AN ABSTRACT OF THE THESIS OF

Kelly M. Foley for the degree of Master of Science in Water Resources Policy and Management presented on November 19, 2013

Title: Examining the Voluntary Adoption of Agricultural Conservation Practices in Northern Malheur County, Oregon

Abstract approved:

Mary V. Santelmann Clinton C. Shock

This study sought to better understand the voluntary adoption of water quality improving practices by agricultural producers in Northern Malheur County, Oregon. 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 vary widely across individual farms because of the diversity in farming practices and heterogeneous 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 and segmented needs of producers operating small to medium sized farms.

©Copyright by Kelly M. Foley
November 19, 2013
All Rights Reserved

Examining the Voluntary Adoption of Agricultural Conservation Practices in Northern Malheur County, Oregon

by
Kelly M. Foley

A THESIS
Submitted to
Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

Presented November 19, 2013
Commencement June 2014

Master of Science thesis of Kelly M. Foley presented on November 19, 2013.

APPROVED:

Co-Major Professor, representing Water Resources Policy and Management

Co-Major Professor, representing Water Resources Policy and Management

Director of the Water Resources Graduate Program

Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Kelly M. Foley, Author

ACKNOWLEDGEMENTS

I would like to extend my sincere thanks to the many people who made this project possible through their contributions of support, knowledge, guidance, mentorship, encouragement, and friendship. I want to especially thank the Malheur County farmers and their families who graciously opened their homes to me to share their knowledge and experiences. I am indebted to them for trusting me to share their story which serves as the foundation of my research project.

I could not have completed my studies at Oregon State University without the invaluable guidance and support of my major advisor and Water Resources Graduate Program Director, Dr. Mary Santelmann. Mary's dedication to her students and her creative thinking are truly inspiring. I am so thankful to have been her advisee and for her constant encouragement. I would also like to thank my generous and supportive committee members: Dr. Clinton Shock, Dr. Denise Lach, and Geoff Huntington. Thank you for your time and willingness to share your knowledge and expertise throughout my research experience. I would also like to thank all of the faculty who made my experience at Oregon State so positive, especially Todd Jarvis, Aaron Wolf, Hannah Gosnell and Hilary Boudet.

I would like to express a special thanks to my supervisor, committee member, mentor, and friend, Dr. Clinton Shock. I could not have asked for a more patient, kind, and encouraging mentor to guide me through my research. As much as he taught me about agriculture, he taught me more about thinking critically, seeing holistic solutions to the most complex of challenges, and how to live life with a positive outlook and sense of humor. This project would not have been possible without his support, generosity, and endless puns. I am also very grateful to the staff at the Malheur Experiment Station without whom my research would not have been possible, including Janet Jones, Monty Saunders, Erik Feibert, Joel Felix, Joey Ishida, Alicia Ramires, the student

workers, and the crew. A special thank you to my co-workers Cheryl Parris and Alison Doniger for their support, knowledge, for sharing their gardens with me, and most importantly, for their friendship.

I'd like also like express my gratitude to my water cohort at Oregon State University and Hydrophiles for providing such a welcoming community to learn and grow through our shared interest in water. Thank you to my friends, old and new, for providing friendship and positive encouragement throughout my graduate studies. I am so grateful to have sustained and built such amazing friendships throughout my graduate studies and I thank you all for your endless laughs, support, and encouragement. Finally, I'd like to thank my family— my father Kevin, my mother, Diana, my brother, Chris, and my sister, Lauren, for their endless love and support as I moved across the country to pursue my dreams. You all inspire me to be the best person I can be and I am proud to have such a wonderful family.

CONTRIBUTION OF AUTHORS

Dr. Clinton Shock
Director, Professor
Malheur Agricultural Experiment Station
Department of Crop and Soil Science
Oregon State University

Dr. Mary Santelmann
Director, Assistant Professor, Senior Researcher
Water Resources Graduate Program
College of Earth, Ocean, and Atmospheric Sciences
Oregon State University

Dr. Denise Lach
Director, Professor
Sociology Department
School of Public Policy
Oregon State University

Candace Shock
Principal
Scientific Ecological Services, Inc.

Geoffrey Huntington
Senior Instructor, College of Forestry Director for Strategic Initiatives
Department of Forest Engineering, Resources and Management
College of Forestry
Oregon State University

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

Page

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

"So the challenge is convincing the public [through] education and educating the farmers to use the resources that's here and the resources that we have— water, land, the whole thing in a responsible way and making it sustainable." -A Malheur County producer.

The interactions among water quality, agriculture, and environmental policy in the intermountain western United States are complex and have evolved as part of a multifaceted system over the last century. Agriculture in the arid West accounted for over 55% of crop sales in the U.S. in 2007 (USDA Economic Research Service, 2012). To meet the needs of irrigated agriculture in arid climates, water must be impounded, transferred out of streams or pumped from groundwater, and budgeted carefully among a number of water users. Conventional irrigated agriculture can impact onsite soil fertility and offsite water quality. When cropland is irrigated, excess applied water can runoff or percolate deep into the groundwater. Sediment, agricultural chemical residues, and nutrients thus enter surface water and groundwater. Excess levels of phosphorus and nitrogen (common fertilizers) and suspended sediment can cause drinking water problems and are detrimental to aquatic life. Sediment and chemical pollution from agricultural runoff are two of the greatest contributing sources of anthropogenic nonpoint pollution of surface waters in the United States; approximately one half of the suspended sediment in freshwater sources in the U.S. comes from cropland (Dzurik, 2003). Removal of riparian vegetation on stream side acreages and along irrigation canals can also increase water temperatures and degrade aquatic habitat for fish. As a result, agriculture has become a major focus of voluntary and regulatory efforts to improve water quality.

In order to reduce sediment and nutrient losses from agricultural fields and improve offsite water quality, a number of innovative irrigation, fertilization, pest management and tillage practices have been developed. The State of Oregon, Oregon State University Extension, the Department of Environmental Quality, the

Oregon Department of Agriculture, the Natural Resources Conservation Service, the Soil and Water Conservation District, Oregon State University College of Agricultural Science, watershed councils and other non-profits, growers associations, and producers have invested thousands of grant dollars to develop and promote these water quality improving practices to producers through educational materials and programs. Many of these efforts have been focused toward Malheur County in eastern Oregon, a highly productive agricultural area.

Although there are many sources of pollution in Malheur County, widespread irrigated crop production has been identified as the primary source of elevated levels of groundwater and surface water pollutants in the Malheur River Basin. Groundwater and surface water quality have been an issue of concern for Malheur County residents for nearly four decades. A Citizen's Water Resources Committee was convened in 1978 to develop a water quality management program for nonpoint source pollution, specifically for agricultural inputs. After two years of intensive water sampling, a report was published by the Malheur County Court (1981) documenting suspended sediment and fecal coliform levels above acceptable standards. The report also cited high levels of nitrogen and phosphorus which were concentrated in particular geographic regions. While water quality has improved since the early 1980s, nitrate levels remain elevated above acceptable levels. Malheur County was declared a groundwater management area (GWMA) by the Oregon Department of Environmental Quality in 1989. Citizens were able to work together with state agencies and policymakers to make voluntary changes which addressed nitrate pollution. The result was widespread change in agricultural practices. While area-wide nitrate concentration goals have not been met, there has been a statistically-significant decreasing trend in groundwater nitrates (Richardson, 2010).

Although grassroots efforts to change agricultural practices continue to improve water quality, these improvements have been slow and not easily quantified. New pressures have emerged to increase the rate of change in

Malheur County. The new pollution target levels are driven by the Clean Water Act of 1977 (Federal Water Pollution Control Act of 1972). The purpose of the Clean Water Act (CWA) is to protect, restore, and maintain the physical, chemical, and biological integrity of this nations waters (§101(a)) with the overarching goal of zero pollution discharge. While the CWA originally targeted point source pollution, the ambitious goals of the act have allowed the statute to target nonpoint source pollution as well, leading to actions that affect entire watersheds. Section 303(d) of the CWA establishes Total Maximum Daily Load (TMDL) parameters in order to meet ambient water quality standards for pollutants such as nitrates, dissolved oxygen, bacteria, algae, phosphorus, temperature and suspended sediment. TMDL parameters establish targets to reduce water pollution by setting a total load of any given pollutant for each source in the watershed. Examples of pollution sources in a TMDL might include industry, urban development, or agricultural runoff. States are mandated by the CWA to develop TMDLs to be approved by the Environmental Protection Agency (EPA). States then choose the policy tools they would like to use in order to meet TMDLs and best achieve ambient water quality standards.

The state of Oregon has taken an outcome-based approach to meeting agricultural TMDLs, which encourages voluntary adoption of water quality improving practices rather than prescriptive regulation. Outcome-based approaches set ambient water quality standards but do not require implementation of specific practices. Instead, farmers are given the flexibility to decide what practices they will use to meet the water quality standards. While this flexibility allows for some autonomy in farming operations, it can also leave farmers unsure of how to achieve water quality standards.

Like many other agriculturally productive areas in the state, Malheur County has experienced widespread adoption of water quality improving practices, but adoption of various practices has not been uniform. In order to meet TMDL water quality standards, there is a need to continue and expand

adoption of these practices. Thus, there is also a need to better understand how and why farmers adopt water quality improving practices such that effective incentives can be provided.

Purpose and Justification

The purpose of this study was to better understand the reasons behind adoption of agricultural practices for water quality improvement in Northern Malheur County, Oregon by pursuing the following research question: What are the factors that influence producer decisions to adopt practices that reduce groundwater and surface water pollution in Northern Malheur County? The practical contribution of this study was to provide recommendations for policymakers about how to best engage producers in sustainable farming practices, all the while maintaining economic prosperity. Additionally, the results of this study are being used to provide recommendations to Oregon State University Extension and local agencies in Malheur County to improve education and outreach programs. These recommendations can be used to further collaborative efforts with local producers and expand adoption of water quality improving practices.

Academically, this study sought to fill a gap in our understanding of producer decision making. While the literature examining how and why producers adopt sustainable practices is extensive, the factors driving adoption of conservation practices are not well understood. Scholars have studied a number of factors that could help explain adoption including farmer characteristics (i.e. age, education, awareness of environmental threats, attitudes, social capital), farm biophysical characteristics (i.e. farm size, precipitation, soil type, slope), farm financial characteristics (profitability, land tenure, labor source), contextual factors (i.e. input prices, community practices, market access), and informational factors (access to and quality of information) (Knowler & Bradshaw, 2007; Prokopy, Floress, Klotthor-Weinkauf, & Baumgart-Getz, 2008). In addition, many studies also consider characteristics of the practices themselves (i.e. relative

advantage, compatibility, complexity, trialability, and observability) (Rogers, 2003).

Despite 25 years of adoption studies, there have been very few universal variables identified that can explain adoption (Knowler & Bradshaw, 2007). Studies synthesizing adoption literature have identified the following variables as more universally influential than others: education levels, farm capital, farm income, farm size, access to and quality of information, positive environmental attitudes, environmental awareness, social networks and social capital (Knowler & Bradshaw, 2007; Prokopy et al., 2008; Baumgart-Getz, Prokopy, & Floress, 2012). In addition, many previous studies have focused on the predictive capacity of these factors. For example, a study conducted using survey data of Floridian farmers focused on quantifying the ability of particular attitudes (i.e. toward being independent) to predict whether or not a farmer would adopt conservation practices (Lynne, Shonkwiler, & Rola, 2012). These types of studies are valuable for predicting behavior, but there is also a need to step back and identify which attitudes, perceived practice characteristics, perceived norms, or other variables might be considered in future research.

Knowler and Bradshaw (2007) call for more nuanced and localized studies that can produce results that are relevant for local management rather than universal understanding. In this study we seek to explore the phenomenon of adoption on a localized level in Northern Malheur County. We focus on collecting rich, in-depth data that provides detailed and contextual understanding of adoption on a small geographic scale. The method of face-to-face interviews used presented a unique opportunity to learn directly from farmers about how and why they decide to adopt new practices within their regulatory, economic, social, and natural landscape. Engagement with farmers can provide a richer understanding of the reasoning behind adoption of specific practices and also gives farmers the opportunity to voice their perspective in matters of water quality.

The body of literature examining farmer adoption of conservation practices focuses primarily on quantitative analysis, frequently through the use of survey methodology. One reason for using quantitative analysis is likely the desire to produce statistically generalizable results with predictive capacity. Another reason may be that producers have been historically difficult to engage in research. Some researchers attribute this difficulty to the social divide between farmers and scientists (Bentley, 1994; Lubell, 2004).

Participants in this study suggested that farmers have an untold story that needs to be heard. When asked about water quality problems in Malheur County, one farmer said the following:

> "[Farmers] are doing better; people are doing much better and I give 'em credit for that. And I think sometimes we don't tell our story well enough. I mean, it's important that we do."

By involving producers in candid discussions about their practices, why they make decisions, and how they perceive water quality, we were able to identify four primary drivers of adoption in Malheur County: relative advantage derived from financial gain, conservation and water quality benefits, ease of practice implementation and use (complexity), farm compatibility, and the observability/trialability of a practice. We were also able to identify five barriers to adoption: relative disadvantage derived from financial loss, farm incompatibility, difficulty of use (complexity), age, and lack of individual agency. Perceived practice characteristics, farmer age, and perceived lack of individual agency emerged as rich areas for future study. Figure 1 summarizes barriers and incentives to adoption in Malheur County that were identified in this study. These factors will be considered in greater depth in the coming sections.

First, however, we will explore what factors driving adoption have emerged in previous studies. In addition, we will detail the theoretical framework that underlies this analysis, the Reasoned Action Approach/Theory of Planned Behavior (RAA/TPB) (modified to include perceived practice characteristics) and the results we would expect to find based on this theory. Next, we will explore all

facets of research design including how data was collected, analyzed, and validated in addition to study limitations. Following the overview of methods, individual interview and focus group results will be considered in greater detail and integrated into a narrative about adoption in Northern Malheur County. Then results will be compared to what we would have expected to find based on the RAA/TPB. We will conclude by outlining recommendations for policymakers and practitioners and identifying rich areas for future study.

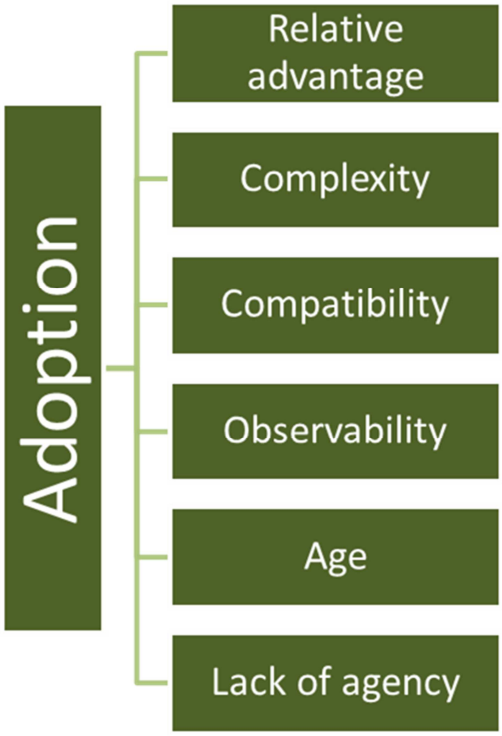

Figure 1. The primary drivers and barriers to adoption identified following interviews conducted in this study. Adoption was more likely when practices were observable and seen as practical and profitable.

CONCEPTUAL FRAMEWORK

The following section reviews previous research on adoption of conservation practices as well as the literature on the proposed theoretical framework of this study. For nearly 30 years, academics in a diverse group of disciplines have been trying to better understand why farmers decide to adopt new practices. A variety of theoretical frameworks have been used to identify the factors or variables that influence or impede adoption of conservation practices. This literature can be broadly divided into three categories; (1) the characteristics of farming practices, (2) characteristics of the farmer and/or farm, and (3) the role of information in the adoption process. More recent studies suggest that local context may also play an important role in adoption. These variables will be examined more closely through a synthesis of different studies and reports in the following section. First, however, it is important to understand what agricultural conservation practices are and how they impact water quality.

Agricultural conservation practices

Best management practices, sustainable agricultural practices, conservation practices and conservation agriculture are all terms that refer to practices intended to minimize negative environmental impacts of farming. Here we use the term conservation practices (CPs) for consistency and simplicity. In this study, we used the term CPs more specifically to mean the integrated management of soil, water, and biological resources in order to reduce agriculture's contribution to nonpoint source water pollution while maintaining social and economic vitality of farming communities. We thus define a CP as an umbrella term to encompass a wide range of innovative irrigation, fertilization, pest management and tillage practices which improve water quality and are voluntarily adopted by agricultural producers. While other practices (for example, those used in animal husbandry) can also be considered as CPs, we focus on irrigated cropland farming. The needs of different farmers and practices

appropriate to different fields can vary widely. Table 1 provides some examples of conventional farming practices and alternatives that would be considered CPs.

Table 1. A comparison of conventional practices and CP alternatives for irrigation, fertilization, pest management, and tillage practices.

Practice type	Conventional	Conservation alternative
Irrigation	Furrow	Drip, sprinkler
Fertilization	Broadcast	Sidedress, band, chemigate
Pest Management	Scheduled chemical applications	Scouting, integrated pest management, controlled droplet application, biopesticides
Tillage	Moldboard plow	Reduced tillage, strip till, no-till

Adoption of practices that reduce nonpoint source pollution is important because agriculture is one of the leading sources of many water quality impairments to freshwater rivers and lakes and a major contributor to groundwater contamination (United States Environmental Protection Agency, 2009; United States Government Accountability Office, 2012) . Managing sediment, nutrients, irrigation water, and pesticides together to stay on fields and not wash away or leach helps to maintain water quality in nearby streams, rivers, and groundwater aquifers. Nonpoint source pollutants from farms can impact drinking water quality, ecosystem health, recreational opportunities, and aquatic habitat. In order to reduce these impacts, section 319 of the Clean Water Act lists impaired waterbodies and designates 40% of its funding to control agricultural nonpoint source pollution. In addition to this funding, there are also many other economic and technical assistance programs through the United States Department of Agriculture and state agencies for CP planning, installation, and implementation (EPA). Since 1985, conservation programs have been included in the U.S. Farm Bill to provide increased incentives for CPs, such as today's Environmental Quality Incentive Program (EQIP) (Gillespie, Kim, & Paudel, 2007).

Despite efforts to encourage CP implementation, adoption rates remain low. It is difficult to quantify the adoption rate of CPs in the U.S., but according to the 2007 Census of Agriculture, out of the 2,204,792 farm operations in the United States, only 503,917 of them reported practicing conservation methods, or approximately 23%. While this estimate includes animal or livestock farming, it is probably the best estimate available because 2007 was the first year that the agricultural census included conservation data (*National Agricultural Statistics Service (NASS) FY 2003 and Revised FY 2002 Annual performance plans*, 2005). The 2012 agricultural census has not yet been released, so as yet we lack data for assessment of recent trends in adoption of CPs.

Information

The role of access to information (and quality of information) in the adoption process has been studied extensively in existing literature. While there are exceptions, most previous studies suggest that access to quality information positively impacts farmers' adoption of CPs. A statistical synthesis of the factors that influence the adoption of these practices confirmed that, even on a global scale, the availability of information about these practices is positively correlated with adoption. Information sources include other farmers, media, meetings, and extension officers (Knowler & Bradshaw, 2007). A meta-analysis of studies conducted within the U.S. was consistent with this conclusion (Baumgart-Getz et al., 2012). Another study conducted on the USDA Demonstration Project program also showed that knowledge of the program correlated with higher adoption rates of CPs. Feather and Amacher (1994) suggest that because of the correlation between information and adoption, education may be a reasonable alternative to direct regulation or financial incentives to increase adoption rates of CPs.

Feather and Amacher (1994) also suggest that a lack of information for farmers regarding the profitability and environmental benefits of CPs may be one

reason why widespread adoption has not occurred. Other studies have also found that the lack of access to quality information on sustainable practices is a barrier to adoption. For example, a survey of agricultural change agents in the southern U.S. suggested that informational issues are among the most salient barriers to adoption of sustainable agricultural practices (Rodriguez, Molnar, Fazio, Sydnor, & Lowe, 2008). Results of a recent mail survey of farmers in four north-central states were consistent with the conclusions of Rodriguez et al. (2008), demonstrating that informational and financial barriers can be interconnected in the adoption process (Khanna, Epouhe, & Hornbaker, 2012). The mail survey showed that low rates of adoption of site-specific crop management can be partially attributed to the lack of demonstrated effects of these technologies, in addition to uncertainty of profitability, high fixed costs of investment and information acquisition. Not only has the role of information and its diffusion among farmers been studied extensively, it is actually used as the widespread rationale for the agricultural extension model in the U.S. (Rogers, 2003). Given the prominent role that information has played in past adoption studies, it is important that the role of information be considered in this study for the purposes of improving education and outreach.

