Proactive Stakeholder Program Measures On-farm Effectiveness of Conservation Practices that Reduce Fertilizer and Manure Nutrient Loss

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Livestock and crop agriculture are often cited as major contributors of nonpoint source (diffuse) losses of soil and nutrients to water resources.

Runoff losses of soil and nutrients from representative farm fields are being investigated under different conservation and nutrient management practices in Arkansas, through a collaborative farmer-stakeholder partnership program.

Results to date indicate that Arkansas farmers are helping to keep sediment and nutrient losses lower than what many had previously perceived.

The Arkansas Discovery Farm (ADF) Program is a statewide collaborative effort to monitor and demonstrate the on-farm effectiveness of conservation practices (CPs) to minimize nutrient runoff (Sharpley et al., 2015). A similar effort is in various stages of operation in Minnesota, South Dakota, and Wisconsin and all are charged to some extent to develop nutrient loss reduction strategies to mitigate local and regional water quality concerns.

Nutrient enrichment remains a major impairment to the designated uses of fresh and coastal waters of the U.S. (Dale et al., 2010; Jarvie et al., 2015; Rebich et al., 2011). While there are many sources of nutrients, the contribution of agriculture, in particular intensive livestock and crop production, has received increased attention to reduce nutrient losses. This attention has been fueled by recent modeling efforts and surveys that have suggested that agriculture remains a major contributor of nutrients to surface waters and their impairment. For instance, a recent model estimates that up to 85% of the N and P entering the Gulf of Mexico originates from agriculture, with Arkansas estimated to be the fourth largest contributing state (Alexander et al., 2008). These estimates are based on large-scale modeling within the Mississippi River Basin. Few farm- or field-scale studies of P and N loss from agricultural production systems have been done in the Basin.

One of the first tasks to determine the need for any additional conservation or nutrient management practice changes on a farm is to determine whether nutrient runoff is an issue or not. There are 12 ADFs operating across Arkansas (**Figure 1**), to measure sediment and nutrient loss from representative fields and farms. Uniquely, the Program involves agriculture producers, scientists, and natural resource managers in work to jointly identify on-farm conservation issues and potential solutions. The Discovery Farm approach to agricultural sustainability challenges is based on the following four cornerstones: 1) sound science, 2) unbiased research, 3) stakeholder driven transparency, and 4) strong partnerships. In Arkansas, the CPs evaluated include managing the rate, timing and placement of fertilizer, reducing tillage, use of cover crops, buffer strips, and water harvesting, along with other practices.

How the Program Works

Only farm operations reflective of typical crop, livestock, and poultry systems are used. Most often, we equip three to four sites (fields) with monitoring stations, which allow us field by field comparisons or comparisons of two to three scenarios, with a control site. At each site, state-of-the-art equipment is installed to monitor runoff, nutrient and sediment transport, and irrigation water-use efficiency. Equipment to monitor flow can vary from site to site depending on field size and presence or absence of natural drainage outlets.

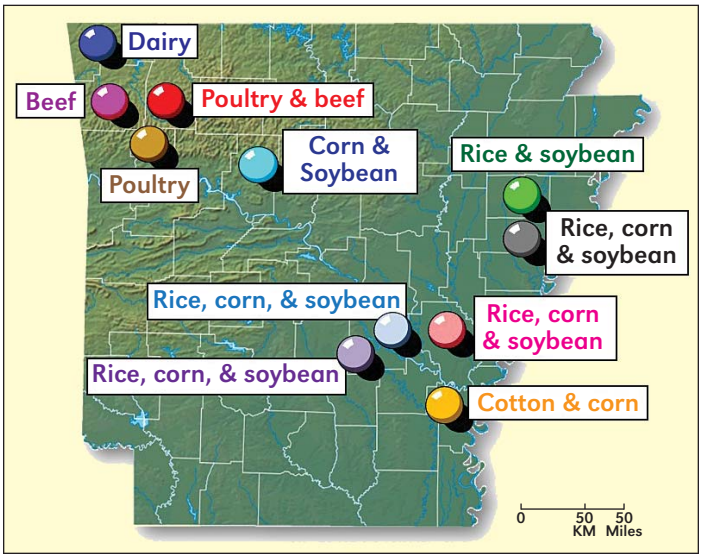

Figure 1. Location of Discovery Farms in Arkansas.

Generally, auto-samplers are programmed to collect 100 ml samples integrated across various stages of the flow hydrograph—with up to a total of 10 L during each runoff event. Each composite flow-weighted sample is collected and analyzed following U.S. Environmental Protection Agency standards for suspended solids, N (as nitrate-N, ammonium-N, and total N), and P (as dissolved and total P) within 24 hours of collection.

For irrigated row crops, irrigation inflow is measured with in-pipe flow meters to determine application rates and cumulative irrigation volume. In some situations, evapotranspiration (ET) gauges are utilized to estimate daily ET losses. Soil moisture sensors are utilized to estimate change in soil water volume. Monitoring stations at the drainage outlet of the field

Abbreviations and notes: N = nitrogen; P = phosphorus.

