 gal increased grain yield and protein content. Soil test P levels were increased with swine manure treatment compared to control during the study. Future long-term research may be needed to understand swine manure N and P cycles.

MPCA Feedlot Program

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The Minnesota Pollution Control Agency regulates large feedlots with NPDES/SDS permits that include manure management plans and land application requirements. A new NPDES general permit covering 2011-2016 includes a public

notice process for permit applications and substantial changes to manure management plants. In general, all manure and process wastewater from all livestock operations must be applied to land in a manner that will not result in a discharge to waters of the state during the application process. Also, manure and process wastewater must not be applied using practices known to cause water pollution from manure-contaminated runoff during rainfall or snowmelt events. Using proper rates and application practices helps to maximize the benefits of manure for crop production.

Greater Blue Earth River Basin Alliance- Nutrient Management

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Serving the Counties of: Blue Earth, Cottonwood, Faribault, Freeborn, Jackson, Le Sueur, Martin, Waseca, and Watonwan

Nutrient management planning is a beneficial tool that can be utilized in various farming operations. By having a completed nutrient management plan (NMP), the producer has a detailed overview of the current farming operation and nutrient planning decisions for the given crop year. The process of managing nitrogen, phosphorus, and potassium applications from manure and commercial fertilizers can lead to an increase in crop yields and an improvement in soil conditions while protecting natural resources. Nutrient management planning is not only a great record keeping system, that helps with the creation of NMPs, is also aids in the development of realistic yields goals while decreasing fertilizer costs. The Greater Blue Earth River Basin Alliance (GBERBA) Nutrient Management Specialist is one resource that can help producers make decisions that fit their personal cropping scenarios.

Conservation Marketplace of Minnesota: Establishing an Ecosystem Service Market to Advance Agriculture Sustainability and Conservation Efforts

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Susan Carlin, Minnesota River Board
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Conservation Marketplace of Minnesota (CMM) is establishing a voluntary ecosystem service market to connect landowners and producers who implement credit generating conservation practices with investors. CMM serves as a niche market to advance conservation adoption by increasing economic sustainability of farm operations while providing an efficient implementation method for others with conservation funding or regulatory obligations. CMM recognizes many best management practices require a higher level of land management, such as nutrient management, conservation tillage and integrated pest management. Conservation measures have differences in environmental efficiency, affects on production and economic requirements. CMM is developing markets in the Greater Blue Earth River, Lower and Middle Minnesota River, and Sauk River watersheds, because of the diversity in land use, geomorphology, political settings and market interests. Each of the three project areas are establishing local, self-sustaining infrastructure that allows easy participation in emerging ecosystem service markets. Ecosystem services are quantifiable environmental benefits or values recognized by society. Markets exist where an entity is willing to pay for the ecosystem service. CMM has identified opportunities for water quality credit trading, carbon sequestration, source water protection and habitat credit transactions. CMM utilizes trained local field representatives to connect implementers with investors in a method that provides simple and easy access to these markets.

Wellhead Protection Program in Minnesota

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“Wellhead protection is a program intended to prevent human-caused contaminants from entering wells used by public water supply systems. Over 98% of the over 9,500 public water supply systems in Minnesota rely on groundwater. Because of this, the protection of wells and aquifers which supply them is an important public health issue.”

Minnesota Conservation Funding Guide

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The Conservation Funding Guide is a one-stop online tool farmers can use to learn about key conservation practices, programs and payments. The Funding Guide organizes a wealth of information all in one place, complementing the information provided by local agricultural conservation professionals. It also provides a handy reference for professionals and policy makers. Visit the Funding Guide on the Minnesota Department of Agriculture website at www.mda.state.mn.us/conservationfundingguide.

Polymer-Coated Urea Maintains Potato Yields and Reduces N2O Emissions in a Minnesota Loamy Sand.