While past studies have shown that information is often necessary for adoption of CPs, information alone may not be a sufficient driver to adoption. Quality information is rarely cited as a standalone driver of adoption. One study conducted with Montana farmers and ranchers indicated that perceived profitability was the most important factor in adoption and that access to information contributed as well, but to a lesser extent (Saltiel, Baunder, & Palakovich, 1994). A 2010 study of northeastern and southeastern American farmers cited economics as a primary driver, which was partially a function of marketing channels and social drivers, including education (Sassenrath et al., 2010). While past studies collectively indicate that information is an important

driver of adoption, there is a need to distinguish whether information is sufficient to lead to adoption as a primary driver.

Characteristics of practices

The role of cost-benefit analysis in the decision to adopt CPs has also been widely considered in the adoption literature, suggesting that farmers may rely heavily on rational decision making. Some of the earliest work in this area was done in economics, demonstrating that adoption can be partially explained using econometrics modeling. To some extent, farmer behavior is profit maximizing (Griliches, 1957). Many studies since Griliches' early work have supported the notion that economics play an integral role in the adoption of CPs (Nowak, 1992; Cary & Wilkinson, 1997; Chouinard, Wandschneider, Ohler, & Paterson, 2008; Rodriguez, Molnar, Fazio, Sydnor, & Lowe, 2008). However, the specific economic factors that explain adoption are not uniform across the literature. Baumgart-Getz, Prokopy, and Floress (2012) conducted a meta-analysis of quantitative adoption studies in the U.S. between 1982 and 2007 and found that financial capacity had one of the largest impacts on adoption. Within the financial capacity category, they noted that capital and the percentage of income from farming carried the most significance.

It is important to consider that not all practices intended to improve water quality are profitable at the field level, even though most are intended to be at least profit-neutral (Valentin, Bernardo, & Kastens, 2004). Factors that may affect whether or not a practice is profitable at the farm scale include micro topography, existing infrastructure, and farm size. As such, it seems logical that there are economic barriers to adoption, such as the uncertainty of profitability and associated costs of labor, materials, and equipment (Rodriguez, Molnar, Fazio, Sydnor, & Lowe, 2008; Cary & Wilkinson, 1997; Pannell et al., 2006).

In the Diffusion of Innovations Theory, Rogers (2003) posits five perceived characteristics of innovations that influence adoption: relative advantage,

compatibility, complexity, trialability, and observability (Reimer, Weinkauf, & Prokopy, 2012). A number of studies highlight one or more of these characteristics as an important component of the adoption of CPs. Cary and Wilkinson (1997) emphasize the need for compatibility and relative advantage, suggesting that CPs need to be technically feasible and economically profitable. A 2008 study of change-agents in the U.S. South found that incompatibility with existing practices was a barrier to adoption (Rodriguez et al., 2008). In a comparison of two Indiana watersheds, Reimer, Weinkauf, and Prokopy found that relative advantage, compatibility, and observability were the most important characteristics of practices to increase adoption (2012). While the perceived costs and benefits associated with a practice may play a role in the adoption of CPs, low adoption rates despite decades of financial incentives indicate that other factors also play a role.

Farmer/Farm characteristics

Demographics & farm characteristics

While many adoption studies have focused on the characteristics of the practices themselves, other studies have focused on characteristics of the farmers and their farms. The first studies to focus on these characteristics tended to focus on social-demographic variables such as age and education level (Ervin & Ervin, 1982). Some studies synthesizing adoption literature indicate that demographic factors and farm characteristics are not consistently influential in adoption of sustainable practices (Knowler & Bradshaw, 2007). Others indicate just the opposite; specific variables such as education level, farm income, and farm size positively influence adoption across studies (Baumgart-Getz et al., 2012) In general, studies examining the impact of social-demographic factors and farm characteristics on adoption have shown conflicting results (Fielding, Terry, Masser, Bordia, & Hogg, 2005). Recently, however, more studies have

focused on the social-psychological characteristics of farmers. The following sections outline some of these factors and their role in explaining adoption.

General Attitudes

Farmer attitudes have been the focus of a number of studies detailing farmer adoption of CPs (Michel-Guillou & Moser, 2006; Ahnström et al., 2008; Gosling & Williams, 2010). However, past studies do not reach consensus as to whether or not attitudes are major factors in adoption. A meta-analysis of adoption literature in the U.S. showed that general environmental awareness and environmental attitudes were positive influences on adoption, but made the distinction that an attitude did not necessarily always lead to adoption (Baumgart-Getz et al., 2012). Knowler and Bradshaw (2007) showed that past studies have identified a mixture of significant and insignificant results when considering the impact of positive environmental attitudes on adoption. Economic profitability of a practice is often more important. Another consideration is that there is not always consensus between farmers and environmentalists as to what stewardship should look like in farm management (Cary & Wilkinson, 1997; Vanclay, 2004). However, many of these studies consider general attitudes toward environmental issues, rather than an individual's attitude toward particular CPs. Baumgart-Getz et al. (2012) suggest that studies focusing on a producer's attitude toward a particular practice and its environmental impact may yield different results. There is a need for further investigation into the role that general attitudes play in producers' decisions to adopt specific CPs and how their attitudes might change based on the particular practice being considered.

Norms, social capital, social networks

Norms have been considered in some studies as potential factors influencing adoption, but they have received less attention than attitudes. This might be simply because social norms can be quite difficult to measure and elicit

in data collection. One critique of the use of behavioral theories in adoption literature is the tendency to focus on attitudes rather than norms, subsume norms under attitudes, or use normative influences as indicators of social norms (Burton, 2004). This suggests that norms may be difficult for researchers to identify and may be easily confused with other social-psychological factors such as beliefs, values, and attitudes.

A meta-analysis of 25 years of adoption literature indicated that being connected to an agency, local network of farmers or watershed groups positively impacts adoption (Baumgart-Getz et al., 2012). Another study conducted by the Alberta Research Council in 2006 found that various forms of capital, including financial, social, cultural, and status capital, contributed to the adoption behavior of some producers. Social capital includes the various social networks in which a producer is connected (i.e. extension, neighboring farms, businesses, agencies). Cultural capital refers to the normative value of a practice; the right or wrong way to farm (Alberta Research Council, 2006). The Alberta Research Council (2006) found that social and cultural capital are barriers for many Alberta producers who find that those who implement CPs are not considered as respected in the farming community as their conventional counterparts. In order to find acceptance, producers have to find social networks outside of their community (Rodriguez et al., 2008).

Another facet of social norms is observability, which is described by Rogers (2003) as the extent to which an innovation is visible to others. This might be a practice that a neighbor is implementing that other farmers see or even an experimentation field at an extension experiment station. The social norm is derived by how the innovation is interpreted once it is observed. A 2012 localized study in Indiana suggests that observability is important in the producer decision to adopt CPs (Reimer et al., 2012); farmers often look to what a neighbor, family, or friend is doing and consider doing the same if it seems to be working and if it is socially acceptable by the producer's social network. The role of social capital

and networks is still young in the adoption literature, and warrants further investigation (Knowler & Bradshaw, 2007; Prokopy, Floress, Klotthor-Weinkauf, & Baumgart-Getz, 2008).

Barriers

While many studies have considered the factors that drive adoption of CPs, others have focused on barriers to adoption. However, the explicit study of barriers has traditionally received less focus in the literature. While barriers to adoption frequently overlap with drivers to adoption (i.e. profitability, loss of profit), unique barriers have surfaced as well. Producers might perceive barriers to be financial, cultural, social, physical, or institutional (Gillespie et al., 2007; Rodriguez et al., 2008; Khanna et al., 2012). A study on the role of land tenure on the adoption of CPs identified market access and differences in renters versus land owners as potential barriers to adoption (Carolan, 2005). The Alberta Research Council (2006) identified access to various types of capital, attitudes, and technological, political, demographic, and ecological factors to be the main barriers to adoption for agricultural producers in Alberta.

Homogeneity in CP design has emerged as a barrier in part due to a lack of bottom-up approaches to CP design and development. A 2008 study of producers in the southern U.S. suggested that adoption might be enhanced when practices are designed and customized to meet local and individual needs, whether they are infrastructural, financial, or social needs (Rodriguez et al., 2008). These results suggest that research and development of CPs should be pertinent to actual conditions at the farm level. In addition to informational and financial barriers, other variables that may impede adoption include social, cultural, physical, and institutional barriers. The barriers to adoption of CPs are integral to understanding adoption as a process, which also includes non-adoption.

Contextual Factors

While contextual factors certainly play a role in how farmers perceive characteristics of specific practices, recent studies suggest that farm context may also provide insights into how farmers perceive their own capacity to adopt new practices. As suggested by Reimer et al. (2012), “farmer’s perceptions of practice characteristics are influenced by the larger physical, economic, and social context. Context changes over time and space, so it is important to address practice-specific barriers to adoption for a given context in a given location” (pg. 127). Context may take the form of a perception about a practice or an attitude toward sustainability, or even as a perceived barrier to adoption, but regardless it is important to consider the larger landscape within which producers are making land management decisions. This landscape may be defined by the broader economic, regulatory, social, or natural conditions within which the producer makes decisions. For this reason, our study will consider contextual factors and seek to understand how these factors might impact adoption of water quality improving practices.

Theoretical framework

A number of well-established theories have been used as frameworks for understanding and describing farmer adoption behavior including, but not limited to econometrics modeling (Griliches, 1957), the Diffusion of Innovations Theory (Rogers, 2003), a conceptual model for conditions necessary for technological adoption (Yapa & Mayfield, 1978), Self-efficacy Theories of Social Learning and Social Cognition (Bandura, 1977a; Bandura, 1977b; Bandura, 1989), Resilience Theory (Gunderson & Holling, 2001), and the Reasoned Action Approach/Theory of Planned Behavior (Fishbein & Ajzen, 2009). This section will outline the underlying premise of these theories and the rationale for using the Reasoned Action Approach/ Theory of Planned Behavior (RAA/TPB) for this study.

Some of the earliest work in adoption of CPs was done in economics. Much of this work was based on the premise that farmer adoption of innovations can be partially explained using econometrics modeling; to some extent, farmer behavior is profit maximizing (Griliches, 1957). In 1962, Rogers built upon economic theory by examining a wide variety of groups of people, including agricultural producers, in order to develop the five characteristics of innovations that affect whether or not innovations are adopted: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003; Reimer, Weinkauf, & Prokopy, 2012). Studies then began considering the political economy of innovation, noting some of the barriers to adoption. Yapa and Mayfield (1978) suggest that four conditions must be met for adoption to occur: 1) availability of sufficient information, 2) the existence of a favorable attitude toward technology, 3) the possession of the economic means to acquire technology, and 4) the physical availability of technology (Yapa & Mayfield, 1978; Gillespie et al., 2007).

Behavioral models have also emerged, building upon the basic assumption that farmers are rational, profit maximizing individuals based on the information they receive and interpret. A 2009 study integrated Resilience Theory with Roger's Diffusion of Innovations Theory to better understand the adoption of CPs in the U.S. Corn Belt (Atwell, Schulte, & Westphal, 2009). Resilience Theory emphasizes the relationship between social and ecological systems, and can be quite useful for describing the adaptation of a system to external changes, i.e. a farming community adapting to climate change. However, owing to the difficulty of measuring system parameters, resilience theory lacks predictive capacity (Carpenter, Walker, Anderies, & Abel, 2001). It does not focus on the role of the individual's behavior, nor does it easily incorporate theories of behavior and cognition. Self-efficacy Theories (Albert Bandura, 1977) describe a measure of power that any given person has over their ability to complete tasks and reach goals. Cognitive theories, such as Social Cognition Theory (Albert Bandura,

1989) and Social Learning Theory (Albert Bandura, 1977) take self-efficacy into account and posit that people learn by self-reflection and by watching what other people do within their environment (Boston University School of Public Health, 2013). Social Learning Theory was used to describe farmer behavior in a study of three Midwest watersheds (Napier, Tucker, & McCarter 2000). The results were only partially consistent with the Social Learning Theory. This suggests that self-efficacy may play an important role in adoption, but that it may not be sufficient to fully explain adoption behavior.

The Theory of Planned Behavior (TPB) has been utilized in a number of adoption studies to describe farmer behavior and the decision to adopt CPs (Ajzen, 1985; Ajzen, 1991; Beedell & Rehman, 1999; Beedell & Rehman, 2000; Fielding, Terry, Masser, Bordia, & Hogg, 2005; Reimer et al., 2012). In 1967, Martin Fishbein proposed that behavior is a function of intention, which is a function of attitude toward the behavior and normative beliefs and the motivation to comply with these beliefs. In 1980, Fishbein and Ajzen partnered to create the Theory of Reasoned Action (TRA) which added a normative construct to Fishbein's original proposal. The TRA also included background factors such as demographic and personality variables that influence behavioral and normative beliefs. Fishbein's and Ajzen's career paths then diverged, where Ajzen continued to refine and test the TRA. After further empirical study, he posited that perceived behavioral control is an important component of behavior which he believed to be derived from control beliefs and the power of control factors. In 1985, he renamed this extension of the TRA the Theory of Planned Behavior (Fishbein & Ajzen, 2009). The TPB assumes that people behave rationally within the context of the information they have, the beliefs they hold about that information, and their psychosocial motivations. The TPB posits that the motivational beliefs held by people can take on a number of different forms, which are categorized as attitudes, norms, and perceived behavioral controls (Figure 2).

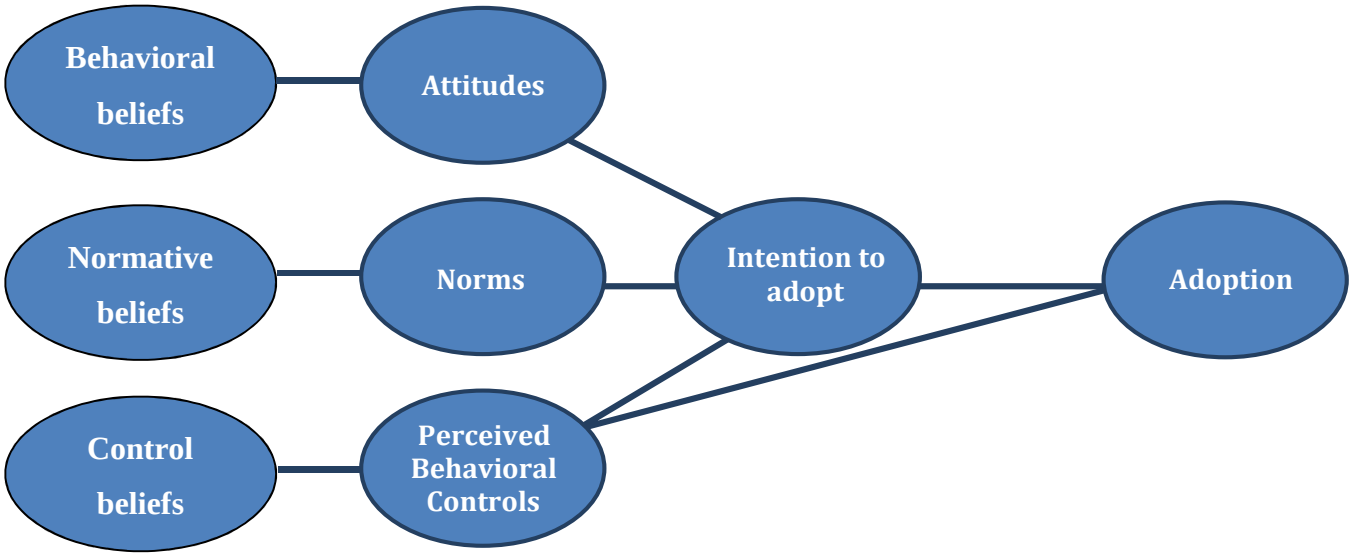

Figure 2. Adapted from Ajzen 1991, this is a visual representation of the Theory of Planned Behavior in which a person's attitudes, norms, and perceived behavioral controls influence their intent and behavior.

In general, the more favorable the attitude and norm toward the behavior being considered and the higher the perceived control over the behavior, the greater the probability that the behavior will be performed (Ajzen & Albarracin, 2007). In 2000, Fishbein created an Integrative Model based on his work in HIV prevention research, suggesting that the following factors are both sufficient and necessary to produce behavior: a strong positive intention, necessary skills, and no environmental constraints making it impossible to perform the behavior. This model was similar to the TPB, but it added in a component of descriptive norms and self-efficacy. Descriptive norms are derived from perceptions of what other people are doing, in contrast to subjective norms, which refer to perceptions of what should or ought to be done (Fishbein & Ajzen, 2009). In 2009, Fishbein and Ajzen came together to integrate the TRA, the TPB, and the Integrative Model into what they refer to as the Reasoned Action Approach (RAA). The RAA follows all of the same basic assumptions of the TPB, but puts emphasis on “background factors” which take into account “global dispositions, demographic

factors, or other kinds of variables often considered in social psychology and related disciplines" in addition to adding descriptive norms to the normative construct and self-efficacy to perceived behavioral control (Ajzen & Albarracin, 2007).

Criticisms of the RAA/TPB suggest that there are missing behavioral constructs and as a result, the RAA/TPB is not sufficient to *fully* explain behavior (Fishbein & Ajzen, 2009). Some examples of constructs that other researchers have suggested adding include: past behavior/habit, self-efficacy, moral and/or personal norms, self-identity, and affective beliefs (Conner & Armitage, 1998). Some of these variables were included the RAA in 2009, including self-efficacy, but Fishbein and Ajzen contend that in order to add a variable to the theory, it must hold predictive capacity (causality), should be behavior-specific, should be conceptually independent of existing constructs, and potentially applicable to a wide range of behaviors (Fishbein & Ajzen, 2009). Other criticisms are more theoretically based. Some argue that RAA/TPB assumes too much rationality, failing to take into account spontaneous action. Fishbein and Ajzen respond that whether or not behavior is rational or irrational is irrelevant to behavioral prediction and depends on how rationality is defined (Fishbein & Ajzen, 2009). Other criticisms deal with issues of methodology. Ogden suggests that social cognition models such as the RAA/TPB cannot be tested. Use of the theory to predict or explain adoption behavior can be used to support models, but no data can be collected to be shown that it is wrong (Ogden, 2003).

Despite these criticisms, the RAA/TPB has been used in numerous studies considering the adoption of CPs (Reimer et al., 2012). While researchers studying the adoption of CPs recognize that the RAA/TPB may not be fully sufficient to explain all variance in adoption behavior, they contend that it offers a useful foundation (Beedell & Rehman, 2000). Looking at the RAA/TPB as it has been applied to adoption behavior, much of the research has focused on measuring attitudes, norms, and perceived behavioral control to predict behavior.

While we see this as an important component to understanding adoption, we believe there is a need to focus on background factors and beliefs that form these constructs in order to better understand why adoption is or is not occurring. By identifying relevant factors and beliefs, future studies can utilize this information to better predict behavior. The RAA/TPB allows for integration of a wide number of factors that have been identified as having an impact on producer adoption of CPs in previous studies such as farmer characteristics, farm characteristics, local context, and information. More recently, a study conducted by Reimer, Weinkauf, and Prokopy (2012) integrated perceived practice characteristics into the RAA/TPB, citing the numerous studies that have identified perceived practice characteristics as an important factor influencing adoption. The categories of perceived practice characteristics are derived from the Diffusion of Innovations Theory, where Roger's identifies five characteristics of innovations that affect adoption of CPs: relative advantage (generally derived from financial advantage), compatibility (with existing values, past experiences, and needs of adopters), complexity (difficulty to use or understand innovation), observability (whether or not results of an innovation can be seen by others), trialability (ability to experiment with innovation) (Rogers, 2003; Reimer et al., 2012).

The advantage to using a behavioral theory like the RAA/TPB is that it provides a simple, yet structured conceptual framework to identify differences in the attitudes, norms, and perceived controls (and beliefs that lead to these constructs) of adopters versus non-adopters (Fielding et al., 2005). The underlying premise of the RAA/TPB provides a framework for relating the factors that have emerged as being important influences on adoption in the existing literature, including characteristics of the farmer/farm, perceived practice characteristics, informational factors, and contextual factors. In an effort to incorporate the perceived practice characteristics that have been identified in the

literature as having an important impact on adoption, we use the modification of the RAA/TPB by Reimer, Weinkrauf, and Prokopy (2012) in this study.

