Drivers and barriers to producers' voluntary adoption of irrigation practices that protect water quality

Kelly M. Foley, Clinton C. Shock, and Mary V. Santelmann

Over twenty alternative agricultural practices have been introduced to producers in Malheur County, Oregon, over the last thirty years to protect water quality. Research and outreach were designed to provide technological options for producers. This study sought to better understand the voluntary adoption by producers of practices improving water quality. The Reasoned Action Approach/Theory of Planned Behavior was used as a theoretical framework to identify barriers and incentives to adoption. Study findings suggest that producers primarily consider practical characteristics of practices when making adoption decisions. Some of these concerns include the relative advantage of the practice (derived from the anticipated financial gain or loss, conservation and water quality benefits from adopting a practice), the compatibility of a practice with existing farm operations, the ease or difficulty of implementing a practice, and the ability to observe the success of a practice prior to adoption. These factors varied widely across individual farms because of the diversity in farming operations. Producer age and lack of agency over decision making emerged as barriers to adoption and provide promising areas for future adoption studies. Recommendations are provided for enhanced education and outreach programs and incentive systems that are better suited for the diverse needs of producers operating small to medium sized farms.

Introduction

The irrigation industry is well aware of the potential negative environmental consequences from irrigation. Groundwater has become contaminated with nitrates and pesticides in the areas of the world with intensive horticultural production. Soil and water erosion losses from farms by irrigation induced erosion transfer sediment and phosphorus to surface waters. The negative environmental effects of inefficient water use are evident. By 1986 the groundwater in Northeast Malheur County was contaminated by nitrate and the residuals of the breakdown of DCPA sold as Dacthal (Bruch, 1986). By 1990 the average groundwater nitrate in the region with intensive horticulture hovered between 18 and 19 parts per million. DCPA residuals were correlated with groundwater nitrate.

Townsend and Howarth (2010) addressed the issue of fixing the global nitrogen problem, and in their manuscript they described the parts of the nitrogen cycle in agriculture that were inefficient and could be improved. They promoted the possibilities of using less nitrogen and applying fertilizer with timing closer to the plants' needs. I n 1985 the Oregon State University Malheur Experiment Station (MES) initiated studies to reduce irrigation induced erosion. In 1990 MES also set out to improve the efficiency of nitrogen fertilizer use and improve irrigation efficiency seeking to improve groundwater quality (Shock and Shock, 2012). Research was conducted to develop locally appropriate technology to reduce nitrogen fertilizer rates on onions, potatoes, sugar beets, and wheat. Research placed emphasis on soil sampling, plant tissue testing, and split nitrogen fertilizer applications. Field trials were intentionally designed to develop locally appropriate technology to result in higher yields using lower total inputs of nitrogen fertilizer.

Nitrogen fertilizer and soil nitrate will only reach groundwater in a semiarid environment when irrigation water is applied in excess of evaporation and crop water use. Numerous trials evaluated potential advantages of sprinkler and drip irrigation compared to the standard flood irrigation. Gated pipe had the potential to increase irrigation efficiency compared to the use of siphon tubes for flood irrigation especially if the gated pipe system was preceded by trash screen filters and if the water was applied via surge irrigation. Additional leveling of fields held potential for improving irrigation efficiency where furrow/flood irrigation continued to be commonly used.

Other production problems compromising water quality were also addressed. Sediment losses could be reduced by adapting filter strips, sedimentation ponds, pump back systems, polyacrylamide, and the use of straw mulch to local conditions. Methods were developed to reduce the application rates of DCPA or eliminate its use completely by adopting other herbicide products and weed control methods. A suite of best management practices was developed, widely advertised, and frequently updated (Shock, 2015). By 2010 some water quality improvements had already been realized. Groundwater nitrate had fallen to 10.5% and DCPA residues were greatly reduced in the most affected wells. Changes that occurred in farming practices happened through a combination of research, demonstration, outreach, and voluntary adoption.

In many parts of the United States water quality has not been improving. It is unknown exactly the extent of the adoption of better practices and why growers adopt certain changes that might improve water quality. We undertook research to understand grower adoption behavior of conservation practices. What motivates growers to change practices and what are the sources of information that they trust as they redesign their farming practices?

Specifically what are the factors that influenced grower decisions to adopt water quality improving practices in northern Malheur County? We sought to understand the drivers and barriers to the adoption of these conservation practices. We sought to investigate the relevant background factors and beliefs and develop recommendations for future study, policy makers, and practitioners of crop production research and outreach.