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Irrigated potato (Solanum tuberosum L.) production requires large inputs of nitrogen (N), and therefore has high potential for N loss including emissions of nitrous oxide (N2O). Two strategies for reducing N loss include split applications of conventional fertilizers, and single applications of polymer-coated urea (PCU), both of which aim to better match the timing of N availability with plant demand. The objective of this three year study was to compare N2O emissions and potato yields following a conventional split application (CSA) employing multiple additions of soluble fertilizers with single pre-plant applications of two different PCUs (PCU-1 and PCU-2) in a loamy sand in Minnesota. Each treatment received 270 kg of fertilizer N ha-1 per season. A non-fertilized control treatment was included in two of three years. Tuber yields did not vary among fertilizer treatments, but N2O emissions were significantly higher with CSA than PCU-1. Over three consecutive years, mean growing season emissions were 1.36, 0.83, and 1.13 kg N2O-N ha-1 with CSA, PCU-1, and PCU-2, respectively, compared with emissions of 0.79 and 0.42 kg N2O-N ha-1 in the control. PCU-1 released N more slowly during in-situ incubation than PCU-2, although differences in N2O emitted by the two PCUs were not generally significant. Fertilizer-induced emissions were relatively low, ranging from 0.10–0.15% of applied N with PCU-1 up to 0.25–0.49% with CSA. These results show that N application strategies utilizing PCUs can maintain yields, reduce costs associated with split applications, and also reduce N2O emissions.

Urea Decreases N2O Emissions Compared with Anhydrous Ammonia in a Minnesota Corn Cropping System

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Quantifying nitrous oxide (N_2O) emissions from corn (*Zea mays* L.) and soybean (*Glycine max* L.) fields under different fertilizer regimes is essential to developing national inventories of greenhouse gas (GHG) emissions. The objective of this study was to compare N_2O emissions in plots managed for more than 15 yr under continuous corn (C/C) versus corn-soybean (C/S) rotation that were fertilized during the corn-phase with either anhydrous ammonia (AA) or urea (U). Over three growing seasons, N_2O emissions from corn following corn were nearly identical to corn following soybean. However, in both systems, N_2O emissions with AA were twice the emissions with U. After accounting for N_2O emissions during the soybean-phase, it was estimated that a shift from C/S to C/C would result in an increase in annual emissions of 0.78 kg N ha^{-1} (equivalent to 0.11 Mg CO_2-C ha^{-1}) when AA was used, compared to only 0.21 kg N ha^{-1} (0.03 Mg CO_2-C ha^{-1}) with U. In light of trends toward increased use of U, these results suggest that fertilizer-induced soil N_2O emissions may decline in the future, at least per unit of applied N, although further study is needed in different soils and cropping systems. While soil carbon dioxide emissions were 20% higher under C/C, crop residue from the prior year did not affect soil inorganic N or dissolved organic carbon during the subsequent season. We also compared different flux-calculation schemes, including a new method for correcting chamber-induced errors, and found that selection of a calculation method altered N_2O emissions estimates by as much as 35%.

What's the Story on Sulfur?

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Sulfur and nitrogen are elements that are needed by plants in larger quantities. Soil organic matter can provide a large amount of both elements by mineralization of these nutrients to available forms. Research on nitrogen has shown a large benefit to this nutrient when applied to corn; however, research on sulfur has been hit or miss in regards to an economic benefit for application outside of sandy soils with low organic matter. Cool and dry climatic conditions in 2008 and 2009 have brought to light some instances where sulfur deficiencies have been showing up on fine textured soils. While the conditions would favor less mineralization and potential deficiencies there still are questions on where, what, and when sulfur should be applied. Research over the past two growing seasons has shown a benefit for sulfur application in certain circumstances and is attempting to answer some of these questions on sulfur application. The objectives of this work are to identify specific soil variables that may influence response to sulfur and to determine appropriate application rates. Two studies were conducted in 2009. The first study consisted of field length strips comparing starter applied sulfur in combination with nitrogen and nitrogen plus phosphorus across soil types and soil properties for corn and soybeans, and the second study focused on sulfur application rates and timing (application at planting and at V3-V4) on corn yield response at 3 locations grown on fine textured soils.

Conservation Drainage

Dr. Gary Sands, Dr. Jeffery Strock, Dr. John Moncrief, Dr. Andry Ranaivoson, Dr. Rodney Venterea and Mark Dittrich
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Rural drainage systems are being repaired and replaced, providing opportunities to install new, or retrofit existing drainage infrastructure with conservation drainage designs and practices. This project measures the efficacy of three conservation drainage practices measuring in-field flows and water quality, and generating computer simulations for southern Minnesota. These practices can play a vital role in improving water quality in Minnesota and the hypoxic zone in the Gulf of Mexico.

Three Practices.

1. Managed drainage; control structures that retains soil moisture by elevating the water table in the field within 2 ft from the soil surface
2. Shallow drainage; tile lines installed at 2.5-3ft depth rather than 4-5 ft depth.
3. Woodchip bioreactor; trench filled with woodchips, capped with topsoil, receiving tile water to filter and bio-remediate nutrients, bacteria and pesticides.