The academic goal of our study was to identify a set of background factors, perceived practice characteristics, and behavioral, normative, and control beliefs that were pertinent and relevant to adoption in Malheur County. While background factors, perceived characteristics, and beliefs have been examined in past studies, the majority of past adoption studies that have used the RAA/TPB have focused on the impact of behavioral constructs on adoption, specifically on attitudes toward adoption (Burton, 2004). We operated under the hypothesis that in order to predict adoption behavior we must first correctly understand the context surrounding adoption; that is, better understand the causes, structures, processes, and human agency impacting adoption (Lofland, Snow, Anderson, & Lofland, 1984). By looking at background factors and beliefs, we hoped to create a foundation upon which future studies could test the ability of each factor to predict attitudes, norms, perceived controls, intention, and ultimately adoption/non-adoption.

We anticipated that among perceived practice characteristics, relative advantage, compatibility, and observability would have the greatest influence on adoption based on results of past studies (Cary & Wilkinson, 1997; Rodriguez et al., 2008; Reimer et al., 2012). In addition, we hypothesized that background factors, which have frequently emerged as influential in previous studies, would have a strong influence on adoption behavior, including: education levels, farm capital, farm income, farm size, access to and quality of information, environmental awareness, social networks and social capital (Knowler & Bradshaw, 2007; Prokopy et al., 2008; Baumgart-Getz, Prokopy, & Floress, 2012). These factors as well as the framework for RAA/TPB that was used in our study are summarized in Figure 3.

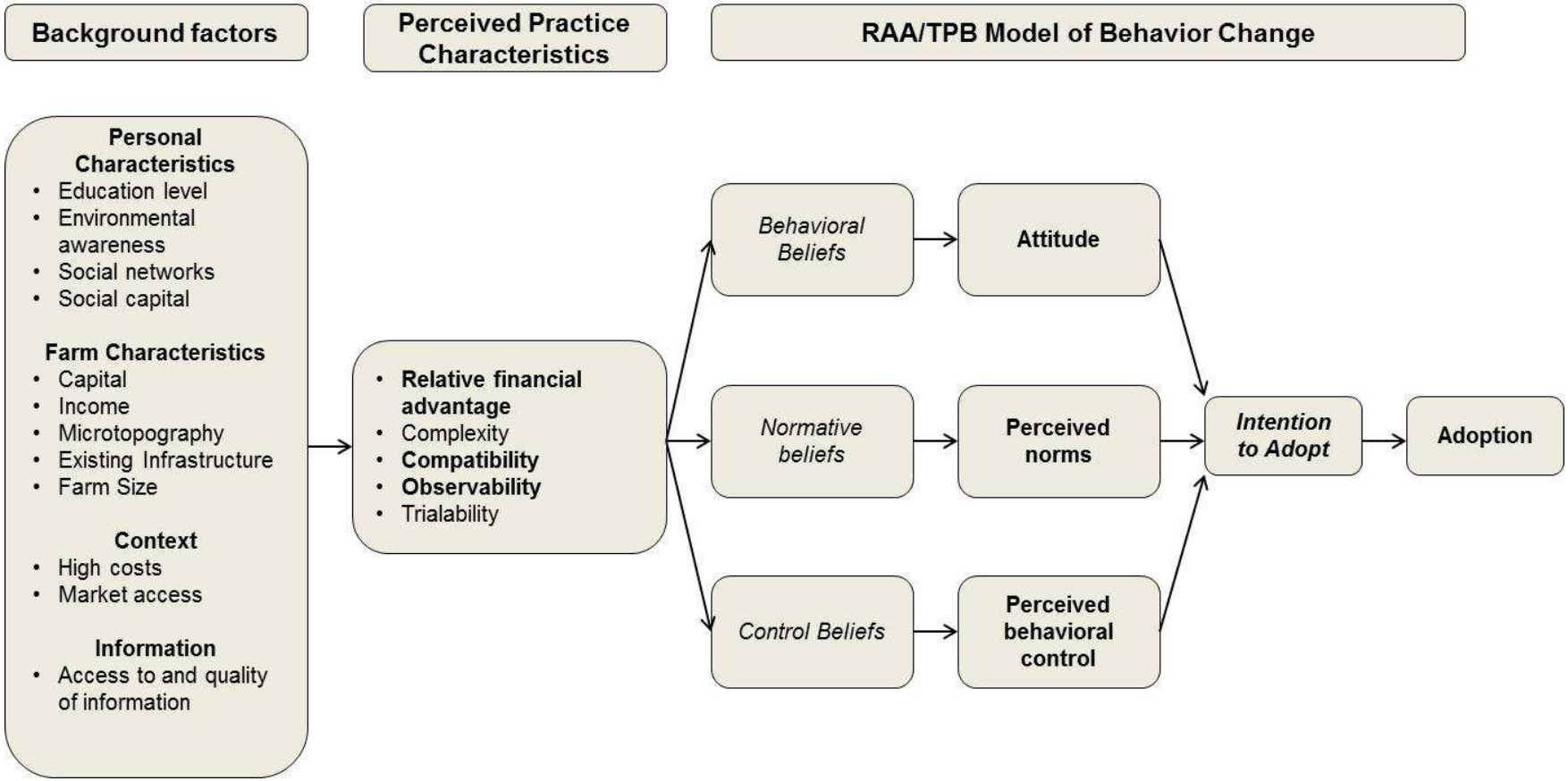

Figure 3. A graphic depiction of the conceptual framework used in this study. This combination of the Reasoned Action Approach/Theory of Planned Behavior with Roger's five characteristics of innovations that impact adoption of CPs. *Adopted from* (Reimer et al., 2012) *and updated to include background factors that have shown the greatest potential for universal impact on adoption in previous studies.*

Objectives

Based on previous work related to the adoption of CPs and the academic and practical goals of this study, the primary research question considered here is: what are the factors that influence the producer decision to adopt practices intended to reduce groundwater and surface water pollution in Northern Malheur County? Using the Reasoned Action Approach/Theory of Planned Behavior as a theoretical framework driving analysis, the objectives of this study were:

1) To identify the irrigation, fertilization, tillage, and erosion control practices being utilized by producers today;
2) To investigate what barriers and incentives influence a producer's decision to adopt a sustainable practice once they have received this information;
3) To identify relevant background factors, perceptions of practices, and behavioral, normative, and control beliefs within the framework of RAA/TPB in an effort to provide rich areas for future study;
4) To develop generalized policy recommendations based on these findings for water resource and/or agricultural organizations in order to encourage further adoption of practices intended to improve water quality.

METHODOLOGY

To achieve the research objectives of the study, we used a qualitative methodology with an emphasis on case study content analysis. This section presents the rationale for the use of qualitative methods in this study, an outline of the study area, describes how data were collected and analyzed, and outlines study limitations and methods used to increase the reliability and validity of findings.

Qualitative Methods

The ultimate goal of qualitative methodologies is to develop a coherent and focused account of some aspect of social life by accessing the observations of others (Weiss, 1995). While quantitative social science research can allow us to identify how many people might fall into a particular category and/or the relationships among various categories, such is not the purpose here. We know that farmers are widely adopting CPs, but that greater levels of adoption are needed to adequately address non-point source pollution problems, not only in Malheur County, but across the country. As water resource managers and policy makers consider various tools and incentive systems to encourage further adoption of CPs, they need to understand how and why farmers adopt and do not adopt CPs. Qualitative methods allow researchers to address these types of questions, for example, by collecting content-rich interview data. These data are then used to describe the perceptions and beliefs of others with the goal of providing insight into the causes, structures, processes, and human agency of any given phenomenon (Lofland et al., 1984). Here, qualitative methods are used to provide a better explanation of how farmers in Malheur County perceive water quality improving practices in an effort to identify drivers and barriers of adoption.

A case study is simply an instance or a class of events in a phenomenon of scientific interest (George & Bennett, 2005). Case studies are frequently used to study social phenomena and for development of social micro theory. In

qualitative methodology, case studies are used to identify causal mechanisms to outcomes being studied (George & Bennett, 2005) and can be used to uncover patterns, refine theory, and use abstract, theoretical knowledge to advance the common good. The underlying assumption in case studies is that context is imperative to understanding the necessary and sufficient conditions that lead to any given outcome (Ragin, 2000). Here we use a qualitative case study of Northern Malheur County to identify the causal mechanisms that lead to adoption of CPs.

Study Area

Our study was conducted in a farming community in Northern Malheur County, Oregon (Figure 4). Malheur County is in a semi-arid desert region on the Oregon-Idaho border known for its agricultural productivity. As one of the largest agricultural counties in the state, it produces more corn for grain and dry onions than any other county as well as a large quantity of vegetables, sugar beets, potatoes, grains and forage (U.S. Department of Agriculture National Agriculture Statistics Service, 2007). Crop production, associated sales, processing, packing, and services generate about $300 million dollars in revenue; Malheur County ranks 6th in gross farm gate sales in Oregon (Oregon Department of Agriculture, 2012). When compared to the top ten most agriculturally productive counties in the state, Malheur County is representative in terms of the amount of land being used to grow crops, median farm size, the market value of products sold and the average per farm market value of products sold (Table 2). The majority of crop production in Malheur County occurs in the northeastern most portion of the county on irrigated alluvial soils where the population is most dense. This study focuses its efforts on this portion of the county.

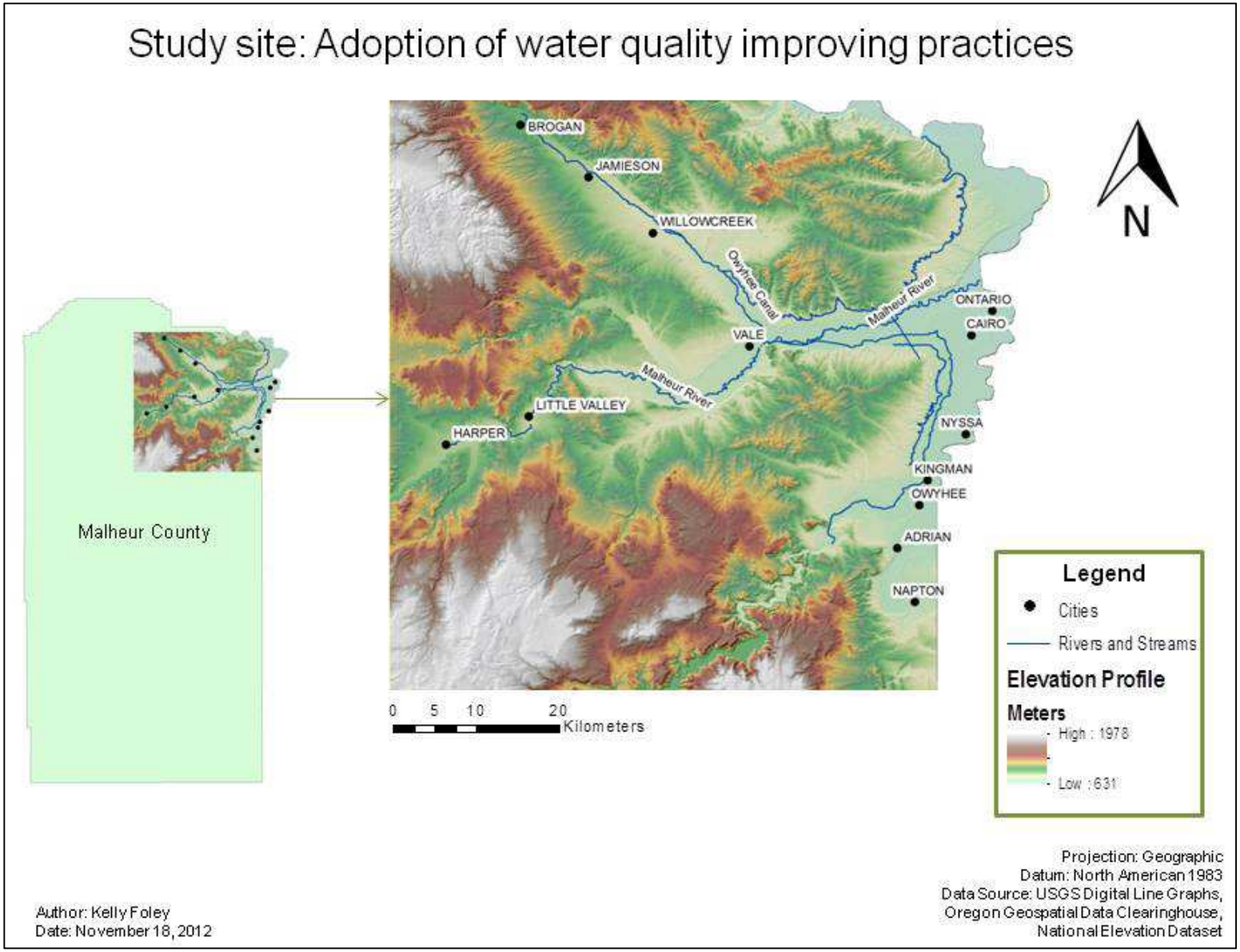

Figure 4. Study area map of Northern Malheur County.

Table 2. Farming characteristics of Malheur County compared to the average characteristics of the top 10 agriculturally productive counties in Oregon.

Parameter*	Malheur County	Top 10 average**
Total land in farms (ac)	1,170,664	573,973
Cropland (%)	20.5%	55%
Cropland (ac)	239,986	261,199
Average size of farm (ac)	937	561
Median size of farm (ac)	101	100
Farms (number)	937	1,865
Total irrigated land (ac)	198,683	88,331
Market value of products sold	$306,795,000	$306,355,000
Average per farm market value	$245,436	$223,885
Government subsidies received	$2,113,000	$4,086,300
Average per farm subsidy	$4,814	$12,615

*All values in the table were derived from the 2007 USDA Census of Agriculture

**The top 10 agriculturally productive counties (based on market value of products sold) in Oregon in descending order are as follows: Marion, Clackamas, Morrow, Umatilla, Washington, Malheur, Yamhill, Linn, Klamath, Polk

Data collection

The primary data for this study were semi-structured interviews with farmers in Northern Malheur County, where each farmer in the area served as one unit within the overall case study. Semi-structured interviews provide researchers with flexibility to adjust the interview based on the respondents' knowledge and perspective, while still allowing for cross comparison between interviews (Berg & Lune, 2012). Semi-structured interviews have been used in a number of producer adoption studies because they allow for flexibility but not at the expense of comparison across units (Beedell & Rehman, 1999; Carolan, 2005; Rodriguez et al., 2008; Atwell et al., 2009; Reimer et al., 2012).

A sufficient sampling size for qualitative research is dependent on theoretical saturation, or the point at which new themes stop emerging during interviews (Marshall, 1996). While there is no standard number of interviews needed to reach theoretical saturation, it has been estimated that between 5 and

25 is a sufficient number of interviews needed for phenomenological study (Mason, 2010). Ultimately, 29 interviews were conducted in order to reach saturation. Interviewees were selected using stratified random sampling from an Oregon State University Extension database. The database contained 330 names of producers in the area and their mailing addresses. Ideally, it would have been best to have a purposive sampling frame in which we could compare perceptions of adopters and non-adopters of CPs. However, there was no practical way to identify interview participants based on this attribute. Thus, stratified random sampling was used in an effort to generate a wide range of both adopters and non-adopters and to create a quasi-random sample.

The stratification was based on topography in an effort to include the wide range of practices, soil types, crops, and irrigation systems used in Northern Malheur County (Figure 5). Observation of past practice adoption behavior suggested that certain practices were more prevalent in certain topographic regions than others (i.e. pivot sprinkler irrigation). We believed that stratifying by topography would be the best way to engage a wide range of practices and adoption behavior. Effort was taken such that each of the topographies was represented proportionately. Ultimately, we were working towards the ability to make analytical generalizations and internal generalizations; conceptual generalizations and generalizations about the subgroup of Malheur County farmers we were interviewing, not statistical generalizations (Firestone, 1993).

All interviews were conducted and transcribed by the first author. Interviews were conducted in person at a time and place convenient to the interviewee and recorded using an audio recorder. Each producer was asked a series of open-ended questions that were directed from the interview guide (Appendix A). The interview guide provided sample questions and probes to gather information about the following topics: trusted information, attitudes towards water quality, farming, laws and regulations, and other groups of people, social norms, incentives and barriers to adoption, practices being used and

perceived practice changes over time. Demographic information for each respondent was collected at the end of each interview, including age, education, primary source of income, total acreage currently, total acreage at beginning of career, and crops grown. The interviews were transcribed using an *Express Scribe*, an open source software program.

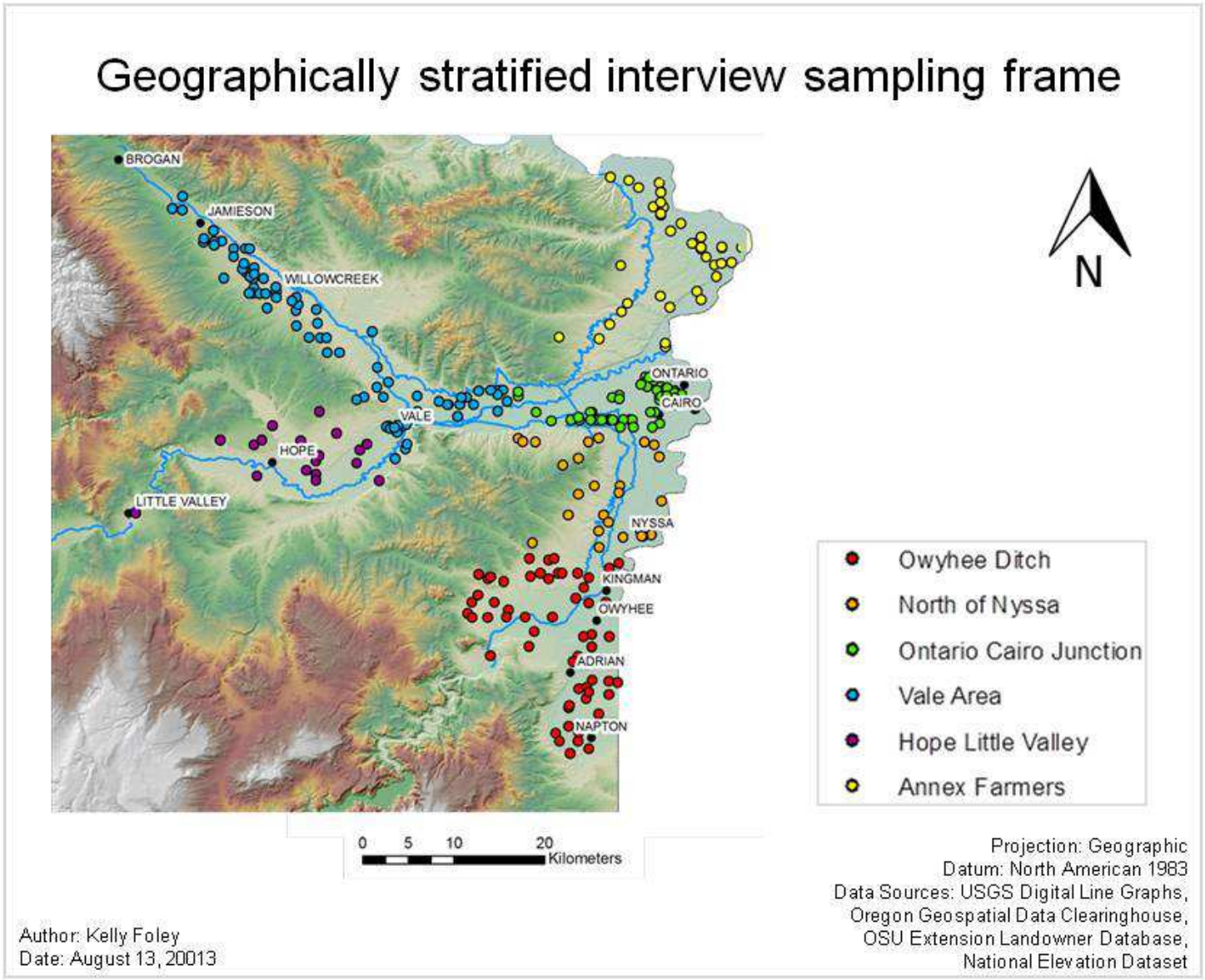

Figure 5. A depiction of the geographically stratified sampling frame of producers in Northern Malheur County.

