The Use Pattern of Irrigation Practices by Arkansas Producers

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Abstract

Using data from the 2016 Arkansas Irrigation Survey, this study documents the use pattern of irrigation practices including both irrigation technologies and water management practices (WMPs) by Arkansas producers. The WMPs have four groups: field management, water flow control, water recovery/storage and advanced irrigation scheduling practices. The most prevalent group of WMPs is field management practices. Nearly 85% of the producers use one or more WMPs in this group. The least prevalent group is irrigation scheduling practices, which only 16% of the sample producers use. About 77% of the producers use WMPs from two or more groups. The use patterns reveal a possible hierarchy of WMPs: field management is considered first and water flow control is the next in line before water recovery/storage is considered. Advanced irrigation scheduling comes last, probably due to its late arrival in the pool of available WMPs. Conservation programs should encourage the use of a package of WMPs to manage multiple aspects of irrigation.

Introduction

Irrigation is one of the most important inputs in Arkansas's crop production. Nearly 86% of irrigation water in Arkansas in 2013 was sourced from groundwater in the Mississippi River Valley alluvial aquifer (MRVAA) (USDA-NASS, 2014; Schrader 2008). However, the continuous and unsustainable pumping has put the MRVAA in danger by withdrawing at rates greater than the natural rate of recharge. In the 2014 Arkansas Water Plan by the Arkansas Natural Resources Commission (ANRC), an annual gap in groundwater as large as 8.6 billion cubic meters (7 million acre-feet) is projected for 2050 and most of the expected shortfall is attributed to agriculture (ANRC, 2015). To combat growing projected scarcity, two critical initiatives have been identified: conservation measures to improve on-farm irrigation efficiency and infrastructure-based

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solutions to convert to surface water (ANRC, 2015). Promoting the use of more efficient irrigation technologies and water management practices (WMPs) is often the policy instrument used to increase irrigation efficiency on-farm. This study aims to provide a comprehensive picture of irrigation practices including both irrigation technologies and WMPs used by Arkansas producers.

Procedures

The data set used is the 2016 Arkansas Irrigation Survey conducted by authors with collaborators from Mississippi State University. The sample in the survey is randomly drawn from the water user database maintained by the Arkansas Natural Resources Commission (ANRC) and a list of all commercial crop growers identified by Dun & Bradstreet records for the state of Arkansas. The final sample includes 224 producers who operate land on daily basis and have completed the survey in its entirety about their irrigation practices in 2015. Among them, 82% of producers are land owners, while 18% of producers are only land operators. On average, producers have 33 years of farming experience, 51% of them have a bachelor's degree or above and 56% of them have an agriculture education background. The average irrigated acres are 2.6 thousand acres. The major crops they grow are rice, soybean, and corn. The survey collected detailed information on irrigation practices employed by Arkansas producers at farm level, including the irrigated acres under different irrigation practices and their knowledge about different irrigation practices.

Results and Discussion

Table 1 reports irrigation technologies used by Arkansas producers in 2015. Four technologies are observed in the data: center pivot irrigation and three types of gravity irrigation (flood, border and furrow irrigation). The majority of Arkansas producers (more than 70%) use two or more irrigation technologies on their farms. Most often, different irrigation technologies are used on different fields. Many producers (about 43%) use two different technologies. For example, the most commonly observed pattern is flood and furrow irrigation on the same farm (35%). Only 5.8% of the producers use center pivot irrigation exclusively on their farms. The remaining (94.2%) either use gravity irrigation (69.2%) or use both gravity and center pivot irrigation (25%).

The survey collected information on 16 WMPs that may be used in Arkansas. The WMPs are put into four groups based on which aspect of irrigation is being managed (Table 2). Field management practices include zero grade leveling, precision grade leveling, end blocking, warped surface and deep tillage. Water flow control practices include computerized pipe-hole selection, multiple-inlet irrigation, surge irrigation, water flow meters and cutback irrigation. Water recovery/storage practices include tail-water recovery system and on-farm storage reservoir. Advanced irrigation scheduling practices include soil moisture sensor, evapotranspiration or Atmometer, computerized scheduling and woodruff chart. The most prevalent group of WMPs is field management practices. Nearly 85% of the producers use one or more WMPs in this group. The least prevalent group is advanced irrigation scheduling practices, which are used by only about 16%

of the sample producers. One of the reasons for the low share is that most advanced irrigation scheduling practices come into use much later than WMPs in other groups.

