The Arkansas Discovery Farms Program

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Discovery Farms are privately owned farms that have volunteered to help with on-farm research, verification, and demonstration of farming's impact on the environment and natural resource sustainability. We currently have six Discovery farms in five counties of Arkansas; including a poultry farm in Washington County, a beef cattle operation in Conway County, a rice-soybean and corn operation in Arkansas County, two adjacent rice-soybean operations in Cross County and a cotton farm in Desha County. We collect water use and water quality data from several fields on each of these farms, utilizing automated ISCO samplers equipped with rain gauges, sensor equipped edge-of-field H-flumes, pipes or weir flow structures. In Washington County, we are monitoring runoff originating immediately near poultry houses due to concerns with spillage of litter during bird removal and house clean out, as well as dust accumulation from tunnel ventilation. We are also quantifying the nutrient and sediment remedial efficiencies of capturing runoff in a farm pond and an un-grazed grass filter strip. In Conway County, we are assessing runoff from pastures and the ability of a wetland to capture and assimilate nutrients. In Arkansas County, we are examining whole farm water management three 80-acre rice and soybean fields with different irrigation scheduling and nutrient management practices, a corn field, and runoff from 1,200 acres that drains back to an irrigation reservoir. In Cross County, we are monitoring a 65-acre rice and soybean field under conventional production, and a 23-acre soybean field and 105-acre soybean field under conservation tillage. Finally, in Desha County, we are monitoring the effects of conservation tillage and cover crops on nutrient and sediment loss from four fields in cotton. However, the Arkansas Discovery Farms program is not just about monitoring but just as importantly, empowering farmers to proactively address environmental concerns. This paper discusses the development, guidance, principals and goals of the Arkansas Discovery Farm program.

Introduction

The Arkansas Discovery Farm (ADF) program uses a unique approach based on agriculture producers, scientists and natural resource managers working jointly to identify issues and potential solutions. The Arkansas Discovery Farm strives to collect economic and environmental data to better define sustainability issues and find solutions that promote agricultural profitability and natural resource protection. The program uses extensive and state-of-the-art water quality monitoring systems installed on real, working farms to document environmental and natural resource impact and to investigate solutions to reduce off-farm impacts. The overall goal of the 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 program is based on following four cornerstones; 1) sound science, 2) unbiased,

research-based, 4) stakeholder driven transparency and 5) partnerships.

1. Sound science

The case of relating runoff from agricultural operations to in-stream water quality data is not as clearly defined as very few studies have been designed to monitor runoff from real, working farms in Arkansas and track these losses through drainage networks to in-stream monitoring sites in Arkansas. Thus determining cause and effect relationships between agriculture and in-stream water quality is difficult due to this void in data. This knowledge gap has been the primary catalyst that makes water issues related to agriculture controversial and emotional. The Discovery Farm approach strives to collect data from real, working farms to help base decisions on sound science rather than emotion.

Runoff and water use studies on real, working farms typically do not conform to the traditional statistical approaches used in other aspects of agricultural research due to the nature of the issue and the cost of state-of-the-art automated water quality sampling. Edge of field monitoring of runoff from the entire field (management unit) is a more appropriate scale rather than traditional small plots to study the effects of management practices on water use and quality as well as other hydrologically related processes.

Thus replicated plot designs do fit the sampling protocol. We typically equip three to four sites (fields) with monitoring stations which allows us to conduct field by field comparisons or compare two to three scenarios with a control site. In this manner, we can look at a singular issue such as water management, tillage, or crop rotation. Because we conduct this research on real-working farms at a field-scale, we cannot predetermine what factors to investigate without first meeting with the host farmer and conducting a thorough farm reconnaissance and developing a research plan that both applies directly to the participating farm, but where results can also applicable to the peers and the region.

2. Unbiased, Research-based

The concern over potential water quality impacts originating from agricultural operations has prompted much controversy and has created a sometimes emotional issue among agricultural producers who feel they have been unfairly targeted. Under the Clean Water Act, the Arkansas Department of Environmental Quality (ADEQ) as well as the United States Geological Survey (USGS) have collected considerable in-stream water quality data (ADEQ, 2012; USGS, 2012) and the Arkansas Natural Resources Commission (ANRC) and USGS have developed a network of groundwater wells in Eastern Arkansas to monitor declining groundwater levels (ANRC, 2012). In the case of groundwater, it is generally accepted by all stakeholders that irrigation is the primary user of groundwater in critical groundwater areas of Eastern Arkansas.