Data analysis

In qualitative methods, analysis is a process of transforming findings into meaningful results (Lofland et al., 1984). The interview data were analyzed using content analysis, a method in which qualitative data are systematically examined through the process of coding in order to identify major patterns or themes (Gray, 2009; Berg & Lune, 2012). Researchers can organize interview data into a rich storyline through content analysis. While content analysis is largely qualitative, the use of descriptive statistics and simple counts can add a quantitative component (Berg & Lune, 2012). In this case, descriptive statistics were utilized to describe codes.

There are different types of content analysis, but directed content analysis was used in this study. While content analysis has both inductive and deductive aspects, directed content analysis is largely deductive, which allowed us to use existing theory to fulfill the research objectives (Gray, 2009; Berg & Lune, 2012). The framework used to analyze our study data was driven by the RAA/TPB in addition to contextual factors and emergent themes. The use of directed content analysis provided direction for our study through existing behavioral theory, while simultaneously examining how the theory could be modified to best reflect what had been observed.

Data coding

Data coding was conducted using NVivo9, a software program used frequently in qualitative research studies to analyze trends and identify major themes in the data (QRS International Pty Ltd., 2011). Interviews were analyzed using thematic units, which ranged in length from one word to multiple paragraphs. Themes were chosen as the unit of analysis because of the nature of the semi-structured interview; each respondent may not have been asked the same questions in the same order and concepts evolved out of an in-depth conversation with the respondent. In addition, sometimes respondents portrayed

a thought or line of thinking in a single word while others used whole paragraphs. Coding by theme allowed us to maintain complete concepts that emerged within responses.

Open coding was conducted in addition to predetermined theoretical codes to develop the codebook for this study (Emerson, Fretz, & Shaw, 1995). Open coding was an important part of this process, which provided validity checks on the coding process such that contextual codes were not confined to the theoretical framework. Focused coding was used to analyze transcripts line by line in order to develop a rigorous coding framework (Lofland et al., 1984). The coding process was iterative, allowing for multiple rounds of coding. The final codebook (Appendix B) reflected primary codes derived predominantly from the theoretical foundation and research objectives while secondary and tertiary codes were contextual, emerging from the transcriptions. Primary codes were mutually exclusive from one another such that another researcher could use our codebook to code the same units with the same codes as our research team.

Reliability

Reliability can be external and internal, where external reliability refers to the extent that findings can be replicated or reproduced. External reliability is not generally regarded as necessary or attainable in qualitative research (Gray, 2009); it is more commonly used in quantitative research where the purpose is explaining phenomena (often through the use of statistical patterns or trends), rather than understanding phenomena (how or why behavior occurs) (Golafshani, 2003). Therefore, most qualitative studies focus on internal reliability.

Internal reliability refers to the extent to which findings are stable or generally dependable (Gray, 2009). In qualitative research, internal reliability can be enhanced using a variety of different methods, including but not limited to, the use of more than one researcher in the field, detailed field notes or quality tape

recording for transcribing, the use of more than one researcher during analysis, intercoder agreement, intercoder reliability, and triangulation (Gray, 2009; Creswell, 2012). Interviews were transcribed using a high quality audio recorder (*Olympus DS-30 Digital Voice Recorder*) on the highest setting of audible sensitivity. Additionally, multiple researchers participated in data analysis, including the calculation of intercoder reliability.

Once contextual coding was finished and a preliminary codebook was created, two researchers worked together to create mutually agreed upon codes. Our focus was on primary codes, but we frequently refined secondary and tertiary coding such that it was clear what themes were contained within each primary code. We met twice to go over the codebook and compared coded transcripts to ensure that the process used in coding was clear and repeatable. Once both researchers felt comfortable with the codebook, codes were tested using intercoder reliability.

Intercoder reliability refers to the stability of responses between coders during analysis, or the degree to which two coders isolated from one another would code the same unit of text with the same code (Creswell, 2012; Campbell, Quincy, Osserman, & Pedersen, *forthcoming*). Two researchers separately coded two randomly chosen interview transcripts. Upon comparison of the coding, it became clear that intercoder reliability could not be calculated because the units of analysis had not been defined. As previously mentioned, the coding unit used was based on interview themes. The length of each theme ranged from one word to one paragraph depending on the response and how the response was interpreted by the researcher. Researchers would frequently code different length units for each theme (i.e. one researcher codes an “attitude” as one line while another codes it as an entire paragraph).

In response, a method developed by Campbell et al. (*forthcoming*) of pre-defined unitization was used on two new, randomly selected transcripts. One researcher coded the transcripts first and then bracketed the units of text that she

perceived to be the “thematic unit.” The transcripts were then given to the other researcher, who coded the blocks with what she perceived to be the matching primary code. We recognize that this method can add a certain amount of subjectivity to the coding towards the first researcher’s bias. However, coding accuracy varied between the two researchers. The first researcher conducted and transcribed all interviews and was thought to have a higher amount of contextual knowledge regarding the transcripts. Thus, it seemed reasonable to base the coding on units predetermined by the researcher who conducted the interviews.

There is no set standard as to how much text should be included to compare intercoder reliability; however, a suggested range is anywhere from 5-10 pages of transcribed text to 10% of the total document being transcribed (Campbell et al., *forthcoming*). We calculated intercoder reliability using two full transcripts out of 29 total transcripts, which amounted to 135 coded units for comparison. This added up to 15 pages of text, or 6% of the total pages of documents.

We used percent agreement to calculate intercoder reliability. Intercoder reliability results showed 79% agreement between coders. The academic literature presents a wide range of reliable scores for percent agreement, ranging from 70% to greater than 90% (Lombard, 2005). Based on the nature of the interviews (semi-structured) and varying coding experience between researchers, 79% was deemed to be an acceptable level of intercoder reliability. Stability and reliability of study results were bolstered by the use of detailed interview transcripts, methodological triangulation (discussed further in the next section) and intercoder reliability.

Percent agreement has been criticized for being overly simplistic, for overestimating agreement in some instances, and for not taking chance into account (Lombard, 2005). However, the nature of in-depth, semi-structured interview data is not amenable to complex statistical analysis; the end goal of this

study was not to generalize to other systems, but rather, to create a narrative describing the phenomenon of adoption in Malheur County. Statistical analysis was not appropriate for this study because not all respondents were asked the same questions in the same order, many interviews lasted longer than others, and interviews covered varying topics. Secondly, many reliability statistics assume that codes have an equal probability of being chosen by the coder (Campbell et al., *forthcoming*). In this study, certain codes were much more likely to be chosen, such as “practices”, while others were less likely, such as “norms.” This was simply due to the nature of the questions asked. Percent agreement may be simple, but it provided the most reliable calculation because more complex statistical calculations would be misleading for this type of data.

Validity

In qualitative methods, validity is a goal that study conclusions be as robust and credible as possible. In an effort to increase study validity, steps were taken to assess whether the findings were consistent with the experience of regional experts, and enhance the credibility of our account of adoption in Northern Malheur County. Validity can be broken down into two parts: internal and external validity, where internal reliability focuses on credibility and external validity focuses on transferability. Here, we will explore how we sought to achieve external validity through a robust research design and examine how we worked towards internal validity through methodological triangulation, among other methods.

External validity in qualitative methods is the goal of achieving generalizability to the extent allowed by the research design (Maxwell, 2004; Gray, 2009). This study was not driven by a statistically representative population of producers in the region. We were thus limited in the extent to which it was possible to generalize from these findings beyond the study area. However, we made an effort to represent all groups of producers in the area by choosing respondents from the various microtopographies in the area. Based on the wide

range of producers, geographies, crops, and practices represented within the study, there is no reason to believe that results are not generalizable to the population of producers in the area. This is referred to as facial generalizability (Maxwell, 2004). In addition, respondents were asked if they felt they were representative of the producers in their area. Seventeen out of 23 (74%) respondents reported that they were representative of the operations in the area (Table 3).

Table 3. Respondents own assessment of representativeness

	Representativeness	
Measure	Yes	No
Number of respondents	17	6
Percentage	74%	26%

*6 respondents did not respond or were not asked the question

% Percentages were based on the 23 respondents who answered this question.

Out of six respondents who felt that they were not representative, three cited topographic reasons for being unconventional, two cited unique practices, and one cited a unique management style. Some representative statements of respondents who felt they were not representative are as follows:

"No…We're really the roughest one in the area and that's why we always had cattle was to maximize the rough ground and then enable us to grow a lot of hay and corn and stuff like that. But we do have some fields that are nice and so people row crop but it's a rough place; for that area, even, it's a rough place because it's at the bottom and then those damn drain ditches really screw things up (laughter)."

"Not really, I think we're above most, a lot of them aren't trying some of these things or doing things to make it that much better yet. Like [my son], gets this higher tonnage of hay and one of the seeds salesmen here, a local one, here, he said well, [my son] gets this, but yeah, he works at it. That was the key. They know what he's doing but he works at it harder to accomplish that so I like to think we're doing a little better job than average, personally."

> "No. No, I've got the highest percent sprinklers of anybody. I think it's going, I mean 15 years ago there were hardly a circle around here. There's a lot more and they are popping up all the time, but no, I'm not very representative as far as farming with no-till or reduced tillage or, you know, direct seeding and that kind of stuff, no that's not the norm."

Of those respondents who did not view themselves as representative, only two respondents attributed this unconventionality to their practices. These responses suggest that the study group was fairly representative of producers in the area; it seems reasonable that the study results may be relevant to the population of producers in Malheur County.

Internal validity refers to the extent to which the researcher's interpretation of reality matches the study group's interpretation of reality (Gray, 2009). A number of methods can be used to lessen validity threats, including but not limited to: triangulation, quasi-statistics, member checks, peer review, clarifying researcher bias, prolonged engagement and persistent observation, negative case analysis, external audits, and writing memos (Maxwell, 2004; Gray, 2009; Creswell, 2012). Steps taken to ensure internal validity in this study suggest that results may be generalizable to lower level theory. The factors that have been identified as drivers to adoption in this study may not be generalizable to all farmers in the United States or in Oregon, but the results could be used to provide new or modified theory for future studies.

In order to ensure internal validity, quasi-statistics, methodological triangulation, and clarification of researcher bias were used to provide an internal check on study results and major findings. While many qualitative studies use terms such as "many", "typical", "rare", or "most" to describe results, the use of descriptive statistics to qualify these claims can be beneficial when analyzing prevailing themes or outliers (Maxwell, 2004). Descriptive statistics can be especially appealing when an audience consists of natural and social scientists as well as policy leaders and land managers. In this study, quasi-statistics were used to demonstrate the prevalence of results or themes and to augment the evidence for our major findings.

Triangulation is one of the most commonly used validation methods in qualitative analysis (Bloor, 1997). In triangulation, researchers consider multiple sources, methods, investigators, and/or theories to provide supporting evidence to their findings (Creswell, 2012). There are multiple types of triangulation, including data triangulation, investigator triangulation, multiple triangulations, and methodological triangulation. In methodological triangulation, researchers use supplementary data from mixed methods to affirm or refute results from primary data collection (Gray, 2009). In this study, methodological triangulation was used to ground-truth interview results and emerging themes. Interview results were triangulated against existing academic literature and a small focus group that was created for purposes of validation. Focus groups are frequently used in the social sciences in combination with individual interviews as a validity check (Berg & Lune, 2012). The individual interviews provide a certain amount of breadth and range to opinions and experiences. Following up with a focus group has the advantage of adding more depth to the overall narrative (Morgan, 1996).

The focus group consisted of 3 key informants who did not participate in the individual interviews. One informant was a successful producer in the area who also helped to design the interview protocol. Another informant held a managerial position at a local United States Department of Agriculture (USDA) office, and another was employed through Oregon State University. All three informants had lived and worked in the community all their lives and were chosen because they are leaders in the community who communicate with a wide array of growers all over the county. Additionally, all informants were farmers themselves of different crops and different sized operations. While one informant farmed as his primary income, the other two informants farmed as a hobby or for supplemental income.

The focus group discussion lasted about 90 minutes and informants were asked about the major themes that had evolved out of preliminary analysis: whether or not they agreed with them or thought they were reasonable, and

whether or not they felt that the theme was missing information. The final discussion revolved around the interaction between the major incentives and barriers that were identified. Responses were generated from all respondents for all themes. The results of the focus group were a source of constructive feedback on the emerging themes which was used to enhance the overall narrative of adoption in Northern Malheur County. In particular, the focus group provided valuable feedback on the relationship of water quality and conservation to other incentives and age and lack of agency as barriers.

It is important to consider potential researcher biases in qualitative studies in an effort to not only try to limit the bias, but also to be transparent and acknowledge those limitations. We did our best to resist allowing our own perceptions of farming, farmers in Malheur County, and any preconceived notions of the prevalence of voluntary adoption in the area to impact our results. While the goal of this study was to encourage the adoption of water quality improving practices, we acknowledge that every farm, farmer, and operation is different from the next. What works for one farmer does not necessarily work for a neighboring farmer. We tried to create a research design that would take this diversity into account by seeking the perceptions and opinions of respondents about water quality improving practices, rather than assuming that all farmers felt the same way or that there is one universal truth that could describe their adoption of these practices. We also tried to communicate this focus to interview respondents before beginning the interviews. After reading consent forms, the interviewer let respondents know that there were no right or wrong answers, but that we were merely interested in their perceptions of water quality and CPs.

During the interviews, several respondents would ask for validation that their answer was the correct answer. The interviewer would always try to respond positively and reiterate that there was no right or wrong answer. Additionally, many respondents expressed that they were not sure that they had helped our study in any way. We tried to assure them that we learned something

new from each person we spoke to and that everyone had something to offer to the greater story at hand. Throughout the interviews, the interviewer tried to refrain from providing her own opinion in an effort to focus on what the respondent had to say. In a few instances, respondents asked the interviewer questions about what she thought about the topic at hand. She would briefly respond honestly in an effort to keep the interview comfortable for the respondents but in a way that the focus did not shift away from the respondent.

Limitations

One limitation of our study (and many adoption studies) is the oversimplification of adoption. We considered adoption to be a binary variable; producers either adopted a practice or they did not adopt the practice. In reality, adoption is more of a continuous variable, where producers adopt practices at varying degrees. For example, one producer may have his entire 1000 acre operation irrigated by pivot sprinklers, while another may have one pivot sprinkler on a small 80 acre section of his 1000 acre operation, the rest of which is conventionally irrigated. We would have considered both of these to have "adopted" the pivot practice. However, our study focus was not necessarily on the outcome of adoption, but rather the factors that lead to adoption.

Analyzing in-depth interview data is inherently subjective. The coding process is one in which interpretation and "reading between the lines" to find meaning is imperative. As a result, the process of coding and analysis can reflect the biases of the researcher. In this study, we sought to minimize this subjectivity by employing intercoder reliability and by having multiple researchers work together to develop and modify the codebook. However, we recognize that these steps to limit subjectivity do not ensure that our results are not biased toward our own interpretations and perceptions.

RESULTS

This section presents an overview of study results. Results suggest that farmers in Northern Malheur County have adopted a wide range of CPs including sprinkler and drip irrigation systems, reduced and minimum tillage, reduced fertilizer applications and use of precision application technologies. However widespread this adoption, it is not uniform, which reflects the general pattern of heterogeneous adoption in the area. Upon analysis of interview transcripts, the major incentives and barriers to adoption reflected characteristics of the practices themselves: relative advantage derived from financial gain or loss, conservation of water, soil, and nutrients, and improvements in water quality, the ease or difficulty in using a practice (complexity), the ability to observe the success of a practice prior to adoption (observability/trialability) and the compatibility of the practice with existing farm operations. Factors that emerged as barriers to adoption and potential areas for future study include farmer age and the perceived lack of human agency amongst farmers to make their own practice decisions and improve water quality.

Respondent characteristics

Twenty-nine semi-structured interviews were conducted with 31 local producers in the area, which were 43 minutes on average in length. One of the interviews was with a husband and wife and one with father and son. One of the respondents was retired, but the remaining 28 were actively farming. The respondents ranged from 29 to 81 years old, and were 58 years of age on average (based on the arithmetic mean). Of these respondents, two were women while 29 were men. Twelve respondents received a bachelor’s degree, and the majority had completed some college courses (Figure 6).

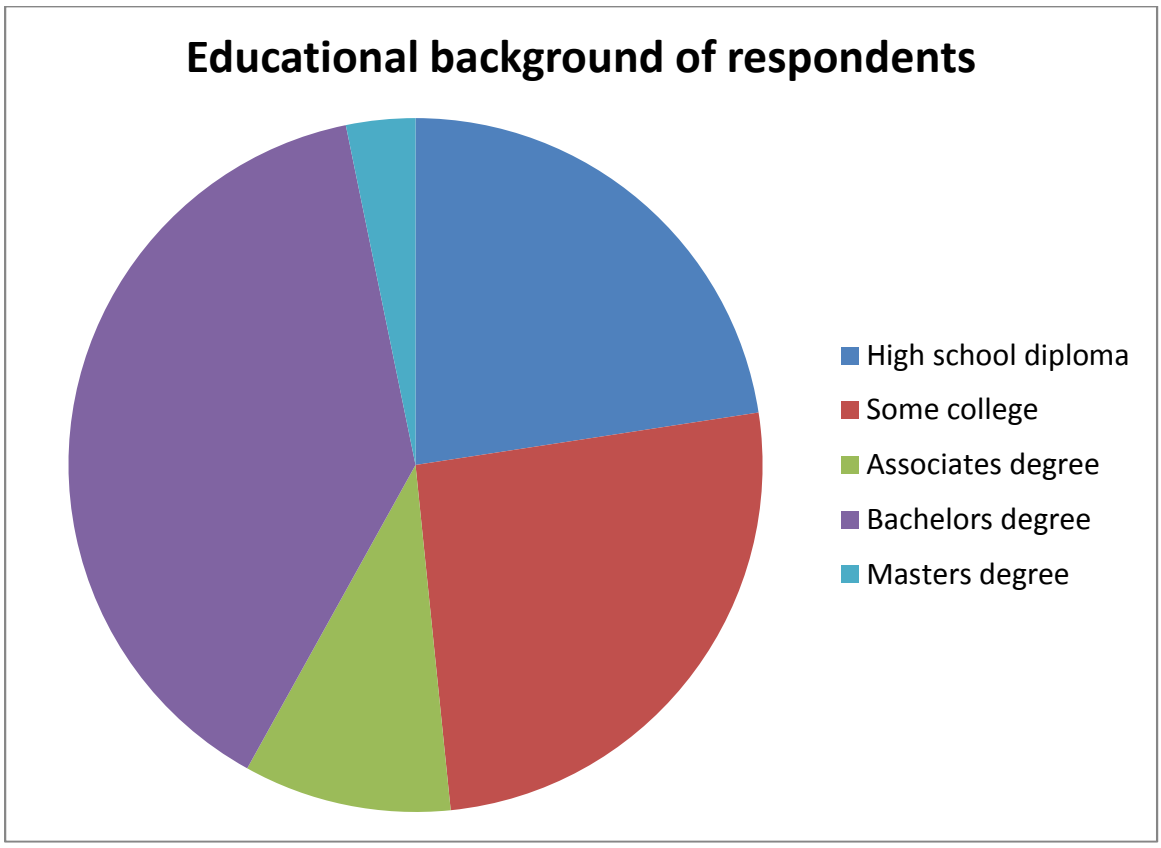

Figure 6. Education attained by respondents. The majority of respondents have completed some college coursework.

The mean farm acreage of respondents was 649 acres while the median was 550 acres. The majority of respondents were operating small to medium sized farms. The largest farm size was 2250 acres (Figure 7).

