DOCUMENTING IRRIGATION EFFICIENCY FOR COTTON VIA THE ARKANSAS DISCOVERY FARMS

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Introduction

Cotton production in Arkansas requires irrigation to overcome seasonal droughts during the growing season. In Eastern Arkansas, most cotton farmers utilize groundwater as their irrigation source. Due to declining groundwater levels, the State of Arkansas has declared several row crop regions as critical groundwater decline areas where withdrawals are not considered sustainable. Agriculture, considered the single largest consumer of groundwater, is facing the possibility of groundwater shortages in the near future. Little data exists on how irrigation water management for cotton relates to tailwater losses via runoff. One objective of this Cotton Discovery Farm was to quantify the relationship between irrigation water management (irrigation and precipitation) and runoff.

Arkansas cotton farmers are under increasing pressure to operate with environmental sustainability. 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 and established a Cotton Discovery Farm in 2013 on the C.B. Stevens farm in Desha County. This program utilizes a unique approach based on agriculture producers, scientists and natural resource managers working jointly to collect economic and environmental data from real, working farms to better define sustainability issues and find solutions that promote agricultural profitability and natural resource protection.

Methods

The Arkansas Discovery Farm is located in Desha County near Rowher, Arkansas on the C.B. Stevens farm. Three cotton fields, Shopcot (22 acres), East Weaver (38 acres) and Homeplace (39 acres), were selected for monitoring the quantity and quality of both inflow (precipitation and irrigation) and outflow (runoff). All three fields were planted to cotton in late May. Stale seed bed with minimum tillage was utilized in the East Weaver and Homeplace fields. However due the residue from the cover crop, the middles in the Shopcot were plowed to ensure that water would move freely down the field. Groundwater was used to furrow irrigate all fields with polypipe. To ensure equal distribution across furrows, the computer program PHAUCET was utilized to determine and vary outlet diameter in the poly-pipe across furrows.

At the lower end of each field, automated, runoff water quality monitoring stations 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. 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

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.

Results

Runoff from precipitation during the growing season ranged from 29 to 63% of the precipitation total received while runoff from irrigation ranged from 23 to 54% of the irrigation total applied (Table 1). This data indicates that runoff losses and trends from irrigation are similar to those of precipitation, which may indicate that field and soil features exhibit much influence on runoff and infiltration as opposed to the source of input. Cumulative runoff from all three fields exhibit similar trends even though the magnitude of runoff was different (Figure 1). Cumulative runoff from the East Weaver field increased much slower with time than the cumulative inputs once irrigation commenced in early July (Figure 2), which most likely reflects the increase in evapotranspiration rate of the rapidly development of the cotton biomass.

Table 1. Precipitation, irrigation and runoff from selected cotton fields.

	Precipitation			**Irrigation**			**Precipitation + Irrigation**		
Field	**Total**	**Runoff**	**% as Runoff**	**Total**	**Runoff**	**% as Runoff**	**Total**	**Runoff**	**% as Runoff**
	-----Inches----		**%**	**-----Inches----**		**%**	**-----Inches----**		**%**
Shopcot	12.61	7.91	63	18.45	8.93	48	31.06	16.84	54
East Weaver	12.61	3.66	29	13.59	3.15	23	26.20	6.81	26
Homeplace	12.61	5.17	41	10.64	5.77	54	23.25	10.94	47