Each monitoring station is equipped with a flow outlet structure such as a flume or weir so that runoff volume can be measured either by a flow stage pressure transducer or a flow velocity profiler (Figure 1). At each station, an ISCO 6712® automated water sampler equipped with a weather station is housed in a storage unit and will automatically collect water samples at pre-programmed intervals once water flow is detected at the flume or weir so that a representative, composite sample can be collected over the course of a runoff event (Figure 2). For example, each sampler is programmed to collect one hundred, 100 milliliter (mL) samples integrated across various stages of the flow hydrograph, or up to a total of 10 liters during each runoff event. Each sample is collected and analyzed following protocol set forth by the USEPA for suspended solids, sediment, nitrogen and phosphorus. Runoff volume is calculated from pressure transducer measurements or velocity flow measurements using the appropriate equations that describe the type of flow structure (weir, flume, pipe, etc.). Flow-weighted concentrations are calculated to determine loads (mass) lost in runoff from fields.

Irrigation water use is monitored with propeller flow meters outfitted with data loggers (Figure 3). On some Discovery farms Atmometers (, ET gauges) are being demonstrated as an irrigation scheduling tool to compare to the Arkansas Irrigation Scheduler. Watermark sensors and dataloggers are being utilized track soil moisture. Monitoring stations at the drainage outlet of the field allows for determination of water quality and quantity of tailwater and irrigation system performance. (Figure 4).

3. Stakeholder Driven Transparency

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 (Table 1) 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 (Table 2). Currently, the Nature Conservancy and the state regulatory agency, ADEQ serve on our Stakeholder and Technical Advisory Committees to ensure transparency among all stakeholders.

5. Partnerships

In addressing water resource issues, partnerships are essential. Several partners have stepped forward with financial contributions through grants, gifts, and contracts to help fund this program (Table 3). These partners include both public and private entities. One interesting aspect of our partnership is the participation of the Discovery Farms in the Mississippi Healthy River Basin Initiative (MRBI) program. The Natural Resource Conservation Service administers this financial incentive program ($320 million) for agriculture in thirteen states along the Mississippi River Corridor. One of the unique aspects of this program is that the NRCS provides financial incentives to producers to conduct edge-of-field monitoring under Conservation Practice Standard (CP) 799. Three of our Discovery Farms currently participate in this program and are under contract for CP Standard 799.

Current Status

The statewide program currently consists of six farms in five different physiographic farming regions of Arkansas (Figure 5). The program targets dominant farming systems in Arkansas. The following is a brief description of the four current locations:

Northwest Arkansas Poultry- Beef Operation (Washington County) –This effort focuses on monitoring runoff originating around production houses. Under the new CAFO regulations, USEPA is becoming concerned with "discharge" waters that interacts with litter spilled during house clean-out, litter temporarily stored uncovered during cleanout, and dust that accumulates from tunnel fan ventilation. This farm has 6 houses (equipped with tunnel ventilation) located at one site where runoff flows to a farm pond from two houses and where runoff flows from 4 houses across a pasture and into an ephemeral creek that flows directly to the White River. In 2011, monitoring stations were installed to quantify nutrient and sediment loadings captured by the pond and immediately before entering the pasture and immediately before reaching the creek to determine if, when and how much nutrients and particulates are transferred to runoff water from around the poultry houses and will quantify the nutrient and particulate trapping efficiencies of the pond and pasture.

Point Remove Beef and Row Crop Farm (Conway County) –This farm raises beef on pastures immediately adjacent to Point Remove Creek and the Arkansas River. These pastures are fertilized with litter that is purchased from other farms. Many of the pastures are utilized to produce irrigated, high quality Bermuda hay and are underlain by poorly drained soils that stay saturated for portions of the winter months and are prone to intermittent flooding. In one pasture, runoff drains into a natural wetland. We have instrumented sites to determine the effect of poultry litter management (i.e., rate, timing and placement) on nutrient runoff

from pasture and to quantify the wetland's ability to capture and store nutrients and sediment by monitoring runoff entering the wetland.