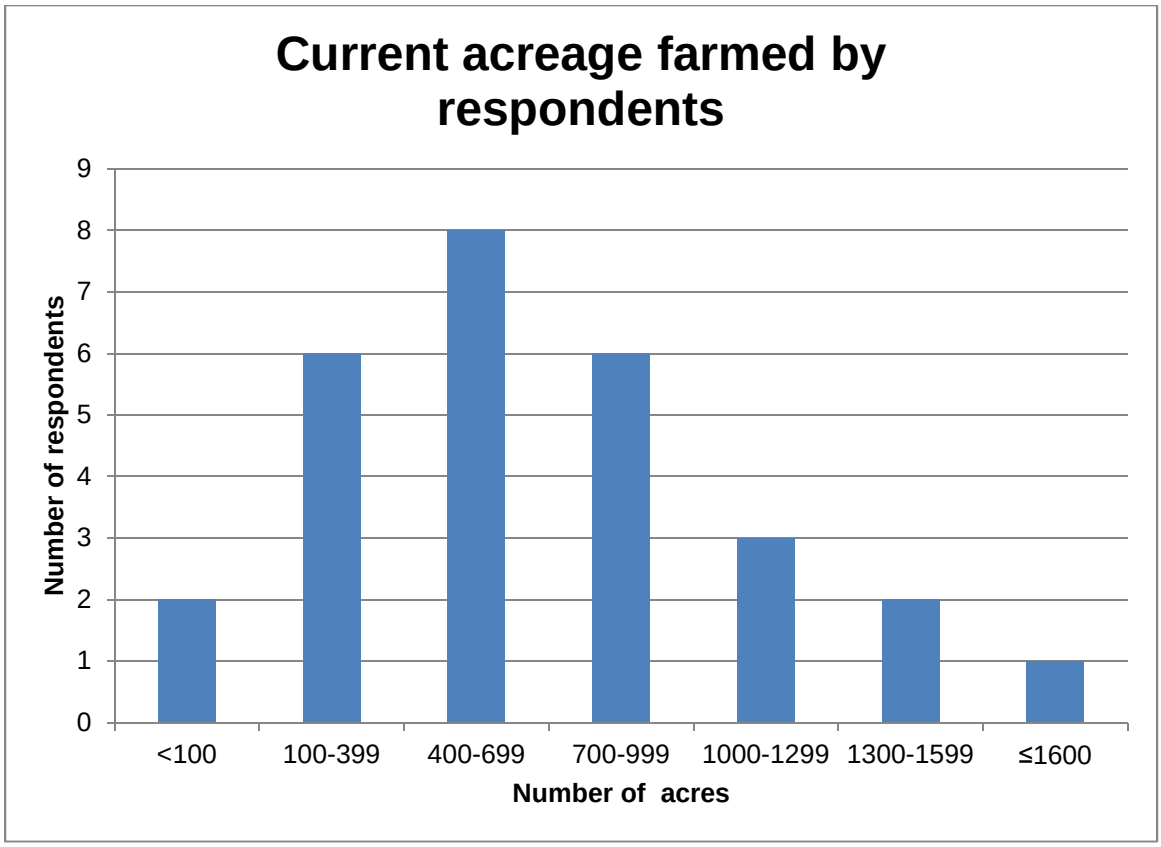

Figure 7. The amount of land being farmed today by respondents.

Twenty-four out of 29 respondents reported that farming was their primary income, although 13 of those 24 respondents also reported having supplemental non-farm income. Additionally, respondents reported using a wide range of irrigation systems across the area. More respondents reported using Owyhee Irrigation District than any other system (Table 4).

Table 4. The reported irrigation district or water source utilized by respondents.

Irrigation district/water source* %						
Owyhee	Warm-springs	Vale Oregon	Snake River	Malheur River	Old Owyhee	Wiilowcreek
10 34%	7 24%	7 24%	4 14%	3 10%	3 10%	3 10%

* Many respondents work with multiple irrigation districts

% Four respondents did not respond or were not asked this question

Other systems that were used by respondents but at low frequency included the Boise River, Buehler Reservoir, Bully Creek, and groundwater

When comparing the demographic characteristics of study respondents to those of the county, interview respondents seemed fairly representative (Table 5). The age and gender ratio of the county was comparable to that of the respondents in this study, while the proportion of producers who reported farming as their primary income was slightly higher among respondents than for the county at large. Although the average acreage of respondents was slightly lower than the average for the county, the median acreage was higher for respondents than for Malheur County.

Table 5. Demographic characteristics of respondents compared to those of the operators across Malheur County.

Characteristic	2007 Census of Agriculture Malheur County statistics*	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

Study respondents reported what crops they are growing today (Figure 8). More respondents reported growing wheat, corn, onions, hay, and alfalfa than any other crops. The top crop items grown in Malheur county, according to the USDA 2007 Census of Agriculture, in descending order include: forage, wheat for grain, corn for grain, vegetables harvested for sale, and onions (U.S. Department of Agriculture National Agriculture Statistics Service, 2007). The crops grown by the respondents were consistent with the major crops grown in the county, suggesting that respondents were growing crops that were representative of those grown in Malheur County.

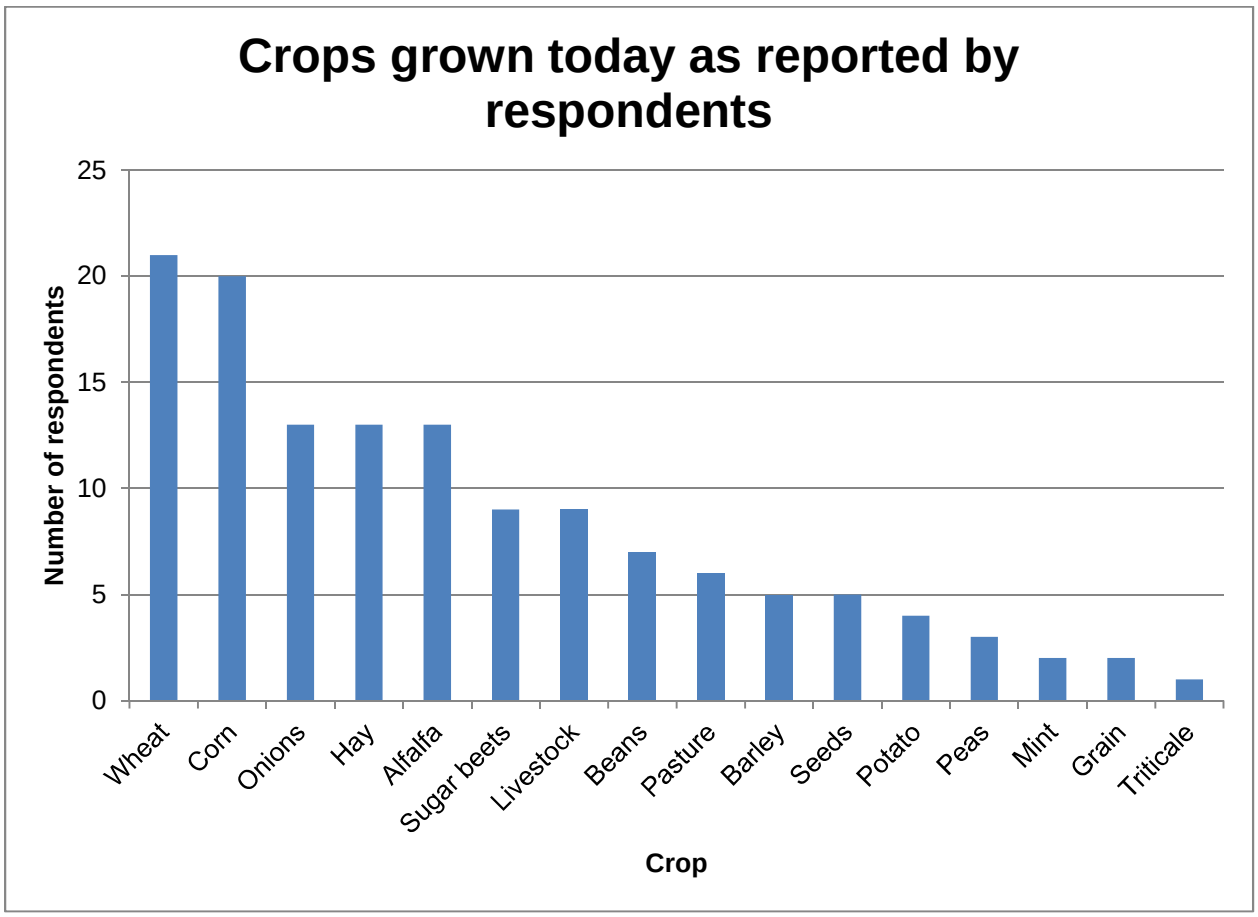

Figure 8. Respondents reported growing a wide range of crops. Most respondents grow wheat and corn within their crop rotations.

Respondent practices

A major perception amongst change agents (OSU extension agents, conservationists with local NRCS, SWCD, Watershed Councils) in Malheur County is that while many growers have adopted practices that improve water quality, adoption is not uniform. The reported adoption of these practices amongst respondents showed a similar pattern: widespread, but not uniform adoption. Throughout the interviews, respondents were asked about the various practices they adopt on their farm. Respondents reported the use of seventeen

water quality improving practices, including erosion control measures, efficient irrigation, precision fertilizer methods, and reduced tillage. All respondents reported having adopted at least two CPs, while twelve was the highest number of CPs adopted by an individual farmer. However, not every practice has the same impact on improving water quality, so it cannot be assumed that adopting two of these practices is inherently less effective than adopting twelve. The respondent who had adopted two CPs was employing sprinkler irrigation combined with sediment ponds. This combination of practices could substantially reduce nitrate leaching and runoff, and are among the most effective ways of reducing farm contribution of sediment and nutrients into nearby waterways.

CPs

The most commonly reported CPs- used by at least half of respondents- were soil testing, precision fertilizer application, sprinkler irrigation, reduced tillage, and sediment ponds (Figure 9).

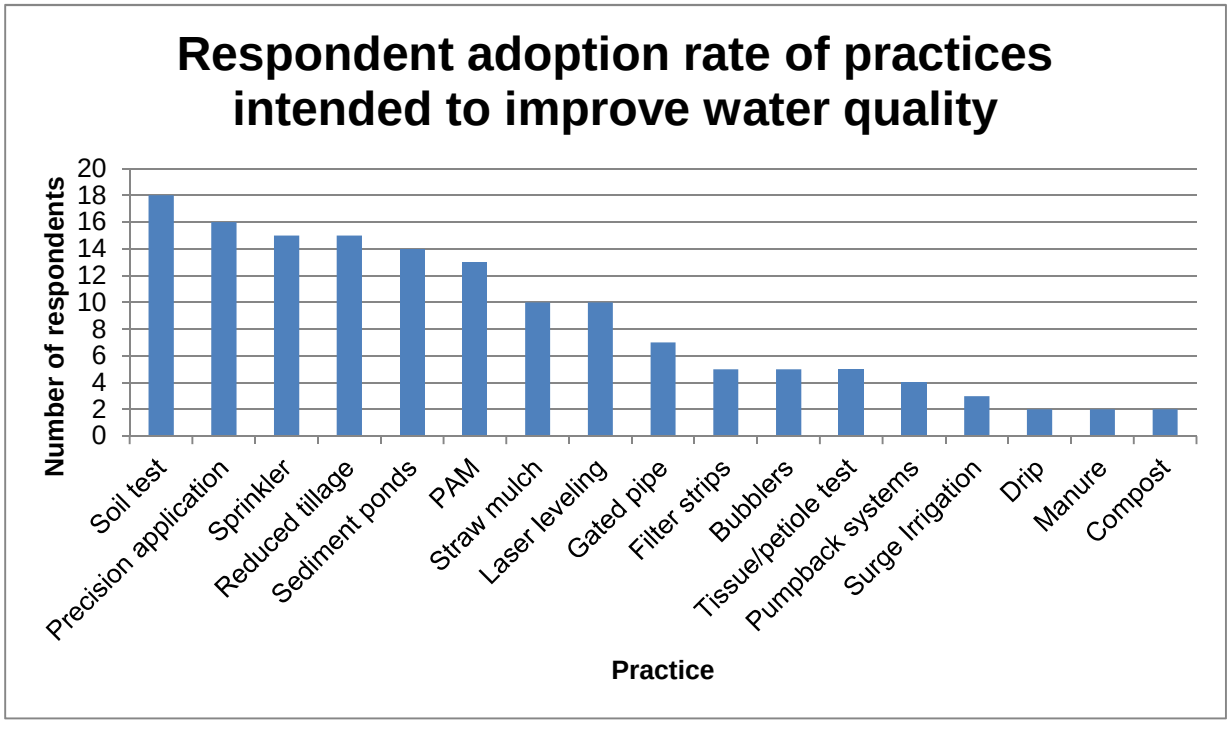

Figure 9. Soil tests, precision fertilizer applications, sprinkler irrigation, reduced tillage, sediment ponds, and use of PAM were the most frequently used CPs as reported by respondents.

Irrigation practices

In irrigated agriculture, the irrigation system used impacts the tillage and fertilizer practices that are adopted due to compatibility. The majority of the respondents reported using furrow irrigation as their primary system, a little over half were using sprinkler irrigation and only a couple were using drip irrigation. Six respondents reported that they have more than one primary irrigation system and 10 respondents reported using a secondary system on a smaller subset of their operation (Figure 10).

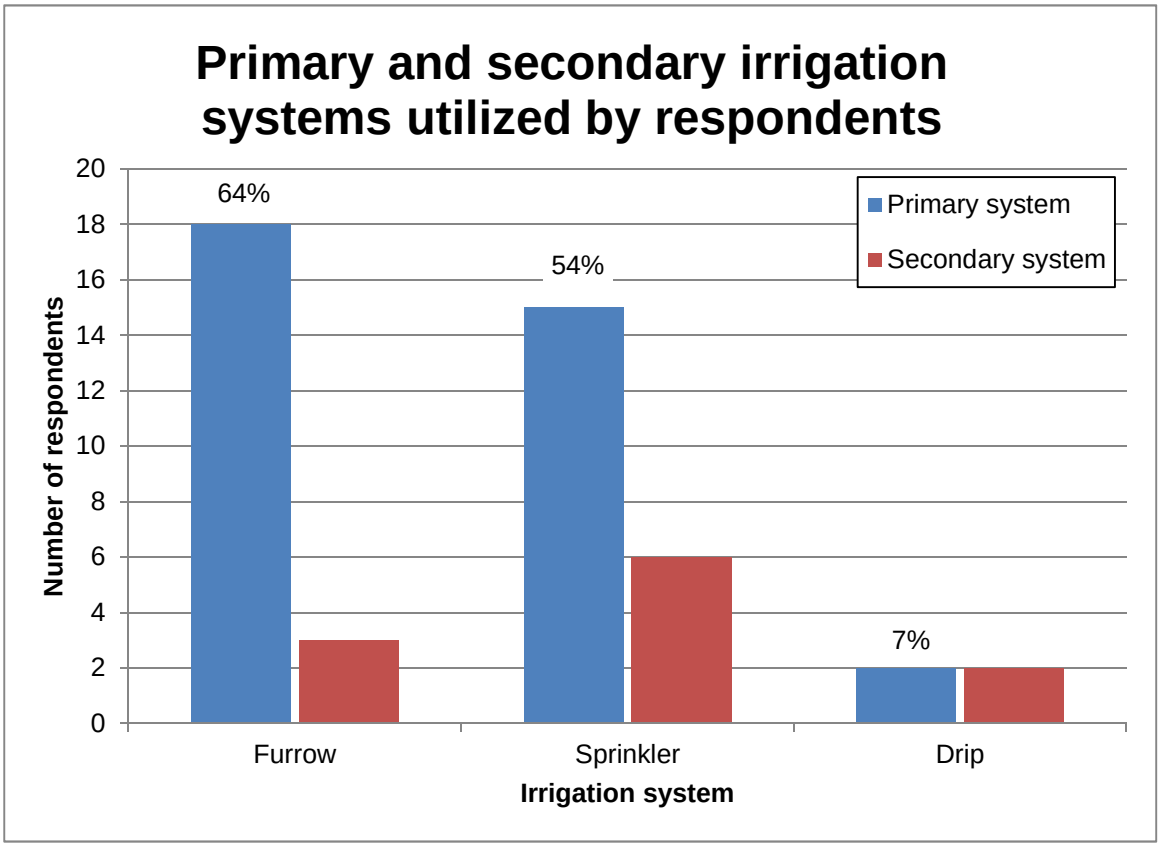

Figure 10. While the majority of respondents reported using furrow irrigation, over half reported using sprinkler as their primary irrigation system. Six respondents reported using a mixture of primary systems while 10 reported using a secondary system on a smaller proportion of their farm.

Adoption of sprinkler irrigation was widespread, but was largely consolidated to the western side of the study area. Eleven out of 15 respondents using sprinkler irrigation were located in the Vale-Willowcreek transect as well as the Southwest Vale-Little Valley transect. The topography in these areas is rougher and considered to be more marginal by growers in the valley, with steeper terrain and more hills. As a result, the installation of a sprinkler irrigation system can be much more advantageous on this type of ground. When asked why so many people were going to pivot sprinkler systems, one respondent replied:

"Labor and you know, being able to open up new ground to farming. A lot of people, without a pivot they just simply can't farm any of their ground. Especially up along the foothills."

While some farm ground has been converted from furrow to sprinkler irrigation, a large area in which sprinklers have been installed was not previously in production.

Many respondents suggested that land under furrow irrigation is not suited for sprinkler or drip irrigation because of its productivity, infrastructure, topography, etc. However, respondents using furrow irrigation reported having used a number of erosion control measures to combat soil and nutrient loss on their fields (Figure 11). All 18 respondents who reported using primarily furrow irrigation were using at least one method of erosion control and most were using three or more methods concurrently. Three respondents reported using five different erosion control measures on their fields. The most commonly cited method of erosion control on furrow irrigated fields were sediment ponds, which were variable in size and were used primarily to catch eroded topsoil before it washed away from the field. The second most frequently cited method of irrigation control was the use of Polyacrylamide (PAM) and/or straw mulch within furrows to keep sediment in place as fields are flooded during irrigation. Many respondents also cited using laser leveling, gated pipe, filter strips, and surge irrigation as techniques for reducing the erosion from their fields.

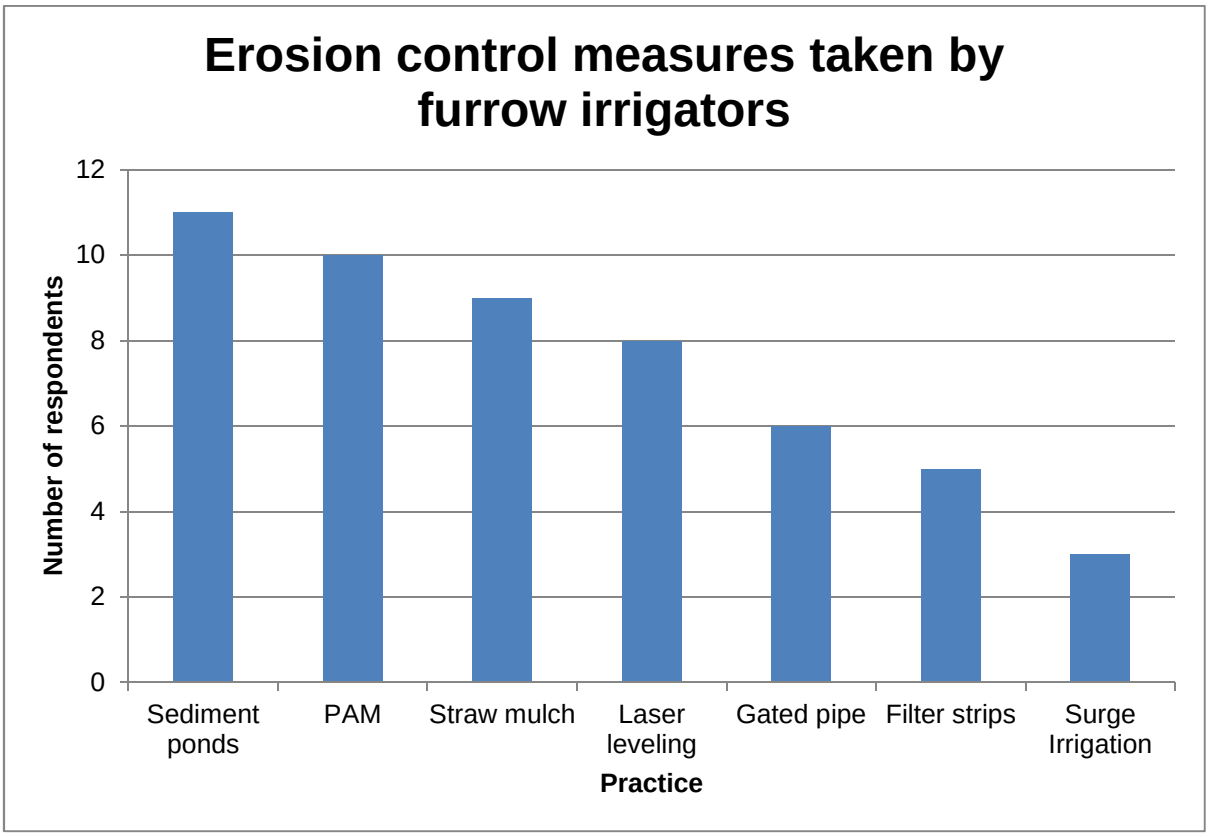

Figure 11. Out of 18 respondents who reported using primarily furrow irrigation, all reported using at least one erosion control practice and many reported using as many as five.

