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Extending Extension's Outreach: Using Student Interns as a Resource for Obtaining Implementation of Irrigation Improvements

Abstract

Student interns are a resource that can increase the capacities of Extension professionals. Trained student interns based out of Nebraska Extension offices provided water and energy reduction recommendations to irrigators using center pivot irrigation systems. Follow-up interviews and a survey performed 1 to 3 years after the original assistance indicated impacts at levels similar to those garnered via previous assistance from Extension staff. In almost all cases, irrigators implemented soil water sensors, and the main motivations for doing so were financial. Recommendations for other improvements were infrequently implemented; however, as part of making those recommendations, the student interns collected fuel usage data that allowed for quantifying the energy and greenhouse gas impacts from reduced water use.

Keywords: student interns, center pivot irrigation, soil water sensors, Nebraska, cost and energy savings

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Introduction

Nearly half of Nebraskan producers who irrigate rely on Extension for information on managing irrigation, reducing irrigation costs, and saving water (U.S. Department of Agriculture, 2013). One perhaps often overlooked resource available to Extension professionals for disseminating this and other information is university student interns. The use of student interns to extend the ability of Extension professionals and programs to provide direct education to Extension clientele has been shown to be effective and successful (Apel, Mostafa, Brandau, & Garfin, 2013; Rogers, Mason, & Cornelius, 2001). Therefore, we identified student interns as a potential resource for extending the outreach efforts of Nebraska Extension. In the study reported here, we examined the efficacy of using engineering student interns, supported by Extension educators and specialists, to provide on-site assistance to (and collect impact data from) agricultural irrigators, with the goal of facilitating changes in the irrigators' practices.

Program Description

Initially the students received 2 weeks' training in preparing reports for irrigators, using Extension guides, evaluating irrigation and pumping systems to reduce water and energy use, and using evapotranspiration (ET) gauges and soil water sensors. Each student was assigned to an Extension office and received day-to-day assistance by an Extension educator who was located at the office and had expertise in ET gauges and soil water sensors. The participating educators had received relevant training as part of the Nebraska Agricultural Water Management Network program, which was started in 2005 to promote water conservation among irrigators through education and demonstrations of innovative irrigation techniques and use of soil water sensors (Irmak, Payero, & Martin, 2005; Irmak et al., 2016; Irmak et al., 2010). Over the five summers during which the project occurred, 18 students participated. The students worked in six Extension offices, with three to five students participating each summer.

All irrigators involved in the program used center pivot systems to irrigate maize and were located in a region of Nebraska where the farms share similar climatic conditions and an average growing-season precipitation range of 15 to 18 in. (Irmak & Sharma, 2014). Each student assisted 10 irrigators with soil water probe installation and interpretation, assessed the irrigators' pumping and irrigation systems, and made recommendations for improvements of irrigation system components.

Soil water sensors and ET gauges usually were supplied at no charge or a nominal cost (<$20 each) by the local natural resources district or Extension office and became the property of the irrigators. The main "cost" to an irrigator was the time required to interpret the sensor's data, remove the sensor at the end of the season, and install it the next growing season.

Data students obtained from the irrigators included water used per irrigation event, pumping plant efficiency, fuel/energy type and consumption, and cost to pump irrigation water. The students prepared an economic analysis for each irrigator related to the benefits of soil water sensor use and other irrigation system improvements.

To quantify fuel use reductions and cost savings associated with the program, we interviewed irrigators by phone 1 to 3 years after the student assistance had occurred. Of 52 irrigators randomly selected from those who participated in the first four summers of the program, we successfully interviewed 43 (83%). After the interviews, we sent irrigators a survey by mail, and 44% responded. Respondents selected from a list of potential motivations to indicate why they had or had not implemented each recommendation.

Program Results

Implementation Rate

Of the 40 irrigators who received the recommendation to implement soil water sensors, 39 (97.5%) did so. The interns also had made 22 suggestions to irrigators regarding improvements other than implementation of soil water sensors, typically related to replacing inefficient engines and aging sprinkler packages. The irrigators implemented only five (23%) of these "other suggestions." Compared to the implementation rate (54%) revealed in a 2014 survey of Nebraska manufacturers who received similar student assistance (Kuppig et al., 2016), the implementation rates by participants in our study were extremely high for soil water sensors and low for the other suggested improvements.