Most sample producers use WMPs to manage more than one aspect of irrigation. About 77% of the producers use WMPs from two or more groups (Table 3). Similar shares of producers use two groups (34%) or three groups (35%) of WMPs. The share of producers who use all four groups drops sharply to only 8%. Also observed were distinctive patterns in which groups are used. Among producers that only use one group of WMPs, field management practices (10.3%) are the most common choice. Among the producers that use two groups of WMPs, the most commonly observed pattern is the combination of field management and water flow practices (24.6%). Among the producers that use three groups, most implement field management, water flow control and water recovery/storage practices, a pattern that nearly 30% of the producers follow. These patterns reveal a possible hierarchy of WMPs: field management is considered first, followed by water flow control, and then water recovery/storage. Advanced irrigation scheduling is the last to be considered, again, probably due to its late arrival in the pool of available WMPs.

Significance of Findings

Our results show that advanced irrigation scheduling practices are not widespread in Arkansas. Programs can be designed to provide both technical and financial assistance. Our findings echo the importance of a systems approach to irrigation management advocated by Sullivan and Delp (2012). Most sample producers use two or more groups of WMPs to manage multiple aspects of irrigation. Most current conservation programs target only one WMP. It is important to design conservation programs that encourage the use of a package of WMPs to manage multiple aspects of irrigation. There is also significant room to spread the systems approach. In Arkansas, only about one-third of the producers use three out of four groups of WMPs, and only about 8% use all four groups.

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Literature Cited

ANRC. Arkansas Natural Resources Commission. 2015. Arkansas Water Plan Update 2014. Little Rock, Arkansas. Accessed 15 March 2018. Available at: http://arkansaswaterplan.org/plan/ArkansasWaterPlan/Update.htm

Schrader, T. 2008. Water Levels and Selected Water Quality Conditions in the Mississippi River Valley Alluvial Aquifer in Eastern Arkansas, 2006. Scientific Investigations Report No. 5092, USGS, 2008. Accessed 15 March 2018. Available at: http://pubs.usgs.gov/sir/2008/5092/

Sullivan, M.E., and W.M. Delp. 2012. Water conservation planning: How a systems approach to irrigation promotes sustainable water use. Natural Resources Conservation Service Report 24: Water Sustainability in Agriculture. Ithaca, NY: North American Agricultural Biotechnology Council, Cornell University. Accessed 15 March 2018. Available at https://ecommons.cornell.edu/bitstream/handle/1813/51384/nabc24_17_Sullivan.pdf?sequence=1&isAllowed=y

USDA-NASS. 2014. 2012 Census of Agriculture: Farm and Ranch Irrigation Survey (2013). No. AC-12-SS 1. Accessed 15 March 2018. Available at: http://www.agcensus.usda.gov/Publications/2012/Online_Resources/Farm_and_Ranch_Irrigation_Survey/

Table 1. Irrigation technologies (ITs) used by Arkansas producers in 2015.

Number of ITs used	Flood irrigation	Border irrigation	Furrow irrigation	Center pivot irrigation	Number of Producers	% Producers
4	Yes	Yes	Yes	Yes	17	7.59
3	Yes	Yes	Yes		26	11.61
	Yes		Yes	Yes	23	10.27
		Yes	Yes	Yes	1	0.45
2	Yes		Yes		79	35.27
			Yes	Yes	12	5.36
	Yes			Yes	2	0.89
	Yes	Yes			1	0.45
		Yes	Yes		1	0.45
		Yes		Yes	1	0.45
1			Yes		22	9.82
	Yes				15	6.70
				Yes	13	5.80
		Yes			11	4.91

Table 2. Water management practices (WMPs) used by Arkansas producers in 2015.

Group	WMPs	% Producers
Field management practices (84.38%)	Zero-grade leveling	18.30
	Precision-grade leveling	57.14
	End blocking	30.80
	Warped surface	25.89
	Deep tillage	47.32
Water flow control practices (67.41%)	Computerized pipe-hole selection	31.70
	Multiple-inlet irrigation (Rice)	38.39
	Surge irrigation	18.30
	Cutback irrigation	13.84
Water recovery/ storage practices (50%)	Tail-water recovery system	45.54
	Storage reservoir	34.82
Advanced irrigation scheduling practices (15.63%)	Soil moisture sensor	9.38
	ET or Atmometer	3.13
	Computerized scheduling	5.80
	Woodruff chart	1.34

Table 3. The portfolio of water management practices (WMPs) used by Arkansas producers in 2015.

Number of WMPs used	Field management	Water flow control	Water recovery /storage	Advanced irrigation scheduling	Number of Producers	% Producers
4	Yes	Yes	Yes	Yes	18	8.04
3	Yes	Yes	Yes		67	29.91
	Yes	Yes		Yes	10	4.46
	Yes		Yes	Yes	2	0.89
2	Yes	Yes			55	24.55
	Yes		Yes		14	6.25
		Yes	Yes		6	2.38
		Yes		Yes	2	0.89
1	Yes				23	10.26
		Yes			6	2.68
			Yes		5	2.23
				Yes	3	1.34
0					13	5.80
				Total	224	100.00