Material and methods

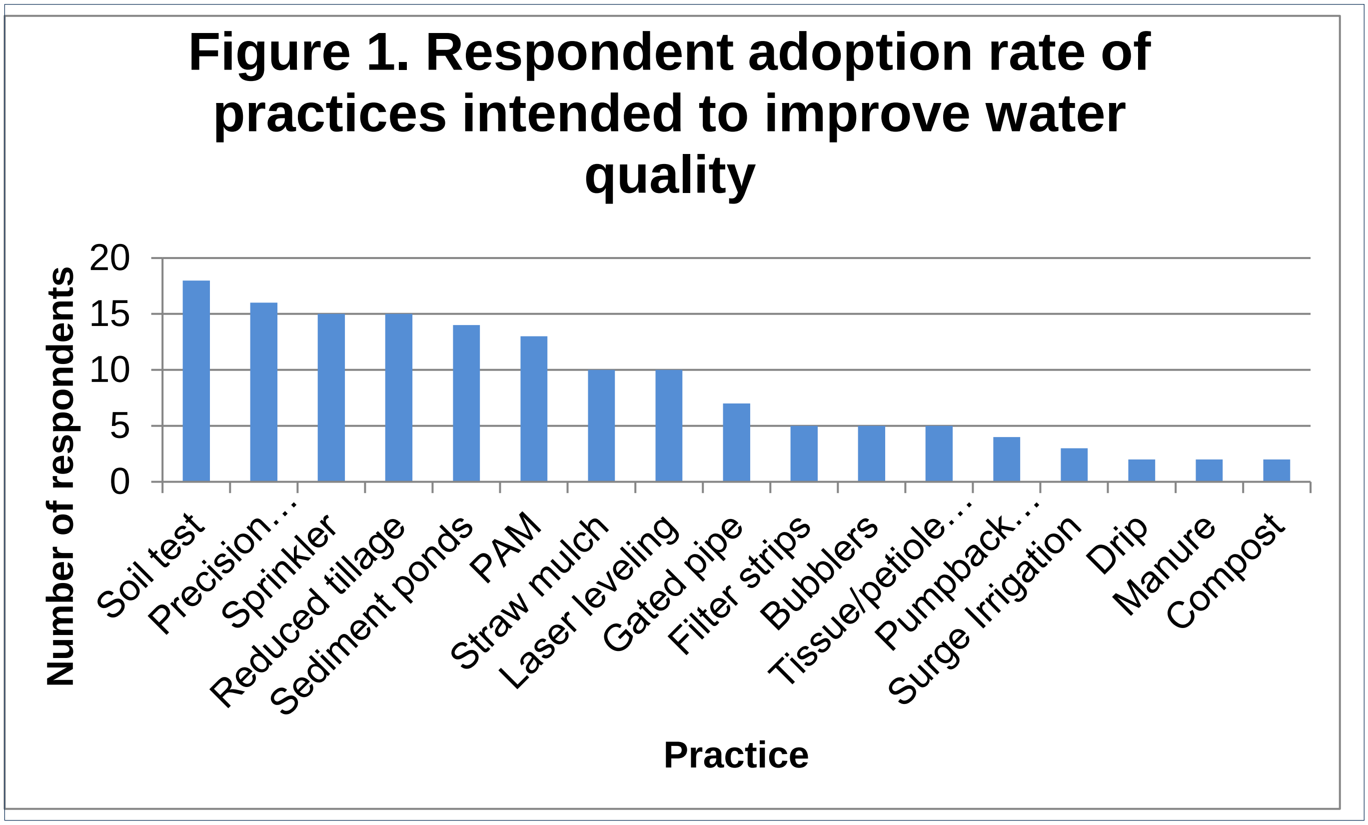
Out of 450 growers in the groundwater management area, 29 growers were randomly selected based on a geographically stratified random sample (Foley, 2013). Growers were chosen randomly from five different parts of the intensively irrigated area and from areas representing both flat and rolling topography. Growers were selected from both types of topography since the crops and practice improvements appropriate for the two topographical areas are somewhat different. The 29 growers were each given a semi structured interview which was audio recorded and transcribed. The data analysis consisted of coding the interview for descriptive attributes practices information on the grower in their production, attitudes, norms, and drivers. In general the size of the farms and the age of the growers was similar to the 2007 agricultural census (Table 1). The average age of the grower was 58 years and the average acreage was 649 acres.

Table 1. Characteristics of growers interviewed compared to the 2007 Census of Agriculture (Foley, 2013).