Drip irrigation was only used as the primary irrigation system by two respondents, and secondarily by another two respondents. All four of these respondents reported growing onions, which is the primary crop grown using drip irrigation in Malheur County. One respondent described why he considered putting a drip system in as follows:

"The efficiency of it number one. Number two it was for onions and they were having very great success with yield and getting that yield with less fertilizer through drip systems. So I thought that it would be a win-win and especially on our marginal ground that it would help my yield out as well as the irrigation would be even."

While drip irrigation use is increasing in Malheur County, furrow irrigation remains the primary irrigation system for crops in the area. Conversion from furrow to drip irrigation in onion production started in the mid-1990s. As of 2011, 42% of onion acreage in the area was grown using drip irrigation and reached 50% in 2012 (Shock C.C. & C.B. Shock, 2012) .

Tillage practices

While the majority of respondents reported using conventional tillage methods (19), just over half of respondents (15) reported using some form of reduced tillage, which could include strip tillage or minimum tillage, and one respondent reported using no-tillage (Figure 12). Many respondents reported using both conventional and conservation tillage on various fields around their farm. Choice of a tillage method was frequently dependent on their crop rotation. However, it should be noted that perceptions of conventional and conservation tillage cannot be easily defined. Previous studies of tillage practices in Malheur County suggest that traditional conventional tillage has largely been replaced with modified conventional methods that reduce tractor passes, compaction, soil moisture losses, and fuel and labor costs. Many producers have slowly adopted conservation tillage techniques over time and now consider them to be “conventional” tillage methods (Foley, K.M. & C.C. Shock, 2013). Based on this varied perception of conventional tillage, study respondents may be using more CPs than would be suggested by the number who report use of conventional tillage.

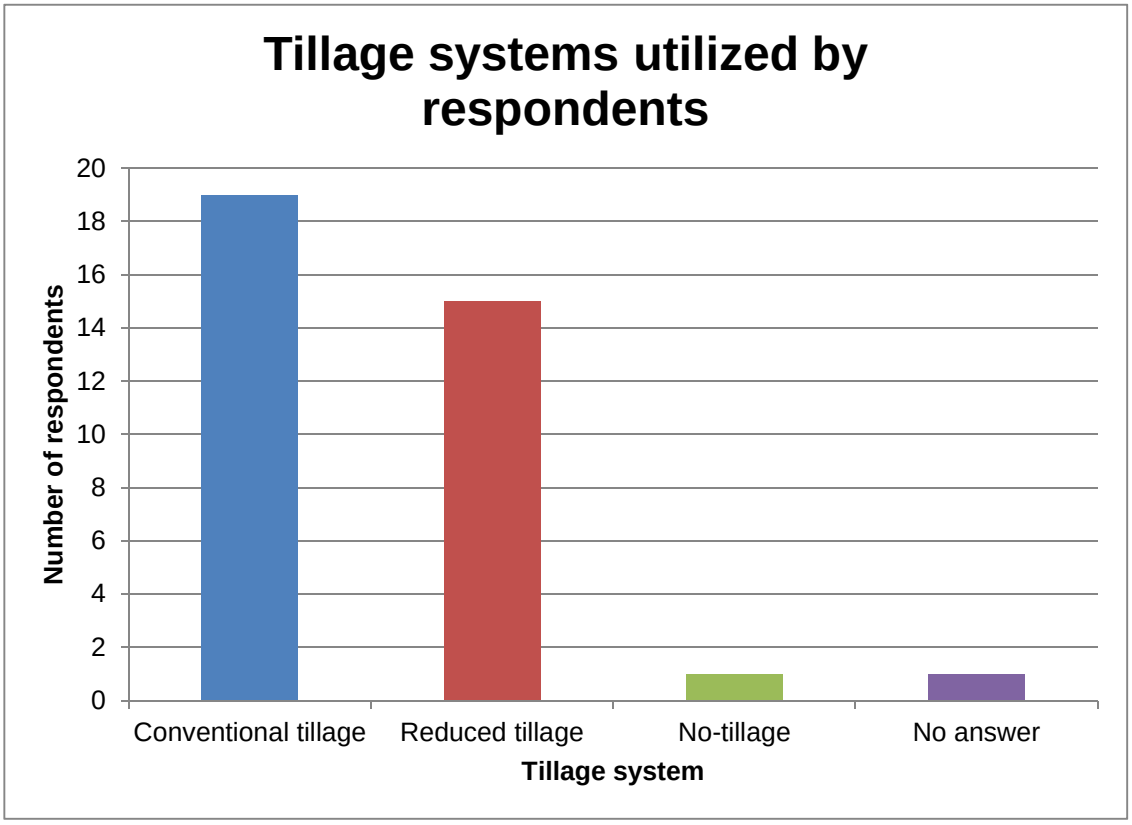

Figure 12. The tillage systems utilized by respondents. Many respondents noted that they used more than one system dependent on their crop rotation. Conventional tillage was most common but over half of respondents reported using reduced or no tillage.

The wide range of tillage practices in Northern Malheur County exemplifies the continuum of adoption vs. non-adoption of CPs. There was a wide range of conservation and conventional tillage practices that can make it hard to distinguish between who has implemented or not implemented this CP. While many producers still use conventional tillage, they are trying to do it with far fewer passes and thereby reducing their impact on water quality issues.

Fertilization practices

While more respondents reported using conventional, broadcast methods of fertilizer application than conservation methods, twelve reported using banding, and six reported using fertigation methods (when fertilizer is applied through an irrigation system) (Figure 13). Eleven respondents reported using more than one method of application, and as with tillage practices, many cited crop rotations as a reason for changing their application method. In addition to more precise application methods, 18 respondents reported using soil tests before applying their fertilizer such that the right amount is applied. Soil testing in Malheur County became more popular in about 1980 and is a common practice today (Shock, C.C. & C.B. Shock, 2012).

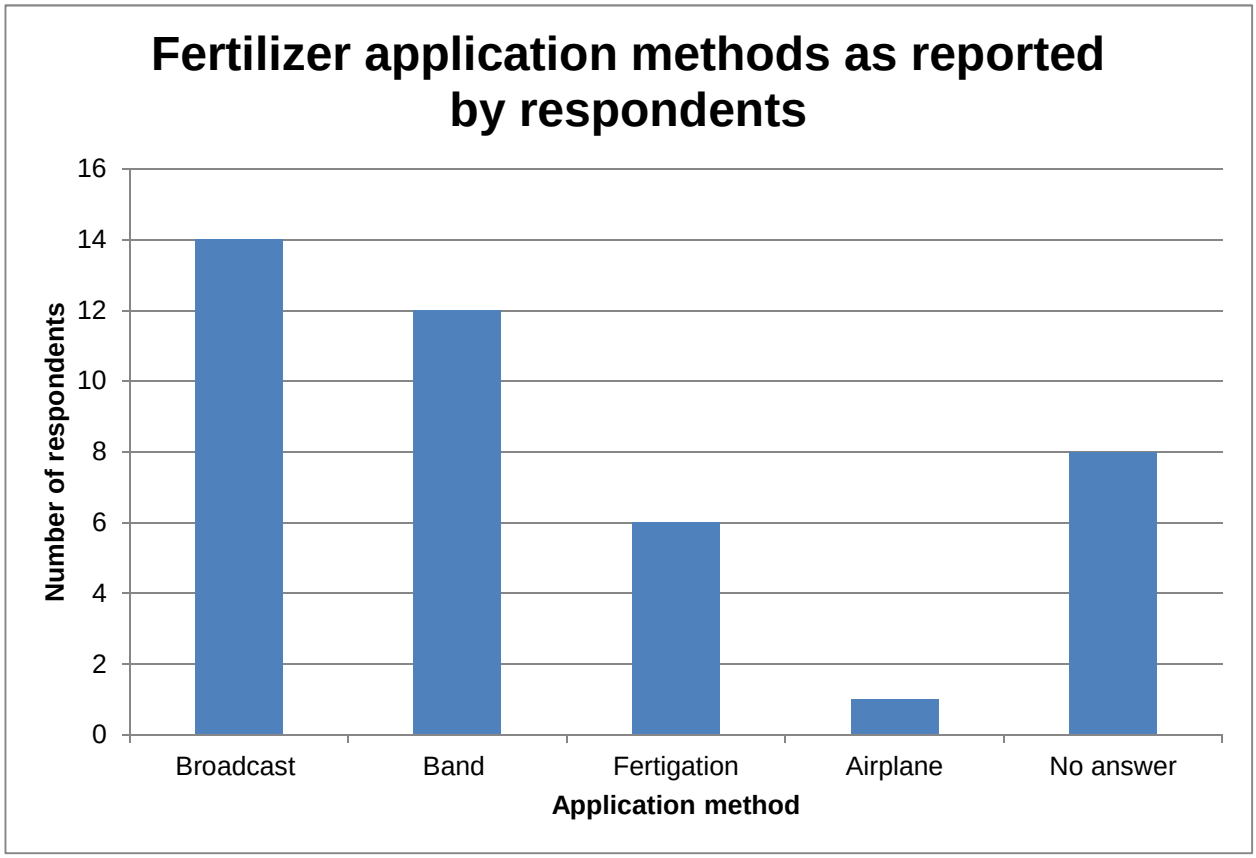

Figure 13. The fertilization application methods as reported by respondents. Many respondents reported using more than one application method. The most commonly reported method of application was broadcasting.

In summary, while CPs were being adopted, their adoption was not uniform and varied widely across producers. This trend was also evident in the practices that were reported by respondents in this study. In the following sections, the incentives and barriers to encourage and impede adoption will be explored.

Factors driving adoption

The primary factors that resulted in adoption that were identified in study interviews were the perceived relative advantage of a practice (driven primarily by financial gain and the desire to conserve soil, water, and nutrient resources and improve water quality); the complexity and ease of use of a practice; compatibility with existing farm operations; and the observability of the practice. Barriers to adoption included relative disadvantage (driven primarily by financial loss); the complexity and difficulty of use of a practice; and practice incompatibility with existing farm operations. Producer age and a desire for individual agency were also identified as barriers to adoption by some respondents. Each of these incentives and barriers will be defined and described in greater detail in the following sections.

Incentives to adopting water quality improving practices

Thirty-two themes emerged as reasons why respondents adopted CPs. These themes were grouped into six categories of incentives: financial gain, conservation, farm compatibility, ease of use, observability, and water quality (Table 6).

Table 6. The main incentives cited by respondents as reasons for adopting practices intended to improve water quality.

Incentive	Themes*	Frequency (n = 29)	Percentage
Financial Gain	• Expense (cheaper than alternative, too expensive to waste, cost reduction, saves/makes money, fuel savings) (24) • Grants or subsidized infrastructure (13) • Increased yields (7) • Increased uniformity (6) • Increased quality (6) • Increased or equal production (5) • Market forces (3) • Reduced or maintained risk (1)	29	100%
Conservation	• Soil savings/soil composition/reduced runoff (18) • Water savings/irrigation efficiency/reduced runoff (18) • Nutrient savings/nutrient precision (5)	25	86%
Farm compatibility	• Topography (11) • Existing infrastructure (6) • Field shape (5) • Existing irrigation systems (4) • Crop rotation (4) • Field size (2) • Operation size (1) • Existing machinery (1)	19	66%
Ease of use	• Labor savings (time, hired help, operator ease, reduced management load) (16) • Weed control (4) • Maintenance (2)	19	66%
Observability	• Observing success of others (6) • Experimentation (6) • Other farms (4) • Neighbors (3) • Experiment station and extension (1)	16	55%
Water quality	• Clean water (6) • Drinking water (2) • Fish (1) • Recreation (1) • Sediment load (1)	9	31%

* Themes are ranked by frequency within each incentive group. Other themes with low frequency included relief from regulatory pressure, technology, autonomy, social pressure, age, desire for latest technology, dislike chemicals, improved seed stand, positive experience with agency, weather

Financial gain was cited by 100% of respondents as a reason for adopting CPs. It includes themes such as profitability, reduced costs, increased yields, market forces, and reduced risk. Respondents expressed that practices that would either save them money or make them money were more likely to be adopted. Some representative example statements from respondents about financial gain incentives include:

"The least amount of tilling that you have to do is the best because fuel with 4 dollar diesel, the least number of times you can get across the field, the better off you are. So by far the pivots or any kind of a no-tillage you can do is a lot better."

"I got a grant to bury some supply mainline through the [watershed council]. I got a 10,000 dollar grant to pipe there again a dirt ditch; a supply ditch that was wasting a lot of water and creating a lot of erosion. So they worked with me on that and were able to help on that."

"But it all comes back to if somebody's gonna pay for half of my pivot, then yes, I'm gonna put it in. And that's the way, not all of them, but the majority of them are."

Conservation includes soil savings, reduced runoff, water savings, irrigation efficiency, and nutrient savings. The emphasis of these conservation efforts were on soil and water quantity, rather than quality. Conservation was the second most frequently cited incentive for adoption CPs, with 86% of respondents stating that it was a factor in their decision to adopt. Respondents detailed that one reason they adopted water quality improving practices was because these practices reduced water use, preserved topsoil, and/or kept fertilizer in place. Some representative statements from respondents about conservation include:

"That's why you're seeing pivots going in; you want to be more efficient with your water. That's one of the reason's you're doing it."

"What we try to do is eliminate soil loss. We have sediment ponds on every field that we have and any soil loss that we have we take this, bring it out, and we carry it all back up the field."

Out of 29 respondents, 19 (66%) cited farm compatibility and ease of use as incentives to adopting practices that improve water quality. Farm compatibility includes themes such as topography, field shape and size, and existing operations. Respondents were more likely to adopt practices that were compatible with their current operation, field terrain, field geometry, or their existing irrigation system or machinery. Some representative statements from respondents about farm compatibility include:

"So when we decide to put in our first pivot we put it in on this farm because it's so irregular; we've got endfall, sidefall, every kind of fall and variable soil depth in places."

"Where people are under these gravity pipelines, they are opting to put in sprinklers."

"Well, actually it laid right; the angles were right for the pivot to fit on. That was part of it. And then it was long. A quarter mile is typically a 7 tower pivot and so it was too long for wheelines and that's how it had been watered and they kind of pointed. So that means we had to hook and unhook as we moved across the field."

Ease of use includes themes such as labor savings, weed control, and maintenance. Respondents were more likely to adopt a practice that saved them on time and labor, especially if it was their own personal time or management. Many respondents also suggested that they were more likely to adopt practices that reduce the amount of time they have to worry about controlling weeds or maintaining machinery or equipment. Some representative statements from respondents about ease of use include:

"I think the ability of one person to farm more ground with less help is a huge issue there because furrow irrigating it, you just can't irrigate that much ground with one person and accomplish what you need to do."

"Management: if I can accomplish something and reduce my management load, that's probably at this stage of the game for me, that's important to me. If I can get something set up to where the hired help can accomplish the end goal and not, for me not to have to micromanage stuff quite so much, that's important for me."

"To take out of the [weed] seed if we're pumping out of the rivers or whatever it is. You know, they tend to be a bit more trashy and stuff, you know, seed wise. And we don't want that [weed] seed to spread out into the fields so we'll have bubblers."

Just over half of respondents (55%) reported that the observability of a practice, or the ability to observe the success of a practice, as an important factor in adoption. Respondents expressed that being able to see that a practice actually works, either from neighbors, other farmers, extension or a small, in-field trial, led them to adopt water quality improving practices. Some representative statements from respondents about the role of observability in adoption include:

"We're copiers. It works and it looked good, that's what we wanted to do."

"If I see something that looks like it's working I'm willing to entertain the thought as long as it works in with my goals as far as what it is that I want to raise and what I feel comfortable doing."

"But regardless of the cost I'd still want to talk to somebody who'd already tried it. Or somebody to give me some figures, somebody who I trusted to prove it."

Approximately one-third of respondents (31%) expressed that improvements in water quality were a factor in their decision to adopt water quality improving practices. Water quality includes themes such as clean water, drinking water, fish, recreation, and sediment load. Respondents expressed that improving water quality standards for human consumption, fish and wildlife, recreation, and aesthetics was important, but rarely the primary driving factor in the adoption of these practices. Instead, participants suggested that water quality improvement is a secondary factor or an added benefit to adoption. Some representative statements from respondents include:

"Testing of water tables had Dacthal high parts per million of Dacthal and they said, that's not a good thing for your water system."

"So I felt for me that the settling ponds and the invention of the polymer, soil binder, PAM or whatever I guess is what it's referred to, for the most part I was

able to accomplish a lot of what I wanted to accomplish and that was to have clean water at the end of the field. And what isn't we recapture a good share of that in the settling ponds."

"But I don't know, there's fish and other things I could talk about and recreation close by for kids and that kind of stuff and whatever. We're trying to do that in as many places as we can. They won't be near as detailed in some places."

It is important to consider that practices that improve water quality can also have other benefits for agricultural producers, whether it is increased profits, conservation, or a reduction in labor. For this reason, among others, a desire to improve water quality is not always the primary driver in the adoption of agricultural practices that improve water quality. The factors impeding adoption of these practices may also be part of the reason why water quality is not the primary factor for adoption.

Barriers to adopting water quality improving practices

Twenty-five themes emerged during the interviews as impediments to adoption or reasons for why respondents did not adopt CPs. These themes were grouped into five categories of incentives: financial loss, farm incompatibility, ease of use, age, and lack of individual agency (Table 7).

Table 7. The main barriers cited by respondents as reasons for not adopting practices intended to improve water quality.

Barrier	Themes*	Frequency (n = 29)	Percentage
Financial loss	• Expense (high costs, distribution costs, initial investment) (26) • Denied subsidy or grant (4) • High risk (4) • Lost acreage (2) • Economies of scale (2)	26	90%
Farm incompatibility	• Field shape (12) • Topography (11) • Crop rotation (9) • Existing irrigation system (9) • Existing infrastructure (8) • Field size (7) • Operation size (5) • Existing equipment (5)	23	79%
Ease of use	• Labor/time intensive (13) • Maintenance (5) • Learning curve (4) • Too much paperwork to get grant (3) • Timing (2)	16	55%
Age	• Older growers not expecting a return or willing to take on a risk on their time/ money invested during their remaining tenure (5) • Aging populace averse to change (4) • General belief that respondents age or age of those around them impacts their ability to adopt new practices (2) • Older growers want to reduce their workload (1)	11	38%
Lack of individual agency	• Belief that practice changes have/will have little to no impact on water quality (6) • Water quality standards are unattainable or always changing (6) • Not in control of own decisions (2)	10	34%

*Themes are ranked by frequency within each incentive group. Other themes with low frequency: aversion to change, rent vs. own, water quantity, lack of access to technical support

Financial loss was cited most frequently by respondents as a primary barrier to adoption. The majority of respondents (90%) noted that high costs and expenses, lack of subsidies, high risk, lost acreage, or economies of scale were financial impediments to adoption. Loss of acreage can occur when central pivot irrigation is used to replace furrow irrigation. Many noted that they could only adopt practices that would make them money or at least break even. Practices that cost money were not considered feasible by most respondents. Some representative statements from respondents regarding financial loss include:

"We do still do some furrow because you know drip is expensive; we can't do it on everything."

"Nobody's gonna help me put in gated pipe or cement ditch now, which I've gotten in the past."

"But I've got one place I did put in for a costshare and I got turned down on that, on the one place I had that I was gonna put in a pivot."

"If it did not work out like we had planned, why there was not enough cushion for me so that's why I ended up not using the drip."

Out of 29 respondents, 23 cited farm incompatibility as a reason for not adopting a water quality improving practice. Farm incompatibility includes themes such as field geometry, topography, existing infrastructure and irrigation systems, crop rotation, and size of operation. Many respondents noted that they could not adopt certain practices because of the way their fields were laid out or the prior investments they had made in equipment and infrastructure. Others stated that their existing crop rotation was incompatible with certain practices (i.e. onions do not grow well or can become diseased under sprinkler systems). Some representative statements of farm incompatibility include:

"It won't work. A round pivot for a square farm? That leaves the corners and I did not want corners growing weeds and gophers."

"We've leveled, touched up through the years so I've been able to grow the yields without having to go to drip. Wrong or right."

“Years ago my dad tried the no-till with the furrow irrigation and that’s a no go. There’s too much trash in the fields for furrow irrigation, but with a pivot then it’s a no brainer.”