Flumes to measure discharge from fields near Wedington, Arkansas (left) and Dumas, Arkansas (right).

allow for the determination of "tail water" losses from irrigation and/or rainfall.

What has been Learned to Date?

Nutrient runoff from pastures fertilized with mineral as well as manure nutrients can be reduced three-fold by simply maintaining a good stand of grass cover, avoiding concentrated water flow, and avoiding nutrient applications to wet soils when heavy rains are forecast in the next 3 to 5 days. For instance, on one poultry/beef grazing operation, the farmer set aside an ungrazed, unfertilized pasture as a grassed waterway to capture and trap nutrients running off from around the broiler house area. Averaged across 2013 to 2015, annual runoff flow, P, and N decreased 88, 50, and 29% respectively, over the 686 ft. reach of pasture (**Table 1**).

Table 1. Mean annual runoff flow, and total P and N loss from poultry houses decreases after passing through a 686 ft. grassed waterway (2013 to 2016), Arkansas.

Location	Flow	Total P	Total N
	gal/A/year	------ lb/A/year ------	
In flow	693,720	0.4	1.4
Out flow	80,540	0.2	0.4

One common finding has resonated with our row crop farms: only a small proportion of the N and P applied as fertilizer each year is lost in runoff from no-till corn, cotton, rice, and soybeans (**Table 2**). Typically, these losses are less than 5% of that applied. Losses are decreased further where winter cover crops were planted to protect the soil surface and the applied nutrients and crop protectants from runoff and erosive forces.

Because of dramatic declines in aquifer levels over the last decade in the Delta region of Arkansas, these areas are now designated by the state as critical groundwater zones. As a result, more farmers are turning to land-levelling and water harvesting to enhance water use efficiency and to ensure adequate irrigation water supplies through the growing season. On these farms, nutrient loss is minimal as farmers are doing

Table 2. Mean annual N and P loss in runoff is a small proportion of that added in fertilizer (2014 to 2015), Arkansas.

Crop system	Location	Applied	Loss	Loss expressed as portion of fertilizer nutrient added
		-- lb/A/year --		%
Nitrogen				
Pasture	Elkins	150	0.3	0.2
Corn	Atkins	120	1.7	1.4
Cotton	Dumas	110	6.1	5.5
Corn	Dumas	268	4.4	1.6
Phosphorus				
Pasture	Elkins	50	0.1	0.2
Corn	Atkins	22	0.5	2.3
Cotton	Dumas	42	1.9	4.5
Corn	Dumas	41	0.9	2.2

all they can to retain any rainwater or runoff on their farm in reservoirs or retention ponds. One Discovery Farmer started using the University of Arkansas Cooperative Extension Service irrigation scheduling program – PHAUCET (Pipe Hole and Universal Crown Evaluation Tool), and was able to appreciably increase irrigation water use efficiency by reducing irrigation runoff (**Table 3**). Less water leaving the farm has also resulted in less nutrient runoff loss.

Table 3. Irrigation water volume, runoff and use-efficiency for corn and cotton production in southeast Arkansas for 2015.

Crop	Irrigation events	Irrigation volume	Runoff volume	Irrigation efficiency[1]
		--- acre-inches ---		%
Corn	6	2.23	0.31	85
Cotton	4	2.44	0.22	91

[1] Expressed as portion of irrigation water retained in the field.

Automated sampler collects water during runoff at Atkins, Arkansas (left) and in-line water flow meter for irrigation water input (right), at Dumas, Arkansas.

Summary

Implementation of standard water quality monitoring methods on private working farms across the state has started to document the true impacts of Arkansas agriculture on surface water quality and efficiency of current cropping systems and the implemented conservation practices. As this runoff monitoring is being conducted on private property, the results are having greater impact and resonate more with the farming community than work conducted on University property. In fact, we are already seeing a sense of farmer ownership of the Discovery Farm Program to the extent that cooperating farmers are requesting runoff data from the ADF Program in order to present their results at farm meetings. In some cases, neighboring farmers are voluntarily implementing additional conservation practices to further reduce nutrient runoff after seeing the ADF results. Most importantly, the Discovery Farm Program is empowering farmers to proactively address environmental concerns. More information on the ADF Program can be found on it's website at http://discoveryfarms.uark.edu/. BC

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IPNI Science Award – Nominations Are Due September 30, 2016

Each year, the International Plant Nutrition Institute (IPNI) offers its IPNI Science Award to recognize and promote distinguished contributions by scientists. The Award is intended to recognize outstanding achievements in research, extension or education; with focus on efficient management of plant nutrients and their positive interaction in fully integrated crop production that enhances yield potential. Such systems improve net returns, lower unit costs of production, and maintain or improve environmental quality.

The IPNI Science Award requires that a nomination form (no self-nominations) and supporting letters be received at IPNI Headquarters by September 30, 2016. Announcement of Award recipient will be in December, 2016. An individual Award nomination package will be retained and considered for two additional years (for a total of three years). There is no need to resubmit a nomination during that three-year period unless a significant change has occurred.

All details and nomination forms for the 2016 IPNI Science Award are available from the IPNI Awards website http://www.ipni.net/awards.