Characteristic		**2007 Census of Agriculture Malheur County statistics***	**2013 Respondents**
Average age of operator		56	58
Average acreage		937	649
Median acreage		101	550
Farming as primary income (percentage of total operators)		62.2%	82.8%
Gender (percentage male)		89.6%	93.5%
	***Statistics derived from the USDA 2007 Census of Agriculture**		

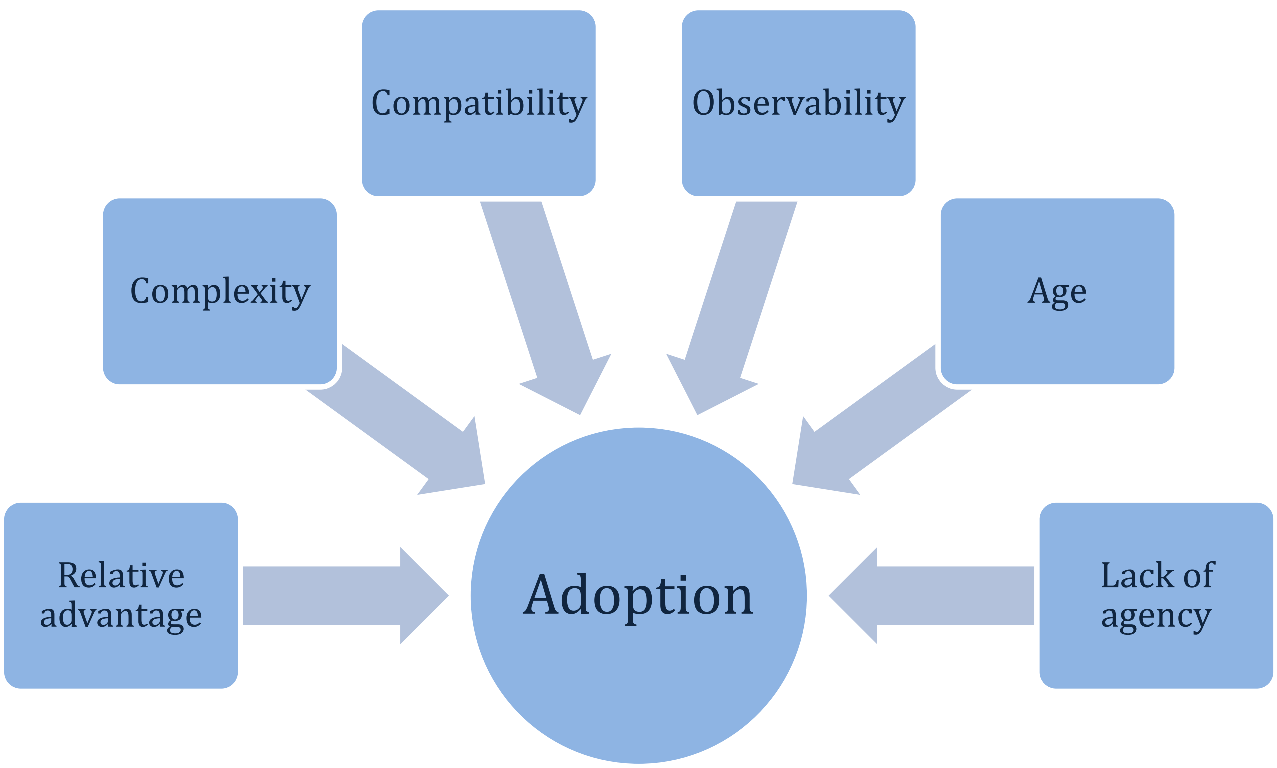
<u>Results</u>

Growers were found to have adopted between two and 12 conservation practices out of 17 practices mentioned in the interviews (Figure 1) (Foley, 2013).



Of the drivers for the voluntary adoption of practices, financial gain was cited by 100% of the growers (Foley, 2013). Other important factors included considering whether a practice compatible with their farm, ease-of-use, and observability (Figure 2). Barriers to the adoption of practices included financial loss, incompatibility with farming practices, difficulty of use, grower's age, and lack of agency. The most important factors affecting adoption were relative financial advantage, lack of complexity, compatibility with current practices, and observability and the most importance barriers were age of the grower and a sense of lack of agency.

Figure 2. Primary drivers and barriers to the voluntary adoption of practices in Malheur County (Foley, 2013).