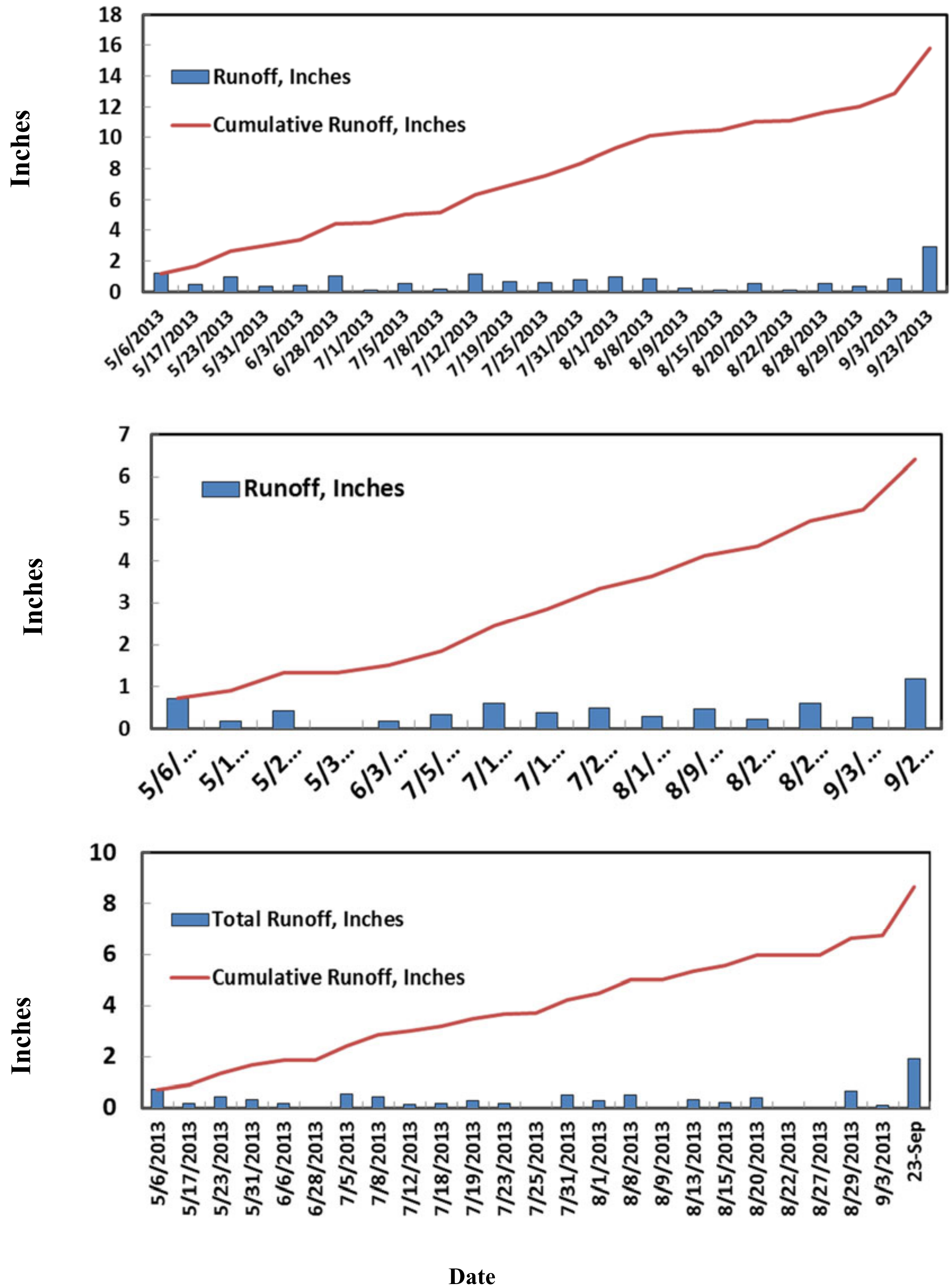

Figure 1. Cumulative runoff during the growing season from three cotton fields, Shopcot (Top), East Weaver (middle) and Homeplace (bottom), on the Arkansas Cotton Discovery Farm.