Cherry Valley Rice-Soybean Rotation (Cross County): Two farms adjacent to the L'Anguille River, one on the east side and one on the west side of the River, were selected as they offer a contrast in conservation practices. One uses conventional tillage and water management for the area, while the other uses conservation tillage and has implemented switch grass filters between the river and fields via Conservation Reserve Program (CRP). These farms are located in a recently declared as a Critical Groundwater area by the ANRC. Because fields in the study region are not candidates for leveling due to cost and the risk of exposing underlying soil horizons that are detrimental to crop production, flood irrigation is still the preferred irrigation method for soybeans. The conventional site uses ground water as an irrigation source, while the conservation site uses a combination of surface sources (re-lift from the L'Anguille) and wells. Through the MRBI, the conservation site has been approved for reservoir construction. Runoff from two fields on this farm will be monitored; for one field, traditional flood irrigation is used for both rice and soybean and drains through a switch grass border and on the other field furrow irrigation is used for soybeans and runoff will eventually be captured by a new tail-water recovery system and reservoir. By monitoring runoff, nutrients, and sediment from the two adjacent rice-soybean systems, we will be able to determine the effect of conservation management on nutrient and sediment losses.

Rice-Soybean Rotation (Arkansas County): This farm has been in a Critical Groundwater decline area for several years. The farm no longer has active irrigation wells in the shallow alluvial aquifer. It does have one well in the deeper (>600 ft) Sparta aquifer but pumping costs render it for emergency use only. The entire farm is irrigated using an on-site surface water reservoir, and all water draining from the farm is captured via tail-water recovery systems and returned to the reservoir. This farm represents a unique opportunity to highlight reuse of water, an issue of national prominence across all sectors of society across the Nation. We have 5 stations to monitor water use and runoff water quality under: 1) rice-soybean rotation on a zero-grade field; 2) rice-soybean rotation on non-graded field (conventional); 3) corn production on precision-graded field; 4) rice-soybean rotation on a precision-graded field; and 5) at the central drain for the entire farm, where runoff drains back to the reservoir. With the this last station we can assess water reuse and nutrient and sediment loss at a farm scale.

Cotton, Corn and Soybean Production (Desha County): This farm grows cotton, corn and soybeans in southeastern Arkansas. We have installed automatic water samplers so that we can monitor the inflow and outflow in four fields where cotton and corn are in rotation. This farm is located in a current groundwater decline study area where intensive groundwater well monitoring is being conducted by the State to determine if the area needs to be declared as a "Critical Groundwater Area" where producers will have to report groundwater withdraw to the State.

Expected Results / Impact

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.

References

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Table 1. Members of the Arkansas Discovery Farm Stakeholder Involvement Committee.

Member	Affiliation
Woody Bryant (Chair)	Arkansas Dairy Producer
Andrew Wargo (Liaison)	Arkansas Association of Conservation Districts
Terry Dabbs	Arkansas Farm Bureau
Jennifer James	USA Rice Federation
Adam McClung	Arkansas Cattlemen's Association
Scott Simon	Arkansas Nature Conservancy
Gene Pharr	Poultry Producers
Dennis Sternberg	Arkansas Rural Water Association
Steve Stephan	Arkansas Pork Producers Association
Brad Doyle	Arkansas Soybean Association
Max Braswell	Arkansas Forestry Association
Andrew Grobmeyer	Arkansas Ag. Council

Figure 1. Various flow structures used in the Arkansas Discovery Farm program to quantify runoff volume: a) 3.5 foot h-flume to collect runoff from around poultry houses, b) culvert under cattle crossing to collect runoff from pasture (Manning's Equation), c) rectangular weir in fice field (also flood depth control and d) monitoring open channel pipe flow from soybean field; sampling strainer and pressure transducer are also shown for collecting water samples.

Figure 2. ISCO 6712® automated water quality sampler and associated rain gauge.

Figure 3. Irrigation flow meter equipped with data logger to monitor irrigation quantity.

The Arkansas Discovery Farms Program
Daniels, Mike

Figure 4. Evapotranspiration (ET) gauge equipped with data logger to estimate daily ET values and to schedule irrigation.

Figure 5. Location of the Arkansas Discovery Farms.