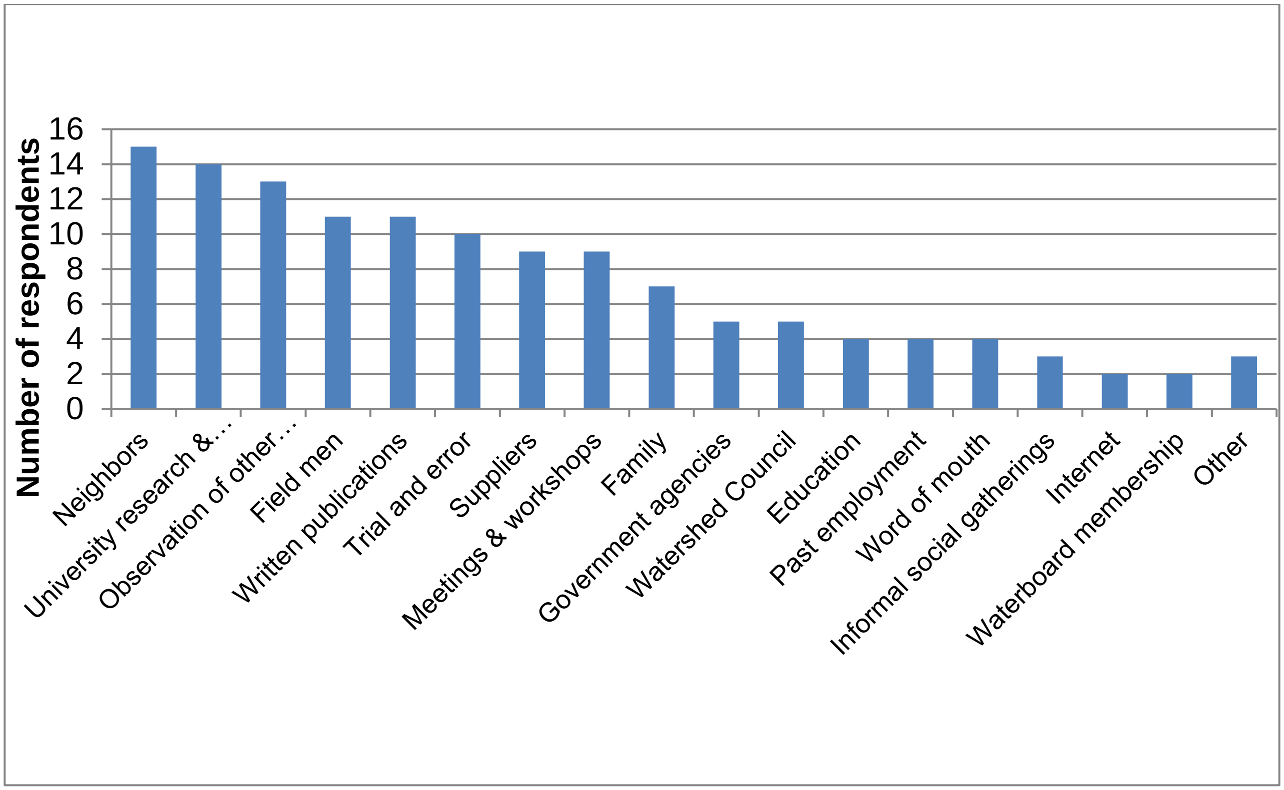


Discussion

Practicality and profitability were uppermost as drivers for consideration of new practices (Foley, 2013). Taking a quote from a grower *"You know, I've always said that the farmers land— the land takes care of you, so you take care of it."*

Observability of a practice was very important for growers. Again taking a quote from a grower *"A lot of people are going that way though. We might have to too if it comes that way. If it looks like my neighbors are doing better with drip then I better [too]."* With regard to observability, the most utilized information sources reported by respondents were information from their neighbors, university research and extension, observation of other farmers in other areas, field men, and written publications (Figure 3).

Figure 3. Most utilized information sources reported by survey respondents (Foley, 2013).



Conclusions

The relative advantage, compatibility, simplicity, and observation of innovations were important factors in the voluntary adoption of new practices while age and lack of agency emerged as barriers to adoption (Foley, 2013). Growers had very different perceptions of water quality. Defining the adoption of practices can be difficult.

Practitioners of field research and outreach need to creatively imagine alternative practices that could profitably increase the efficiency of input use and that will reduce off-site losses of water, nutrients, and pesticides. Rigorously test and adapt these practices in field trials so that they are viable options for growers.

Outreach agents need to emphasize the practicality and profitability of crop practice options now. They need to design demonstrations that make new practices observable. Extension activities should consistently promote extension as being a reliable trusted source of information.

Policymakers need to provide strong funding and support for applied research and continued use of subsidies and technical support programs for growers. Policymakers can empower growers through education and incentive programs that encourage voluntary adoptions of innovations. There needs to be better communication between growers and policymakers about what the water quality standards are and the goals.

Literature cited

Bruch, G. 1986. Pesticide and nitrate contamination of ground water near Ontario, Oregon. In: *Proceedings of the Agricultural Impact on Ground Water - A conference.* Omaha, Nebraska; National Water Well Association, Dublin, Ohio.

Foley, K.M. 2013. Examining the Voluntary Adoption of Agricultural Conservation Practices in Northern Malheur County, Oregon. Thesis for the degree of Master of Science in Water Resources Policy and Management, Oregon State University.

Shock, C.C. 2015. Malheur County best management practices. Malheur Experiment Station, Oregon State University. http://www.cropinfo.net/BestPractices/

Shock, C.C. and C.B. Shock. 2012. Research, extension, and good farming practices improve water quality and productivity. Journal of Integrative Agriculture 11(1):14-30.

Townsend, A.R. and R.W. Howarth. 2010. Fixing the global nitrogen problem. Scientific American 32(2):64-71.