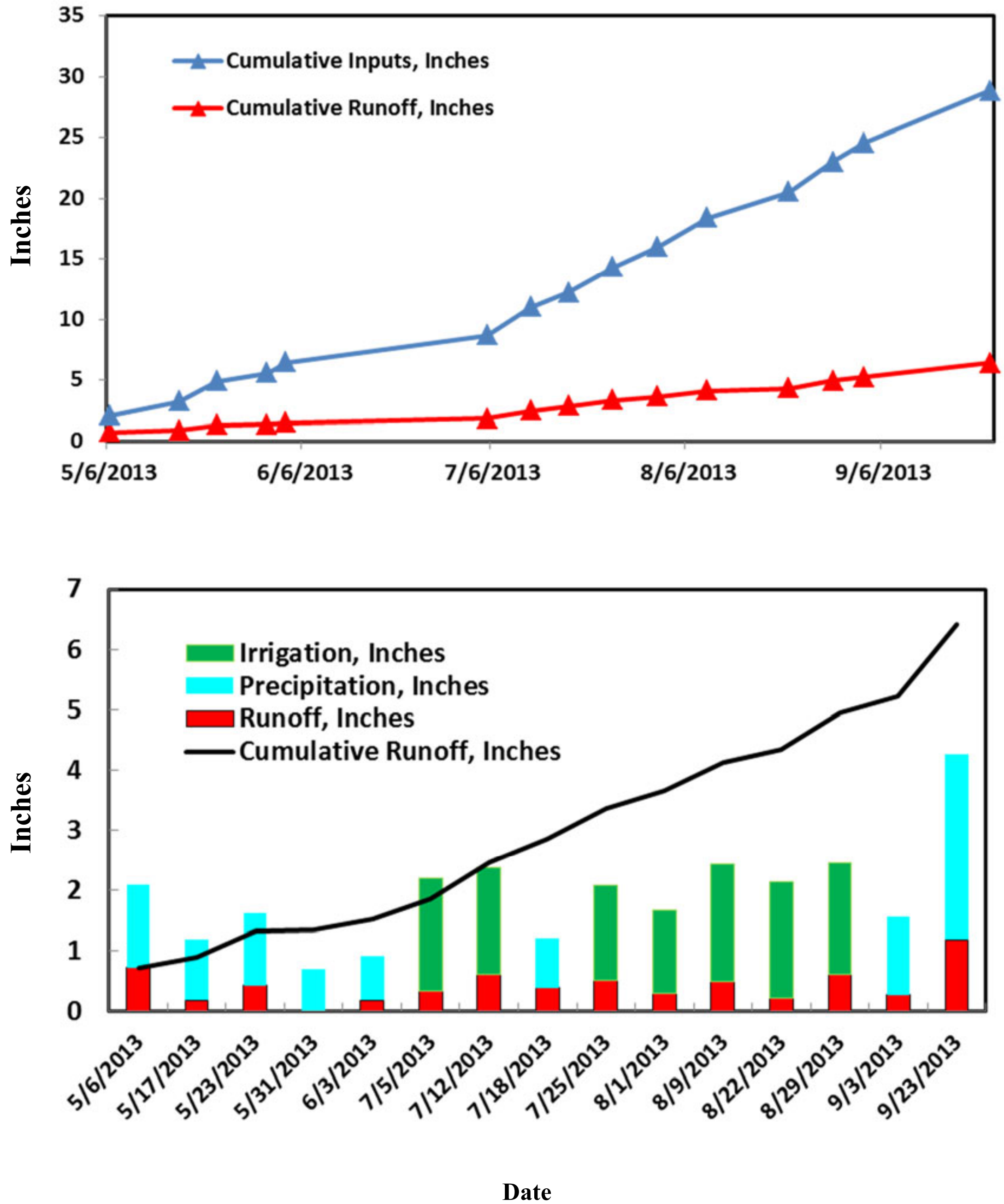

Figure 2. Cumulative inputs (precipitation and irrigation) and runoff for cotton in East Weaver (Top) and precipitation, irrigation and runoff by event (bottom).

Summary

The data collected during this first year indicates typical hydrological variability among fields, runoff events and in time as it relates to cotton development. Studies and data such as this is important to understanding the impact of cotton production on water use and water efficiency, which are becoming increasingly important considerations for row crop agriculture in Arkansas in light of declining groundwater levels. However, it is still preliminary as it is generally accepted by the scientific community that runoff studies should be conducted for a minimum of five years to account for climatic and hydrological response variability.