Just over half of respondents (55%) cited difficulty of use as a reason for not adopting water quality improving practices. Difficulty of use includes themes such as labor intensive practices, high maintenance, and an initial learning curve with adopting that practice. Many respondents suggested that adopting certain water quality improving practices can be labor intensive or time intensive regarding their personal management. Others suggested that there are major maintenance issues with certain practices that might outweigh the benefits of those practices. Additionally, learning new practices takes time; many respondents reported feeling that their time was already spread thin. Some representative statements about difficulty of use include:

“And so it was extra work for me; we had to plant a cover crop of wheat and then we had to spray it out before it got too big so it didn’t crowd the onions out.”

“There’s a lot of work to that drip. Lot of problems, I mean, even if deer run through the field they can rip a hole in the tape just from their hoof in the tape so they’ve got guys out there patching the drip tape.”

“You had to learn how to use all this stuff.”

Age was cited by 11 out of 29 respondents (38%) as a barrier to adoption of water quality improving practices. Interview respondents cited age as a barrier in the sense that older growers might not expect a return or be willing to take a risk on an investment in their remaining tenure. Others cited an aging populace as being adverse to change, while others simply felt that they were getting older and wanted to reduce their workload. Some representative statements about age include:

“Of course, more farmers around here are 50’s, 60’s, 70’s. You know, I’ve heard others say that on a change of crops they want to maybe get out of onions or

something. They said I can't afford any of the equipment to go into any other crops. I gotta stick with what I am; I'm too old to start paying for new equipment."

"So you know, when you're farming with older people and multiple people you don't change immediately. "

"It was just a lot of extra work that I guess as you get older you just decide you [don't] (laughter) need to do that anymore."

Lack of individual agency was cited by 10 out of 29 respondents, or 34%, as a barrier to change. Lack of individual agency includes three themes that seem to inhibit grower's ability to make their own decisions and control water quality problems. Some respondents believed that changes in their practices would have little to no impact on water quality problems. This varied by pollutant and how the respondent interpreted water quality. Others felt that water quality standards were largely unattainable due to natural ambient pollutant levels or that water quality standards were constantly changing, making it hard to keep up. Some respondents also cited that decisions were made for them by populations around cities or lawmakers that reduced their ability to control their own operations. Some representative statements of lack of individual agency include:

"The other part of it is we're saying that we have too much phosphates, we have too much chemicals. Granted there probably is a certain amount of that but the natural geological parts of this area, the phosphate up above Adrian, the phosphate bed that the Snake River runs through, these are naturally occurring things that as farmers we're being told that you have to clean this up because you're polluting the area when we have no control over it and no way to even control those excess amounts of phosphates."

"In fact, I can do anything I want here to improve water quality and it runs into the Snake, which is simply a sewer system for eastern Idaho, and goes down there into a reservoir and heats up 20 degrees. So no matter what I do here, has almost no impact on water quality coming out of the end of Hell's Canyon."

"I get a little frustrated with some of the mandates of water temperature because apparently those people that make those things haven't been here and looked at our situation. When you look at the Malheur River all the way up and they say well, you gotta maintain a certain temperature. It's like; you don't live in the

desert and maintain a low temperature because the water is hardly ever that temperature unless it's in the snow coming off of the fields."

"We haven't learned our lesson. The lesson is, stay with the first line, you get run over, you get run over. You're gonna get run over anyway."
"I think I do know where it ends at and I don't think it's pretty, for us. You know, you've got 12 farmers, 12 votes here and 300,000 there and it don't really matter what we feel, what we say, what we think, it's irrelevant."

As with our findings on perceptions of the incentives to adoption, producers appeared to be thinking rationally, considering the costs and benefits of a practice, the feasibility of a practice, and compatibility of a practice with their operations when reporting factors that were impeding adoption. Age and lack of individual agency emerged as barriers in some instances as well and may be rich areas for future study.

Focus group results

A summary of focus groups results is presented in Table 8. As detailed in the methods section, a focus group was asked to review and comment on the major themes that emerged from preliminary analysis of the individual interview data. These themes are outlined in detail in Appendix C. In this section, focus group responses to each of the major themes will be considered to examine areas where the focus group feedback and individual interview findings disagree.

Table 8. A summary of focus group feedback on interview findings.

Theme	Respondent feedback
Practicality	• Respondents supported this theme, stating that producers are looking for the economic benefit of a practice and that it needs to be easy and save time • However, sometimes resource scarcity is enough to drive adoption of practices which may be time or labor intensive
Stewardship	• Respondents supported this theme, but suggested that conservation is not a stand-alone incentive to adoption. • There must be a connection between economics and conservation • There are exceptions to the stewardship ethic, but respondents perceive that harm is unintentional • Legacy issues and rented land may play a larger role than previously thought in conservation behavior
Observability	• Respondents supported this theme, reiterating that observation is a major incentive to adoption • Neighbors inform and copy each other • However, observation must be of someone whom producer trusts (i.e. certain neighbors, other peers, extension) • Producers exchange information on the ditch bank, through cell phones, grower meetings, at the store, etc.
Water quality	• Respondents agree that water quality is a factor, but rarely the main factor for adoption. Instead, it is another benefit of practice change, much like conservation • They suggest that water scarcity is a greater factor than water quality • They disagree that a belief that water quality problems are resolved is the reason that water quality is only a secondary driver • They instead suggest that the concept of water quality has a different meaning for different producers • Water quality recognition depends on the pollutant and the time period
Ambient pollution	• Respondents suggest that this may be the case, but only for a selection of growers. • Respondents propose that there are 3 groups of growers with respect to their perceptions of water quality: those who do not realize that there are problems, those who feel that there are problems and that it is partially their fault, and those who have learned that ambient water quality levels impact their ability to alleviate the problem • Respondents suggest that most growers are in the second group
Unattainable standards	• Respondents agree that this a common perception amongst growers, but is not necessarily a barrier to practice changes • Instead, they categorize this as a frustration or background noise • They suggest that growers are not less incentivized because of the rules, but that it all goes back to economics and observability
Aging populace	• Respondents suggest that age might make someone less likely to voluntarily adopt a practice, but that age is not necessarily a barrier • They also suggest that age being a barrier may be the exception rather than rule • Respondents have observed older growers adopting water quality improving practices because they have pride in their operation and see clear benefits to themselves or the land

The first theme discussed with focus group participants was that of practicality. Focus group respondents agreed that relative advantage/disadvantage, complexity, and difficulty/ease of use were drivers of adoption. Participants suggested that producers were looking for the economic benefit of a practice in addition to time and labor savings. Participants also agreed that producers value stewardship when adopting new practices. Although conservation came up among 86% of interview respondents as an incentive to adoption, focus group participants felt that the area was not water limited enough, even in the most water limited areas, that conservation would be a standalone driver of adoption. Instead, there must be some economic or practical benefit in addition to conservation. A review of interview results suggests that overall, conservation was a perceived benefit that was taken into account (along with financial incentives) when producers were considering the overall relative advantage or disadvantage of a practice. Future studies might further explore the relationship between conservation and adoption to investigate the lack of consensus between focus group findings and individual interview results.

Focus group participants also suggested that legacy issues may be impacting the stewardship ethic among producers. One focus group participant stated that many of the producers in Northern Malheur County were fourth or fifth generation family farmers, with an incentive to leave resources in good condition for future generations. However, participants did clarify that while having a legacy farm is an incentive to adoption, not having a legacy farm is not necessarily a disincentive. This is a theme that emerged in interviews and may have a greater impact on adoption than interview frequency suggests. Upon further investigation of interview data, legacy issues may have been an implicit motivation behind conservation, as many respondents were farming with their children or were getting ready to turn over their farm to the next generation. As one interview respondent noted:

“But I started with 40, 50, 60 acres to get started on and just recently my youngest son just came back. He graduated from [college] and so we just took on another 320 acres just this fall. So the majority of— up until then, the majority of our land we already owned. So we probably own 60, 65% and rent the rest.”

This excerpt suggests that producers were making sacrifices and investments for the next generation; they just did not explicitly tie those investments to conservation. Other respondents noted how they would look into an investment that would not pay them back during their tenure for the sake of the next generation:

“My husband is 66 and so long term investments would definitely have to be done taking into account our nephew, not just us because we’re at the point where that isn’t coming back to us, personally. But if he wanted to do something that was long term— it’s like if he chose to do a pivot— that would be something we would work with him but it’s nothing we want to try to do.”

Another respondent mentioned his legacy as an incentive to improving water quality:

“When I was a kid we used to catch trout right down here on the Willowcreek. Hopefully we get everything piped and all the water quality things that we’re working on [finished]— and we’re working on some riparian areas. There’s places these little creeks and stuff that run up in the draws that people are fencing and making watering stations for their cattle. But anyway, yeah, I would hope that my grandson and his kids can catch trout in the Willowcreek again like we did there like when I was a kid in the 50s.”

While legacy farming may not have come up explicitly during individual interviews, in some cases it was playing a role in adoption of CPs in Northern Malheur County.

Focus group participants also mentioned the role of rented land as a barrier to adoption. They suggested that as many producers rented ground on short term contracts and have less incentive to conserve or invest in conservation efforts. However, they noted that many land owners who rented out their land gave preference to producers whom they knew would take good care

of the land, furthering the stewardship ethic in the area. Two interview respondents cited renting land as a disincentive to adoption of CPs:

"But the way farming is— but like I said, it's an investment that will pay you back in the long run but if you don't own the ground it's not gonna pay you back anything. I mean, it will help you, and yeah, if it would work it'd be feasible."

"A lot of people that rent don't take care of their ground as well as people who own it… and that's normally a big red flag that you're gonna have soil erosion."

Interview results were inconclusive regarding the role of renting land as a barrier to adoption, but we suggest that it should be considered as a possible factor driving adoption in future studies.

Focus group participants agreed that observation was a major incentive to adoption. Participants clarified that the most salient observations were made when producers observed practice changes from people that they trusted, which may have been, for example, particular neighbors or peers, or the experiment station. Participants described the unique nature of the farming network, where communication often happened informally "on the ditch bank" talking with neighbors, at the store, grower meetings, or on the cell phone where producers inevitably discussed what they had observed as successful practices.

Focus group participants agreed that water quality was a factor in adoption, but rarely the main factor for adoption. They clarified that economics, practicality, and water scarcity were greater driving factors of adoption than water quality, which was an added benefit to other primary incentives. Focus group participants also proposed that producers interpret "water quality" differently, depending on the pollutant. Producers' perception of temperature pollution may be vastly different than their perception of nitrate pollution. When re-evaluating interview respondent's attitudes toward water quality, we observed varying perceptions of water quality based on the pollutant being discussed. When one respondent was asked if he felt there was a water quality problem in the area, he responded as follows:

“In some ways, yes. Depends upon how you define water quality. If you’re defining water quality as temperature limited, I think that’s bogus because if there weren’t any trees in this valley 100 years ago and the streams dried up, how can you say now that the streams need to be maintained at 68 degrees for the fish. To me as an agriculturalist it doesn’t make sense.”

He went on to further qualify his response by discussing groundwater quality:

“Nitrogen on the other hand, 50 years ago nitrogen was cheap and everybody used it to the max because every unit of nitrogen that went into the ground produced more crop and they found that to not be the case. So this Malheur County part of the area was very highly nitrate poisoning and it doesn’t need to be that way. And so we’ve changed our practices.”

These excerpts supported focus group feedback that water quality is interpreted differently by producers based the pollutant.

Regarding ambient water quality pollution, focus group participants described three main producer perceptions: those who did not realize that there were water quality problems, those who recognized the problems and believed they are caused by agricultural production, and those who recognized the problems but believed they are largely a function of ambient pollutant levels. Participants suggested that there had been an increase in the number of producers who believed that the water quality problems were due to their agricultural activities. There was a smaller subset of producers who had learned about ambient water quality levels for various pollutants. Participants reiterated that these perceptions were a function of the type of pollutant being considered.

Despite recognizing these subsets of producers, focus group participants suggested that lack of agency due to unattainable water quality standards was a frustration, but not necessarily a barrier to adoption. Participants described this is as background noise or a frustration that producers deal with, but did not see it as a major contributing factor to practice adoption. Furthermore, they suggested that other economic, practical, or observable incentives would be enough to overcome this perception, if it were to serve as a barrier. The lack of consensus between the focus group and interviews may have been a result of a number of

factors, including the small size of the focus group, a wide range of perceptions amongst Malheur County growers regarding their control over water quality issues, or a topic that was seldom discussed between change agents and producers. The three focus group participants were either employed by or partners of OSU Extension and the Experiment Station. Participants may simply have not seen or heard this concept from the producers they frequently interact with on a daily basis. It was also likely a concept that would not easily surface in day to day conversations. While the focus group disagreed that lack of agency was a barrier to adoption, the prominence of this theme among 10 interview respondents suggests that it warrants further inquiry in future research as a potential barrier.

Producer age was presented to the focus group as a barrier to adoption. Focus group participants largely disagreed that age was a barrier, suggesting that although age may have made a producer less likely to adopt a CP, many older producers had pride in past success that encouraged adoption. In addition, participants did not feel that they observed this trend amongst older producers. However, age emerged as a self-reported barrier for 38% of interview respondents. The lack of consensus between the two groups suggests that age may be a factor that is seldom discussed between change agents and producers, that age may only be a barrier for small portion of producers in Northern Malheur County, or perhaps that age can be interpreted as more than simply a numerical value (this will be further explored in the next section).

In considering the barriers and incentives to adoption as a whole, focus group participants reiterated that financial gain, compatibility, ease of use, and observability were standalone factors driving adoption of CPs. The perspective of focus group participants was that conservation and water quality are added benefits of CPs, but were not standalone factors driving adoption. They also did not agree that age or lack of individual agency were necessarily barriers for most producers in Northern Malheur County. The lack of consensus between the focus

group and the individual interviews regarding some emergent themes suggests that further study is needed to examine the role these variables are playing in adoption. Focus group results and individual interview results have been combined to describe the phenomenon of adoption of CPs in the subsequent discussion section.

DISCUSSION

Farming today in Malheur County

They landed there with a '33 Ford Truck, a team of mules, a plow, and $10 cash. He showed us under the hill there was a good spring where they could get drinking water. They pitched a tent and of course, started grabbing sagebrush and that's what they used for fuel and to keep warm. But those people [that] came out of [the] dust bowl, they were poor. I mean the Grapes of Wrath? Ok, that was it .-A Malheur County Producer

Farming in Malheur County today is a part of a unique community where hard work and innovation are an aspect of everyday life, neighbors come together and share stories of success on the ditch bank, and families strive to continue the legacy of their farm. Producers in this area take pride in their clean fields and onion yields and remain thankful for the snowpack that fills their reservoir every year. Many farms in this area are small to medium sized, worked by fourth or fifth generation farmers who tell stories that their parents told them of the Malheur River running dry before construction of the low-elevation dam or how their family migrated to the community from Oklahoma during the dustbowl for the promise of a reliable water supply. The Owyhee Dam was constructed in 1932 as a result of decades of cooperative community efforts (Shock, C.B., Shock, M.P., & C.C. Shock, 2007). Water from the dam brought prosperity to Treasure Valley and the widespread recognition that "water is lifeblood." A number of crops were grown in the area, with farm size limited due to smaller equipment and manual plowing. World War II brought new farming into the area and many Japanese families came to the Treasure Valley to avoid internment. The Japanese influence brought new ideas and innovation to the valley. As one respondent described it:

"Well, I think as you farm and have to go through the struggles of working hard you try to figure out ways to make life easier and I think people shared ideas. For us here, I think the biggest change might have been WWII. We got people in from other parts of the country; Portland or Seattle….or some things like that. They had a different method of farming and they incorporated that into our area here and we learned from that."

As this excerpt suggests, producers in Malheur County have a long tradition of sharing information and new ideas and a willingness to try new things and learn from their peers. Farming in Malheur County is much more than a profession or an economic driver; it is a culture and a way of life.

Some interview respondents thought back to their childhood and remember swimming and fishing in the irrigation canals in the 1950s, seeing salmon migrating through the irrigation canals, and catching fish out of the Willowcreek:

> "Out here in the Malheur River, yeah there used to be salmon come up there. We used to go swimming in these irrigation ditches and things like that; the water was fairly clean. Of course, back then we probably built up a resistance to whatever might have been in the water (laughter)."

In the 1950s and 1960s, mechanization, the development of chemicals, pesticides, herbicides, and fertilizers increased prosperity and brought wholesale change to farming practices. Simple innovations that are used in agriculture today changed the face of farming in Malheur County. Before the siphon tube was invented, producers used anything they could find to redirect water from the canals into the furrows of their fields. Some farmers remember cutting up paper sacks, using tin cans, or anything else they could to irrigate until the siphon tube was invented— but this was only the beginning of a technological revolution for irrigated agriculture. The moldboard plow was replaced with rippers, disks, and chisel plows and siphon tubes were supplemented with wheelines, solid set sprinklers, and eventually pivots and drip systems. Fields went from being leveled with a keen eye of an experienced farmer to the exactitude of a laser. Biotechnology brought hybrid seed and Roundup ®- ready crops to the area. Tractors now use GPS technology to apply fertilizer with precision and accuracy. Equipment is bigger today than it has ever been, farms have increased in size to keep up with economies of scale, and being a producer means using the latest technology and science.

As much as technology and mechanization have brought positive change to farming practices, many challenges have emerged as well. Whether it is increased cost and regulation, lack of political clout, or the feeling that the American public does not value their service, producers in this area expressed frustration and sometimes a sense of futility in trying to keep up with ever-increasing demands of the federal and state government, the American consumer, environmentalists, the Willamette Valley, suppliers and buyers.

Water quality has become one of many challenges facing farmers today. Overall, producers in Northern Malheur County recognize that there are water quality problems and that the use of certain practices can minimize agriculture's impact on these problems. Adoption of water quality improving practices in Northern Malheur County is a phenomenon that is intimately related to the historical, social, political, and financial landscape that is perceived by local producers. While the results of the individual interviews and focus group reflect the incentives and barriers to adoption of these practices, the purpose of this section is to create a rich narrative built upon the beliefs, attitudes, norms, and contextual information that emerged in this study. The emphasis on practicality, observation and stewardship, perceptions of water quality and lack of individual agency, and the impact of producer age will be detailed here by exploring a narrative of what it is like to be a farmer in Malheur County. We will also revisit the theoretical framework which was used to identify drivers and barriers to adoption and evaluate it against our expected outcomes. This evaluation will be used to make analytic generalizations about the RAA/TPB and to highlight promising areas of future study.

Practicality, common sense, and cost/benefit analysis

Study participants painted a picture of what it is like to operate a small to medium size American farm today using irrigated agriculture. Detailing shrinking profit margins, volatile markets, and the unforgiving nature of their job, producers described the need to be as efficient and precise as possible in their operations.

They noted that farming has changed substantially in the last couple of decades. One farmer described agriculture today as follows:

> "Everything is much more business-like because today, if you make a wrong decision or a wrong move financially, I mean, it can devastate you. Twenty-five years ago there was more room for error. Because of our profit margins and our input costs and all of those, you have to do a good job with that crop, whatever it is, and if you don't you're out the door. There's no second chances, you're gone."

This excerpt exemplifies the challenges that these farmers feel they are facing today. Respondents described how costs are continually growing, whether it is fuel, fertilizer, energy, machinery, or seeds. Every aspect of their business was becoming increasingly more expensive, and they did not necessarily see the same increases in their profits. Some respondents indicated that they are lucky that they started when they did or that they were lucky in their success. As one farmer put it, "I'm not a good farmer, [I'm] a lucky farmer, that's all." However, while some describe their success in farming as luck, others describe it as more of a science where precision and perfection are necessary to overcome financial challenges and the ever-changing nature of crop production.

As a result of the increasingly tight profit margins and the need to adapt to changing conditions, respondents described how conservation measures and environmentally-friendly practices are a necessary component of being a successful farmer today. There was a direct connection between the adoption of CPs and economic benefit. As a result, participants perceived that farmers who are not environmentally conscious are going or have gone out of business. When asked about whether or not most people are adopting CPs, one respondent replied:

> "I think there's a lot of people out there that [say] this is the way my dad did, this is the way my granddad did it, but they're slowly going away just like the mom and pop farms."

This suggests that farming has evolved quite a bit in the last couple of decades, resulting in more efficient and sustainable production. Taking good care of one's land and water was largely associated with being successful in farming and

planning for long term prosperity. This was not always the status quo, but participant's perceived that in order to make it today in farming, being environmentally conscious and working to preserve land and water resources is an important component to success. Many respondents reflected upon the farming community in the area and expressed the perspective that farmers are, by and large, environmentalists looking to take care of their resources. As one respondent put it:

"I think there's very few farmers that deep down their environmental— they're environmentalists really, I mean that's how you make your living, really."