Water Use Reduction

Every interviewed irrigator who implemented the water sensors reported a reduction in water use. The average water use reduction for the irrigators was 1.86 in. of water for maize. Yearly, irrigators reduced water application by an average of about 6.60 million gal per irrigation system, with an average yearly water use of 47,800 gal/ac. This result is comparable to the water reduction rate associated with soil water sensor education provided by Nebraska Extension educators (Irmak et al., 2010).

Energy Use Reduction

The interns inspected irrigation water pumps and collected energy use data. The observed variability in fuel use (Table 1) reflects differences in pump efficiencies, field elevations, and well depths. Though diesel was the most expensive fuel used, it is commonly used by irrigators for pumping water in the region because it is readily available and does not require electric lines or gas lines to each pump.

Table 1.
Fuel Use and Cost of Pumping Plants

Fuel type (fuel unit of measure)	Number in study		Fuel usage per circle[a]		Fuel cost per circle[a]		Ave. fuel usage savings per acre	Ave. fuel cost savings per acre	Ave. irrigator fuel cost savings ($/year)	Ave. greenhouse gas[b]— MT CO2E /circle (*SD*)[c]
	Irrigators	Pumps	Ave. usage per circle (*SD*)	Range per circle	Ave. cost per circle (*SD*)	Range per circle				
Diesel (gal)	17	32	330 (95)	170–550	$1,100 (370)	$360–$1,900	4.6	$16	$3,900	3.7 (1.1)
Natural gas (MJ)	12	16	75,000 (16,000)	38,000–110,000	$370 (120)	$140–$670	830	$4.10	$700	3.8 (0.8)
Electricity (kWh)	15	21	4,500 (2,200)	2,700–12,000	$350 (170)	$200–$850	64	$4.80	$900	4.2 (2.1)
Propane (gal)	4	5	520 (290)	130–830	$750 (460)	$180–$1,300	7.2	$10	$1,400	2.4 (1.0)

[a]A circle is a full 360-degree rotation of a center pivot irrigation system. [b]Conversion factors for each specific energy source are from the 2014 U.S. Environmental Protection Agency (EPA) greenhouse gas spreadsheet based on state-specific data from the U.S. EPA eGrid (U.S. EPA, 2012, 2013) and using global warming potentials (GWPs) from the Intergovernmental Panel on Climate Change's Fourth Assessment Report (AR4) (U.S. EPA, 2014). [c]MT CO_2E = metric tons CO2 equivalent.

Greenhouse Gas Emissions

Table 1 lists the greenhouse gas emissions from each fuel type based on the combustion at the pump for diesel, natural gas, and propane and the combustion at the power plant for electricity. The three nonelectric fuels resulted in similar emission values. The high proportion of fossil fuels used to power the electric grid in eastern Nebraska influenced the higher value for electricity.

Motivation for Implementing Suggestions

The main motivations for implementing the recommendations were financial (acceptable payback, reduced operating cost, and energy efficiency) (Table 2). A secondary driver was reduction of "business risk," indicating a desire to lessen the potential of decreased production rates or increased cost (Table 2).

Table 2.
Motivations for Implemented Suggestions

	All implemented suggestions[a]		**Soil water sensor suggestions[b]**		**Other implemented suggestions[c]**	
Motivating factor	**# Selected**	**%**	**# Selected**	**%**	**# Selected**	**%**
Acceptable payback	20	77%	15	88%	5	56%
Reduced operating cost	20	77%	15	88%	5	56%
Energy efficiency	18	69%	13	76%	5	56%
Reduced business risk	17	65%	12	71%	5	56%
Enhanced environmental awareness	10	38%	6	35%	4	44%
Increased employee productivity	8	31%	4	24%	4	44%
Improved public image	6	23%	5	29%	1	11%
Regulatory compliance	3	12%	3	24%	0	0%
Reduced environmental and health risk	3	12%	3	18%	0	0%
Neighbors also implemented	1	4%	1	6%	0	0%

Note. The numbers in this table are based on the total 26 implemented suggestions. [a]There were 26 total implemented suggestions. [b]There were 17 soil water sensor suggestions. [c]There were 9 other implemented suggestions.

The survey results are comparable to other work indicating that irrigators are motivated to adopt new technology by financial drivers and the desire to produce higher quality crops (Bjornlund, Nicol, & Klein, 2009). The results from our survey suggest that financial considerations, especially long payback periods, were the major reasons for nonimplementation.

Summary

Trained student interns working together with local Extension educators can help irrigators implement positive changes in their irrigation system management to reduce water use, fuel use, and greenhouse gas emissions. This information may be useful for Extension specialists and educators to justify using financial resources to hire student interns to extend their program's reach.

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