AN ARKANSAS DISCOVERY FARM FOR COTTON

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Introduction

Arkansas cotton farmers are under increasing pressure to operate with environmental sustainability. The U.S. Environmental Protection Agency (USEPA) considers agriculture as a leading source of water quality degradation. Within the Mississippi River drainage basin, large–scale, basin-wide, water quality modeling efforts by the United States Geological Service projects agriculture in States along the Mississippi River corridor as the leading source of nitrogen and phosphorus delivery to the Gulf of Mexico where excessive nutrients are thought to be the cause of large hypoxic (waters with low dissolved oxygen) zone within the Gulf. In addition, several streams in eastern Arkansas have been declared by the Arkansas Department of Environmental Quality (ADEQ) as being impaired due to high turbidity levels thought to be caused by sediment delivery from row crop agriculture and are in need of Total Maximum Daily Loads determination as required by the Clean Water Act.

These issues have been defined by in-stream or in-body water quality monitoring or by modeling stream systems based on water quality data from in-stream monitoring. While in-stream monitoring can define elevated nutrient or turbidity levels, it does not by itself clearly define the source. Often agriculture has been targeted based on data generated by modeling. However, little data exists that quantifies edge-of-field losses from agricultural operations and tracks these losses through drainage pathways to streams and rivers. Edge-of-field data is needed to truly determine agriculture's impact on these issues. This need has been recognized by the USDA-NRCS as it now provides financial assistance to eligible agricultural producers to conduct edge-of-field monitoring through conservation activities 201 and 202.

To help agricultural producers take ownership of documenting environmental impact and water-related sustainability, the University of Arkansas' Division of Agriculture in conjunction with many stakeholder groups launched the Arkansas Discovery Farm (ADF) program in 2011. Discovery Farms have been established in eight locations for all major row crops and livestock operations. This program utilizes a unique approach based on agriculture producers, scientists and natural resource managers working jointly to collect on-farm economic and environmental data to better define sustainability issues and find solutions that promote agricultural profitability and natural resource protection. While the University of Arkansas' Division of Agriculture provides leadership and expertise to ensure that data is collected in a scientifically rigorous and valid manner, the program is led by the ADF Stakeholder committee consisting of leaders from agricultural organizations and one seat reserved for environmental organizations. The Stakeholder committee is supported by the Technical Advisory committee consisting of representatives from State and Federal agencies that assist agriculture.

Goals and Objectives

The overall goal of the Arkansas Discovery Farm program is to document sustainable and viable farming systems that remain cost-effective in an environmentally sound manner. The following objectives would be applied to each farm:

1. Conduct on-farm research and monitoring to assess the need for and effectiveness of best management practices (BMPs). This will also help determine individual and synergistic nutrient and sediment loss reduction efficiencies and water conservation.

2. Provide on-farm verification and documentation of nutrient and sediment loss reductions and water conservation in support of nutrient management planning and sound environmental farm stewardship.

3. Develop and deliver educational programs from on-farm data that will assist producers in achieving both production and environmental goals in support of sustainable farming in Arkansas.
   The specific objective for the Cotton Discovery Farm in 2013 was to document the impact of water management, cover crops and crop rotation on water quality and quantity as it relates to sustainable cotton production in Arkansas.

   Specific tasks included:

1. Quantify irrigation water use and tail water runoff volumes in furrow irrigated cotton

2. Monitor and quantify any sediment and nutrient losses associated with runoff associated with precipitation and irrigation

Approach

In 2012, with financial support from the State of Arkansas and Cotton Incorporated, the University of Arkansas' Division of Agriculture established a Cotton Discovery Farm in Desha County in Southeastern Arkansas. In the spring of 2013, monitoring the quality and quantity of water inflow (precipitation and irrigation) and outflow (edge-of-field runoff) was initiated.

The Arkansas Discovery Farm is located in Desha County near Dumas, Arkansas (Figure 1). Four fields were selected for monitoring with fields Dum2 (Shopcot, 22 acres), Dum3 (East Weaver, 38 acres) and Dum4 (Homeplace, 39 acres) in cotton for 2013 (Figure 2).

Figure 1. Location of the Arkansas Cotton Discovery Farm

At the lower end of each field, automated, runoff water quality monitoring stations (Figure 3) were established to: 1) measure runoff flow volume, 2) to collect water quality samples of runoff for water quality analysis and 3) measure precipitation. The ISCO 6712 automated portable water sampler was utilized to interface and integrate all the components of the flow station. Runoff flow volume was collected with a trapezoidal flume especially designed to measure flow in agricultural drainage channels. An ISCO 720 flow module equipped with a submerged pressure transducer used to measure the hydraulic head (H) at a flow-calibrated measurement point within the trapezoidal flume and was integrated with the automated sampler. Runoff discharge at any given time was estimated from the equation:

$$Q = 1.467\,H^{2.5} + 2.22\,H^{1.5}$$

Q = discharge in cfs
H = head in feet

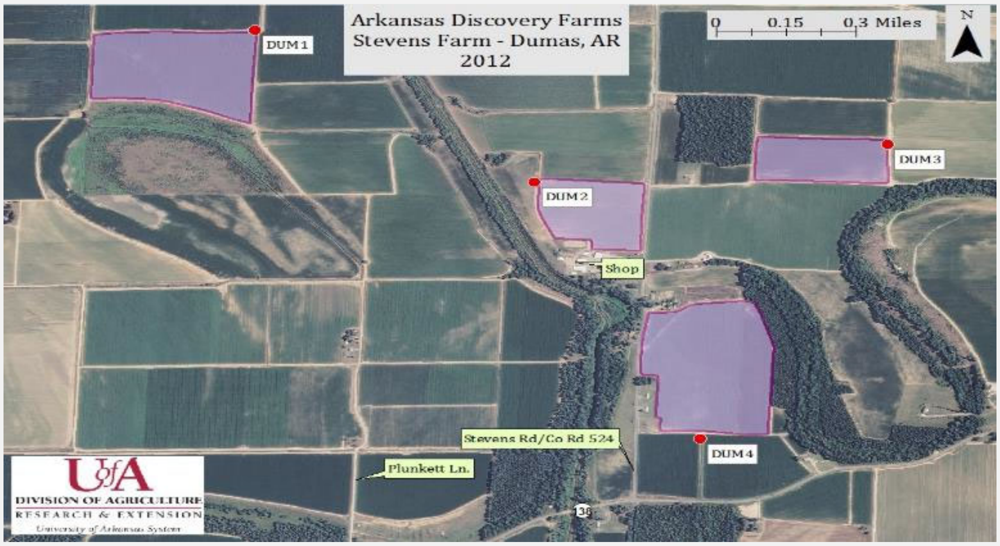

Figure 2. Aerial view of the farm showing location of the fields that are being monitored as part of the Arkansas Discovery Farm Program

Figure 3. Components of an automated water quality monitoring station including an ISCO integrated automated sampler (upper right), tipping bucket rain gage (lower right) and trapezoidal flume for measuring runoff volume (upper and lower left).

Hydraulic head data and runoff discharge data was downloaded into the ISCO Flowlink software where discharge curves integrated over time (hydrographs) were used to calculate total discharge for a single runoff event.

Discharge data were utilized to trigger flow-paced, automated collection of up to 100, 100-ml subsamples which were composited into a single 10 liter sample. Flow pacing was used to ensure that subsamples were collected along both the rising and falling limbs of the hydrograph.

At the completion of sampling for a given event, a text message was sent to cell phones via a wireless modem to indicate that a sample was ready for collection. A subsample of the 10 liter sample was collected, processed in the field for preservation and shipped in insulated shipping vessels to keep samples chilled to meet EPA guidelines for prepping and handling samples. Samples were shipped to the University of Arkansas' Water Resources Lab (certified by the Arkansas Department of Environmental Quality) to determine concentration of ortho-phosphorus, nitrite-nitrate- Nitrogen, total nitrogen, total phosphorus and total solids according to handling, prepping and analytical methods outlined by EPA.

Mass loading of nutrients and solids were calculated using the equation:

$$\textit{Mass loading} = \textit{nutrient concentration} * \textit{integrated runoff discharge}$$

Precipitation at the site was measured using a plug and play tipping rain gage (Figure 3) that was integrated with the 6712 sampler. Irrigation volume was measured with a turbine-type, in-line irrigation flow meter equipped with a data-logger (Figure 4) that automatically record flow volumes. Flow data was down loaded periodically in the field with a laptop computer.

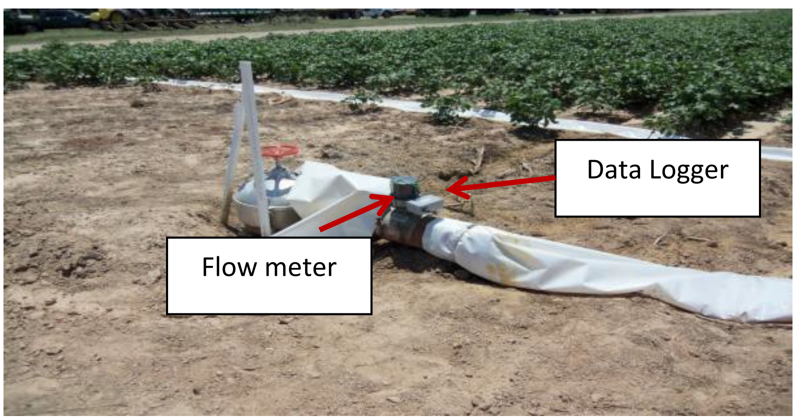

Figure 4. Turbine-type, in line irrigation flow meter equipped with data logger to automatically record irrigation flow volume.

Summary

Documenting environmental impacts of Arkansas farming systems, as well as evaluating the efficacy and cost-effectiveness of alternative practices, will bridge a knowledge gap that now keeps farmers, natural resource managers and decision-makers alike from confidently taking effective actions that ensure both economic and environmental sustainability. This program, as well as the formation of strong partnerships has the potential to affect millions of agricultural acres across the state. Program results will also give all of us the confidence that we are doing our part to maintain safe and affordable food supplies while protecting our natural resources for future generations of Arkansans.