Research Activities

PHASE I
The first phase of research is referred to as the calibration phase. The calibration phase helps determine if there are similarities between plots, specifically if the hydrologic patterns respond to storm events in a similar manner. If each plot responds consistently with one another during the calibration phase, then researchers can be confident that differences observed during the treatment phase are due to the practices imposed on each of the plots. The calibration phase continued until the number of recorded events was adequate to perform an evaluation. The results of the evaluation were used to determine the experimental design and to ensure that observed differences between plots in the future are statistically valid.

During the calibration phase, all drainage plots were uniformly managed and the stop logs in all six control structures were held at a constant elevation of three feet below the soil surface to simulate common tiling depth in this region

PHASE II
The second phase of the research is referred to as the treatment phase. The focus of the treatment phase is to evaluate a set of agricultural management practices and monitor the associated nutrient and sediment losses. The management practices evaluated during the treatment phase could include changes in drainage water management, fertilizer type, rate, timing, or placement. The economic impact of these changes will also be recorded during the treatment phase. Based on the outcome of the calibration phase, the experimental design at the site is a paired watershed approach.

Timeline

Monitoring equipment was installed during the 2010 growing season. The calibration phase began in 2011 and consisted of five complete years of data collection (2011-2015). The project shifted from a calibration phase into a treatment phase in 2016. The treatment phase is designed to compare controlled drainage (drainage water management) and conventional drainage. Controlled drainage is the process of managing the timing and amount of water drained from subsurface tile. Conventional tile drainage is subsurface tile that flows freely throughout the year. This is a long-term research project that is expected to last for a period of at least ten years

Education, Outreach and Partnerships

Minnesota Department of Agriculture will host field days as well as private site tours to share results. Minnesota Department of Agriculture staff make presentations at scientific meetings and conferences and are happy to share information with a group of any size.

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MINNESOTA DEPARTMENT OF AGRICULTURE

CLEAN WATER LAND & LEGACY AMENDMENT

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Clay County Drainage Site

Innovative Research with Innovative Farmers

Unique Opportunity to Study Drainage in the Red River Valley

The Clay County Drainage Site offers a unique opportunity to monitor the environmental impacts of both surface and sub-surface drainage from agricultural fields. This site includes six sub-surface drainage plots and one surface drainage plot.

Project partners are working together to answer these key questions:

- What is the range of nitrogen, phosphorus and sediment in drainage water when agricultural fields in the Red River Valley are artificially drained?
- How effective are certain agricultural management practices at reducing nutrient and sediment losses from these artificial drainage systems?

Description of the Research site

The Clay County Drainage Site is located in the Red River Valley, approximately 15 miles north of Moorhead in northwest Minnesota. This area is characterized by flat topography (0-1% slope), large fields and a short growing season. Agricultural crops are grown on approximately 70% of the acres in the area; major crops include corn, soybeans, spring wheat, edible beans and sugar beets. The soils in this region are highly productive and are classified as silty clay loam.

The Red River Valley has experienced an increase in the installation of sub-surface drainage. Drainage tile is common in other areas of the state; however it has only recently become a widely accepted method of drainage in this region. Drainage tile is installed below the soil surface to remove excess water in order to do fieldwork and provide soil conditions for good crop growth. Historically, agricultural drainage in the Red River Valley was accomplished with surface drainage ditches.

About the Clay County Drainage site

Beginning in 2010 the Minnesota Department of Agriculture allocated Clean Water Fund dollars (from the Clean Water, Land and Legacy Amendment) to instrument this site and monitor both the quantity and quality of artificially drained water that leaves this field. The soils and topography across the Clay County Drainage Site are representative of some of the most productive agricultural areas in the Red River Valley. Information collected will help local crop advisors, conservation professionals and policy-makers understand the impacts of crop land drainage in the region and provide relevant information to producers and landowners. Evaluating the water quality from surface and sub-surface drainage plots over a long period of time (>10 years) will provide an important comparison of two drainage practices and enhance the limited amount of scientific data that currently exists. Information collected will be used for educational and research purposes.

A Field scale Approach

Research activities are occurring in cooperation with the producer who owns the land. The monitored field is approximately 155 acres in size. Sub-surface drainage tile is installed at 55 foot spacing and a four foot depth with a gradient of just eight inches of drop over the half mile length of the field (very flat landscape). The sub-surface drained area consists of six individual plots that range from 20-24 acres in size. The central surface plot is 24 acres in size with a shallow drainage way carved into the field to direct surface runoff from this plot to one outlet location. The rotation on this field includes corn, edible beans and sugar beets.

Edge-of-Field Monitoring

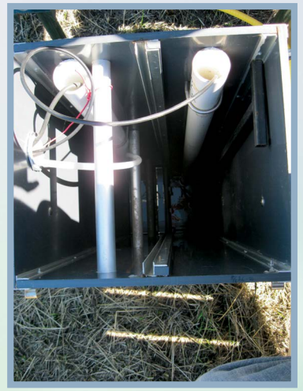
Edge-of-field sites provide information about the amount of water, nutrients, and sediment moving off a field by surface and sub-surface drainage into an adjacent waterway. Seven edge-of-field sites are monitored separately and fully automated to collect water samples whenever runoff occurs. Grab samples are manually collected during dry periods (i.e. between storms). Water samples are analyzed for nitrogen, total phosphorous, ortho phosphorus, and total suspended solids (surface drainage plot only).

Sediment, phosphorus and nitrogen water quality data are reported as yield and flow weighted mean concentration. Yield is presented as pounds per acre (lb/ac) and is defined as the total load divided by the area of the plot. Flow weighted mean concentration is reported as milligrams per liter (mg/L) and is defined as the total load divided by the total water volume. By combining the measure of water flow with measures of sediment and nutrient concentration, it is possible to calculate total nutrient and sediment loss from a field.

Monitoring equipment

Both the sub-surface and surface drainage plots are sampled with automated water samplers. The primary difference between the monitoring setup for surface and sub-surface plots is the method used to calculate the amount of water that flows from each plot.

Sub-surface water flow is monitored inside an AgriDrain control structure located at the outlet of each of the six sub-surface drainage plots. Inside each control structure are stop logs that can be used to manage the water table in the field. Water levels are measured in each control structure to calculate the volume of water discharged from the plot.



The flow of water from the surface drainage plot is measured through a 2 foot H-flume at the outlet. The depth of water in the flume is measured continuously and then converted to flow based on the dimensions of the flume. The wing walls (plywood on either side of the flume) direct water through the flume and water samples are collected automatically whenever runoff occurs.

In addition, precipitation and air temperature are continuously measured. Soil moisture and soil temperature are measured near the surface drainage monitoring station.