Results

Managed Drainage: Nicollet and Mower County field sites.

- 20% reduction in flow and nitrate loads in managed drainage plots.

Computer simulations for managed and shallow drainage: Lamberton, Waseca and Mower sites.

- Lamberton exhibited the greatest drainage volume reduction for shallow and managed drainage and Mower the least.
- Managed drainage provided 15% volume reduction beyond shallow drainage, at each location.

Woodchip Bioreactor: Rice and Dodge County Sites

The primary focus at these sites was to retain tile water in woodchips long enough to significantly reduce nitrate concentrations.

- 50% of nitrate reduction was completed in 32 hours; 30% reduction in 22 hours, and 100% in 50 hours.
- Phosphorus concentrations were also reduced by about 50%.

Conclusions

- When managed drainage and woodchip bioreactors are used in unison, they can reduce flow and nitrogen loads by 50-80%.
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Managing Nitrates in the Drainage System

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As a result of many projects Brown-Nicollet-Cottonwood Water Quality Board (BNC WQB) has been trying to reduce the amount of nitrates and other impairments in the Seven Mile Creek and Little Cottonwood Watersheds since its inception. Some of the projects involved several different management practices implemented to reduce the nitrate load in these streams. First, BNC WQB worked with individual farmers and landowners to reduce the amount of nitrates applied. BNC WQB realized that nitrate loads could not be reduced by only reducing the amount of nitrates applied on the fields and began to study and implement Best Management Practices (BMPs) that provide denitrification and filtration of nitrates. The second series of BMP projects involved traditional filter strip and wetland restoration projects to intercept surface and tile water. Currently BNC WQB is working on two different projects involving tile drainage management. These two projects involve controlled drainage and interception of tile water to be pumped into a wetland for denitrification. To date our results of these projects have been promising. Controlled drainage has measured about a 50% reduction in nitrate load leaving the tile system. Nitrate load is reduced because the total volume of the drainage water is reduced by about 25% and further reduced approximately 25% because the water resides in the soil profile longer. The increased residence time allows for the plants and microbes to utilize more of the nitrates. The other pilot, as mentioned above, project involves draining tile water into a sump station and pumping water, via a solar powered pump, into a nearby wetland. This practice continues to be monitored for effectiveness. Initial results, during a dry summer, are promising; almost 100% of the water was drained during daylight hours. This is about 50% of the total volume of water drained. No water left the wetland throughout the year. Unfortunately this particular project has not been stressed tested yet.

Field-scale Evaluation of *Escherichia coli* and Nutrient Transport Through Subsurface Tile Drainage Water

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Dr. Shannon Fisher, Faculty Advisor, Biology

Water quality is a global issue, and anthropogenic actions contribute the most to the detriment of aquatic systems. Microbial contamination and eutrophication of freshwater systems continue to be an issue. The focus of this project was to analyze differences in *Escherichia coli* (*E. coli*) and nutrient movement in subsurface drainage water from manure and non-

manure agricultural fields with and without surface tile intakes. The Water Resources Center at Minnesota State University - Mankato maintains five field-scale monitoring stations and partners with the Cannon River Watershed Partnership, Minnesota Department of Agriculture and the University of Minnesota to collect samples at an additional seven sites across southern Minnesota. Tile water is collected by an Isco 6712 automated sampler that collects 24 one liter samples over a 24 hour period. Samplers are triggered by increases in tile water velocity or stage during rain events. Where automated equipment is not feasible, grab samples are collected. For each rain event sampled, 4-6 samples were taken from the auto-sampler. All samples are analyzed for total and ortho-phosphorus, nitrate+nitrite, and total suspended solids at Minnesota Valley Testing Laboratories. *E. coli* samples are also collected and analyzed at Minnesota State Mankato's Environmental Laboratory. The purpose of this project was to use agriculture field-scale settings to gain insight about the movement of *E. coli* and nutrients into subsurface tile drainage systems; therefore, providing knowledge and ability to improve best management practices in agricultural production of crops.

Cannon River Watershed

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Ongoing assessment of the Upper Cannon sub-watershed has found impairment due to excess nutrients and sediments. The Upper Cannon Assessment Project (UCAP) is a multi-agency effort to quantify water quality problems and evaluate potential solutions. Extension in Rice, Steele, and Le Sueur Counties developed a plan to assess current tillage practices and evaluate the effectiveness of strip-till as a farming practice that has been shown to reduce erosion.

Thank you for attending the conference.