Another described this environmental ethic more specifically to water quality and described the changes that have occurred in the last 20-30 years:

"I tell ya, I think everybody in agriculture's becoming more conscious of water conservation, water quality. Twenty-five years ago, you didn't talk about it."

As a result of the connection to economic returns, it is not surprising that the costs and benefits of a practice were the greatest incentive and barrier to adoption amongst interview respondents. Based on the economic climate of farming today, producers were constantly looking for ways to save money. Frugality was a normative belief that emerged amongst a number of respondents. Producers expressed a need to be simple and efficient in their practices. Saving time and labor also means saving money and as a result, the inclusion of practicality and common sense are integral components of adoption. As one respondent described it:

"Hard lessons learned has made us better farmers. When it hits in your pocket book you learn real quick."

Producers are adopting new practices that are simple, practical, and rational in an effort to increase their bottom line. If their farm was split into 10 acre segments by irrigation ditches and canals, it did not make sense to install a pivot system because it would not fit on their farm. If respondents were furrow irrigating, they could not adopt reduced tillage because it is too difficult to get the

water through the fields with the crop residue. Fertilizer is very expensive, so if they could soil sample to avoid over applying, they recognized that this would save them money in the long run. A drip system might save water and increase onion yields, but it involves a large initial investment and requires time to learn how to run the system and maintain the lines. Producers were weighing the costs and benefits of adopting these types of practices given time, money, and effort. It is this type of common sense and rational thinking that appeared to be driving the majority of practice adoption decisions in Malheur County.

The role of observation and trusted information

In addition to weighing the costs and benefits of any given practice, producers expressed a strong desire to be able to observe the success of a practice from someone they trusted before adopting that practice. Unlike many other professions, farming is a transparent and open process. Farmers in Malheur County were more than willing to share their trade secrets with neighbors and friends, knowing that communication and shared information were keys to surviving in the farming industry today. Producers were not afraid to ask a neighbor or a friend why their crop looked so green. The transfer of information within this community is fast and open because there is a need to continually change and adapt and there is little room for error. Producers in Malheur County knew that they cannot take unnecessary risks, and that meant sharing those risks within their community and working together to overcome challenges and find innovative ways of operating. When asked about whether or not he had considered putting in a drip system, one producer responded as follows:

“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].”

This excerpt exemplifies the need to continually observe and communicate with fellow farmers and adopt new practices and trends to reduce risks.

An important component of observation was trusted information. Producers in Malheur County had certain sources that they frequently went to for

information. When asked which information sources they trusted the most, respondents tended to trust their neighbors, the experiment station/agricultural extension, and observation of other farmers the most when gathering information about new practices (Figure 14). Other sources of information included field men (salesmen for fertilizer companies), written publications and materials, their own trial and error, suppliers, meetings and workshops, family members, government agencies, watershed councils, college coursework, past employment experiences, word of mouth, informal social gatherings, the internet, and membership on irrigation water board among others.

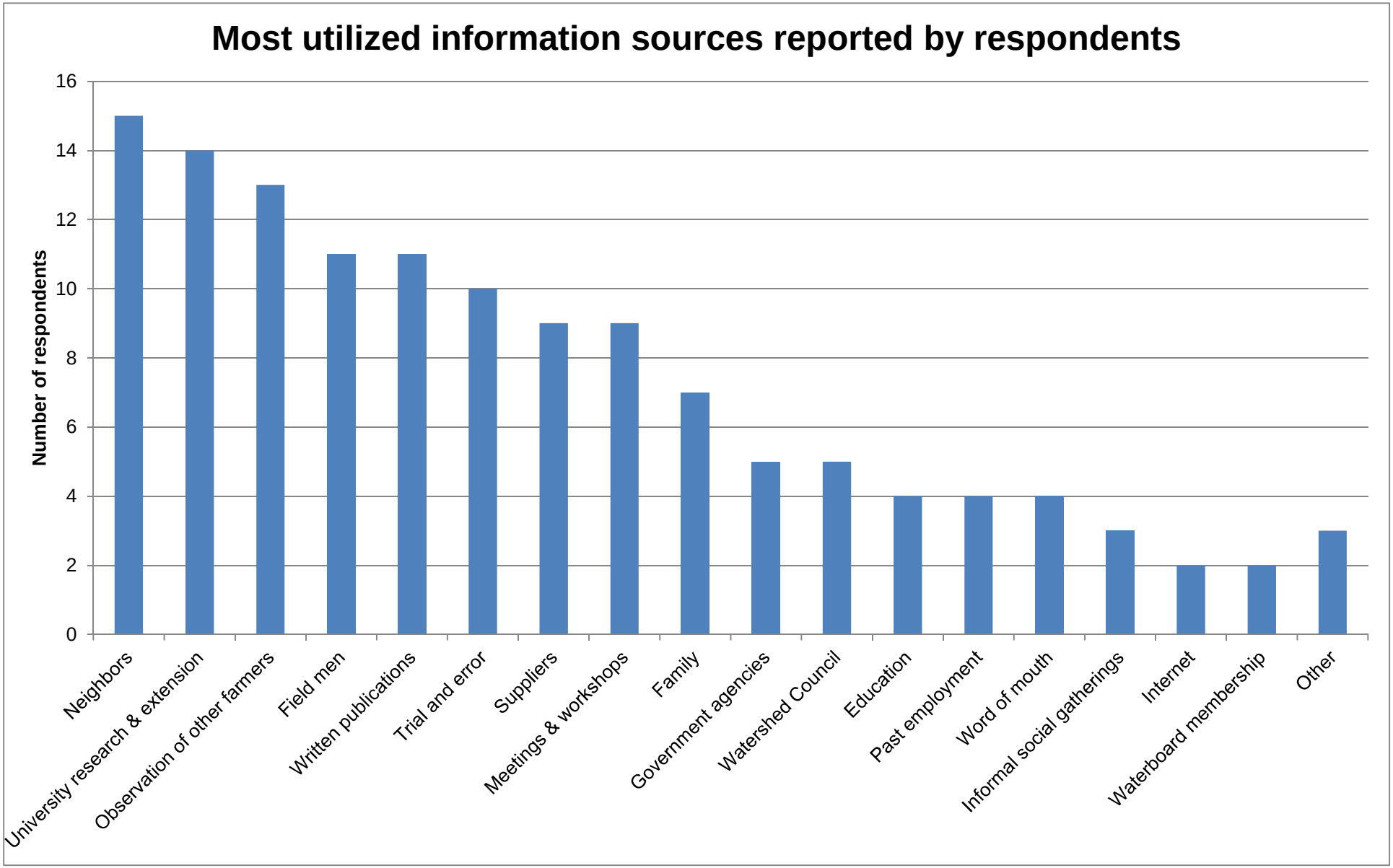

Figure 14. Respondents reported on where and whom they get information regarding new management practices. Most frequently cited were neighbors, Oregon State University research and extension, and observation of other farmers.

A strong stewardship ethic

In addition to practicality and observability, a strong stewardship ethic amongst growers emerged as a factor impacting the adoption of CPs. This stewardship ethic made soil, water, and nutrient conservation a major incentive in the adoption of sustainable practices, but perhaps not a standalone driver of adoption. While conservation was the second most frequently cited reason for adopting a water-quality improving practices, it was not necessarily the sole or primary reason for adoption. This stewardship ethic was tempered by practicality. There was widespread understanding amongst producers in the area that environmentally-friendly practices, whether they are for water or soil conservation, were also economically advantageous. As a result, the stewardship ethic was largely utilitarian amongst many respondents. As one interview respondent put it:

"[You] try to keep your dirt on the farm because it's what makes you your money."

Here he makes the connection between conserving topsoil and production. When asked about his use of PAM, another producer reiterated the same sentiment:

"The topsoil on the ground is what makes me a living. I gotta take care of it."

Producers recognized that their soil and water resources were intimately tied to their ability to produce a profit. As a result, stewardship emerged as a normative belief among Malheur County growers. Many respondents suggested that they and their peers had a responsibility to serve as the steward of their land and resources. To them, being a good farmer meant being a good steward of the land:

"You know, I've always said that the farmers land, the land takes care of you, so you take care of it."

Another respondent described what it meant to be a good farmer to him as follows:

"I think a farmer, if he's a good farmer, he knows what he has to do as far as being an environmentalist to make money. It's not a one shot situation where you produce a crop and that's the end of it. You're in here for your lifetime so you're trying to improve your production and the production area that you're producing the area on; least that's how I felt when I was a farmer. You didn't just go out and tear everything up and say well, I made this and to hell with it. It doesn't work that way, at least if you're a good farmer."

Here he suggested that being a good farmer meant taking care of your land for your lifetime; recognizing that long-term planning and conservation of one's resources was necessary to be a successful farmer in this area.

Water resources were also largely included in this ethic as well. In an area where rainfall averages 10 inches a year, farmers were highly aware of the need to conserve water. One respondent described how he valued his land and water resources as follows:

"You do need to take care of your resources that you have. Your land and your water— I mean, without water we're nothing here so you gotta take care of it."

Another factor that might have been driving stewardship in the area was legacy farms. As previously mentioned, many producers in the area were fourth or fifth generation farmers. They anticipated leaving their land to a son or daughter or even niece or nephew. As a result, they had an incentive outside of present-day financial profit to conserve their water, soil, and nutrient resources. One respondent describes his desire to pass his farm down to future generations:

"In forty years or fifty years or however long I'm gonna be here you could ruin this ground. Well I want to leave it in the family. It's to my best interest to leave the soil right where it is and try to maintain it."

While legacy concerns did not necessarily come up as a major theme across individual interviews, they were emphasized by participants in the focus group and may play a larger role in adoption than interview results suggested.

The interview respondents' overall attitude towards environmentally friendly practices supported the finding that conservation is an important perceived benefit of water quality improving practices, but not necessarily a

standalone factor. Most respondents perceived these practices as positive as long as they are cost-effective and practical. Respondents expressed a desire to compromise and find some middle ground between people and the environment. While producers perceived some practices as lacking common sense, most were open to these practices as long as they were cost effective and not regulated because they frequently helped farmers produce a better crop.

Focus group respondents also emphasized that any environmental harm that is done by producers is not intentional. Most producers in this study valued stewardship and wanted to take care of their resources. Interview respondents perceived that those who did not care were not around anymore because stewardship is necessary to make it in farming today. Many respondents described themselves as practically minded environmentalists. One respondent described the changes he saw over the course of his lifetime as follows:

> "I actually think that over the year since I was a little kid, farmers have looked to slow down erosion, to make better use of their water, but it's been in small ways, what they could afford to do and how they could change their farming practice, far as tillage. They're aware; becoming aware and instead of a big jump they take small steps. And I think we all want a good environment for our children and our grandchildren. So let's work at it in a, shall I say a practical way or affordable way? We realize the need."

This excerpt exemplified how the stewardship ethic was intricately linked to the other major incentives driving adoption of water quality improving practices, whether it was economic gain, farm compatibility, ease of use, or observability. Ultimately, producers in Malheur County saw water and soil conservation as an added benefit of a practice and were looking for practical, common sense ways to integrate these practices into their operations.

Water quality: is there a perceived problem?

Improving water quality for drinking water, fish, aesthetics and recreation, or ecosystem health was cited as a reason for adoption much like conservation, but relative advantage, complexity, compatibility and observability ranked as

higher priorities for most respondents. As a result, water quality improvement was rarely the main reason for adoption, but certainly an added benefit of CPs. Out of nine interview respondents who cited a desire to improve water quality as a reason for adopting a CP, only three suggested that improving water quality was their primary motivation in adopting a water quality improving practice. The practices they were referring to were the use of sediment ponds, filter strips, and the discontinuation of using Dacthal, a chemical known to contaminate drinking water.

Many participants suggested that producers in Malheur County were adopting practices that improved water quality because they were also economically beneficial, saved time or labor, and/or someone they knew had success using that practice. Responses from interview respondents largely reflected this sentiment, suggesting once again that water quality improvement is a perceived benefit for most producers and a factor that is considered in adoption, but not enough for a respondent to adopt a practice that might be less practical. When asked about his decision to install a sediment pond, one respondent said as follows:

> "And that's kind of the way it works out so you have your choice of there is drip irrigation but there again, that is expensive for the amount of acres that I do. So I felt for me that the settling ponds and the invention of the polymer, soil binder, PAM or whatever I guess is what it's referred to, for the most part I was able to accomplish a lot of what I wanted to accomplish and that was to have clean water at the end of the field. And what isn't we recapture a good share of that in the settling ponds."

This excerpt is representative of the way that many producers weighed the practicality of practice when they wanted to improve water quality. However, it seemed that producer attitudes toward water quality problems may also have been impacting the role that water quality played in practice adoption.

Interview respondents expressed a wide range of attitudes toward water quality problems, depending on how the producer perceived the term "water quality" and the particular pollutant being discussed. Many producers spoke

about a particular pollutant or problem that they associated with water quality. By allowing respondents to define what would be discussed as a water quality problem, we were able to observe the variation in how respondents defined water quality issues and the different attitudes expressed toward different water problems. When asked about water quality problems, respondents brought up a range of different issues, including *E. coli*, mercury, arsenic, phosphorus, and sediment in surface water, nitrate groundwater pollution, fish and wildlife habitat degradation, and food safety issues. Concerns over water quality varied depending on what type of pollutant the respondent equated with water quality problems. For example, many producers cited that nitrate groundwater pollution was significantly better than it was 20 or 30 years ago, while others voiced apprehension over recent TMDL regulations on temperature and phosphorus. While a few producers felt that there were no water quality concerns or that claims of water quality impairment were false, most producers perceived some level of overall water quality problems in the area.

Many producers were skeptical about their ability to control water temperature in the hot, semi-arid climate of Malheur County. Others felt that ambient levels of arsenic, mercury, and phosphorus made it difficult for them to ever meet mandated water quality standards. Overall, this created a subset of producers who perceived that water quality standards were largely unattainable. Focus group participants confirmed that there were producers in the area who had learned about ambient background pollutant levels and had developed this attitude towards water quality. One representative statement from this subset is as follows:

> “They have an issue with it, is it the phosphate levels I think, in our area? But what I’ve been told it’s our water that’s coming into our area than it is what we’re creating a problem on the farm ground. I think the levels have been known to be higher in our watersheds for some reason than they are in the farm ground. So I don’t know if there’s actually an issue.”

Focus group participants suggested that there were two other subsets of producers when it came to perceptions of water quality problems: those who believed that there were many problems and that those problems could be directly linked to agriculture and those who were largely unaware of water quality problems. There were interview respondents who fit these criteria, but such a pattern could not be identified across the interview population. Future studies could focus on this perception because it may provide insight into why water quality is not usually a standalone factor in practice adoption.

A lack of human agency

Interview respondents expressed frustration over their perceived lack of control over decision-making processes. Whether it was the government, the Willamette Valley, the American consumer, or environmentalists, many producers felt that farmers are outnumbered in today's political climate and the result was the setting of unattainable water quality standards. Producer attitudes toward these entities resulted in a decrease of perceived control over water quality and a fatalistic attitude towards CPs for some respondents. The role that this perception plays in adoption will require further investigation, but it may be acting as a barrier to adoption in some cases. Producer attitudes towards these particular entities will be explored here as well as the potential impact that these attitudes might have on perceived control over adoption.

Many respondents suggested that educating the American public about farming and food production in the United States will become a major challenge for them as regulations become stricter and profit margins become tighter. Respondents perceived that the consumer wants cheap food but is largely uneducated or indifferent about where their food comes from, the work it takes to produce it, and the value of American food production. One respondent suggested that education of both the consumer and the farmer is necessary to use our resources responsibly and maintaining food production in the United

States. When asked what he perceived the greatest challenge to farmers would be in the future, he responded as follows:

"Educating people, I guess. We've already talked about educating the farmers but educating other people about farming that it's not just a big bad whatever. But farmers are working and trying and changing and trying to do things better and I don't want to buy my food from South America. If I have food here, fine, we'll trade back and forth. I'm not trying to say I don't think there's any trade needed, but I want to have it available here and always have farming and so on. So the challenge is convincing the public [through] education and educating the farmers to use the resource that's here and the resources that we have— water, land, the whole thing in a responsible way and making it sustainable."

Another respondent explained how farmers are impacted by an uneducated American public. He described how farmers are largely outnumbered and underrepresented in the U.S. population:

"Well, if people don't understand where their food comes from, they're not gonna realize how important it is that farmers have water and all the necessary items to grow that food that they take for granted that came out of the back of the grocery store. And we're outnumbered. Last statistic I heard it was like 1000 to 1, but people in agriculture in the United States is less than 2% now."

He went on to suggest that the densely populated cities control the vote and thus farmers cannot win; some respondents felt that they lacked control over what they could and could not do as farmers and that densely populated city centers controlled the vote and thus, controlled what they did.

Respondents also perceived the government and environmentalists as a limiting factor and a future challenge for them as they try to continue to farm. Respondents seemed to imply that the government and environmentalist interests are closely tied. Respondents perceived that there is a need for more practicality when creating regulatory solutions to environmental issues like water quality. One example of this was a respondent who described government regulation on point source discharges from a local factory:

"It may be the best, yes, but I know when they first started some of this environmental stuff the sugar factory over here in Nyssa, they told 'em they

couldn't have any particulates to speak of; there was a limit. There was no technology available at that time to know how to do it. It took 'em 4 or 5 years and there was lots of 'em working on it. But they expect you to do something; how you gonna do it? You know what I mean; the technology hadn't even developed at that point yet."

Another respondent reiterated this sentiment when describing his perception of environmentalists:

"Probably, one of the big factors [is that] there is a lot of money behind environmentalists and most of those people don't understand. And some of them are so intelligent that there's no common sense."

This excerpt exemplifies the perceived connection between environmentalists and government regulation. It suggests that in addition to the American public acting as a control on their farming practices and operations, the government and environmentalists may also be a source of limitation from the producers' perspective.

The perceived lack of control seemed to intensify amongst respondents when they expressed concern over state government or the Willamette Valley (which were sometimes used synonymously). Many respondents felt that the voting power was on the west side of the state where the population was most dense. One respondent suggested that the laws are decided by the population in Portland and he had no control over what goes on. He tied this lack of control into his frustration derived from a perception of an uneducated general public:

"That's just my feeling 'cuz I'm trying to make a living and people are deciding the laws for me that don't even know where their food comes from? It's sad that I gotta be the one that's trying to survive but they decide my law. One county in Portland decides our laws. We don't have no say in what goes on."

Other respondents built upon this frustration by expressing a feeling that not only did the population in the valley control laws that were made, but furthermore, they controlled the practices that were implemented. One respondent emphasized the differences between the west side of the state and the east side as follows:

"In other words, it's hard for people out east to tell us how to do practices 'cuz it's a whole different scenario. It's hard for people in Multnomah County, which controls the state of Oregon, to tell us how to do our practices. So yes, the less mess we can down put towards those people the better off we are."

Another piece of this frustration came from a feeling of being a scapegoat for water quality problems and that blame was unfairly placed on agriculture. Some respondents pointed to the pollution coming off the urban streets of Portland or suburban lawns as a source of pollution that was not nearly as targeted or recognized as agricultural runoff. Some also believed that the cities in Oregon were creating higher amount of water pollution than their farms.

Ultimately, the frustration and lack of control over one's own decisions that was felt by these farmers may be traced back to the feeling of being disconnected from the state. One respondent expressed this feeling as follows:

"As far as the state goes you kinda feel like the forgotten brother, you know what I mean."

This sentiment of lack of control and being segregated from the rest of the state created a fatalistic attitude amongst some interview respondents. They suggested that no matter what they did or what practices they adopted, they would never be enough to meet the demands of these many interests. This emerged as a barrier to adoption for 10 interview respondents (34%). One respondent described his feelings toward water quality improving practices as follows:

"We haven't learned our lesson. The lesson is, stay with the first line, you get run over, you get run over. You're gonna get run over anyway."

This excerpt exemplifies this fatalistic attitude toward CPs. While there was not consensus between focus group participants and individual interviews, we believe that this may be a rich area for future study that has not been explored in previous adoption studies. A lack of self-efficacy or control over water quality and practice adoption decisions was a disincentive for some farmers in Northern

Malheur County and could be playing a role in other farming communities as well.

Age as a barrier to adoption

The average age of respondents interviewed was 58 years old, and the average age of producers in Malheur County was 56 in the 2007 Agricultural Census. In addition, the majority of respondents that were interviewed fell between the ages of 50 and 70 years old (Figure 15), suggesting that the farming population in Malheur County is aging. While the role of age in previous studies has been an inconsistent predictor of adoption, age was reported as a barrier to adoption for 11 respondents or 38% of the all respondents.

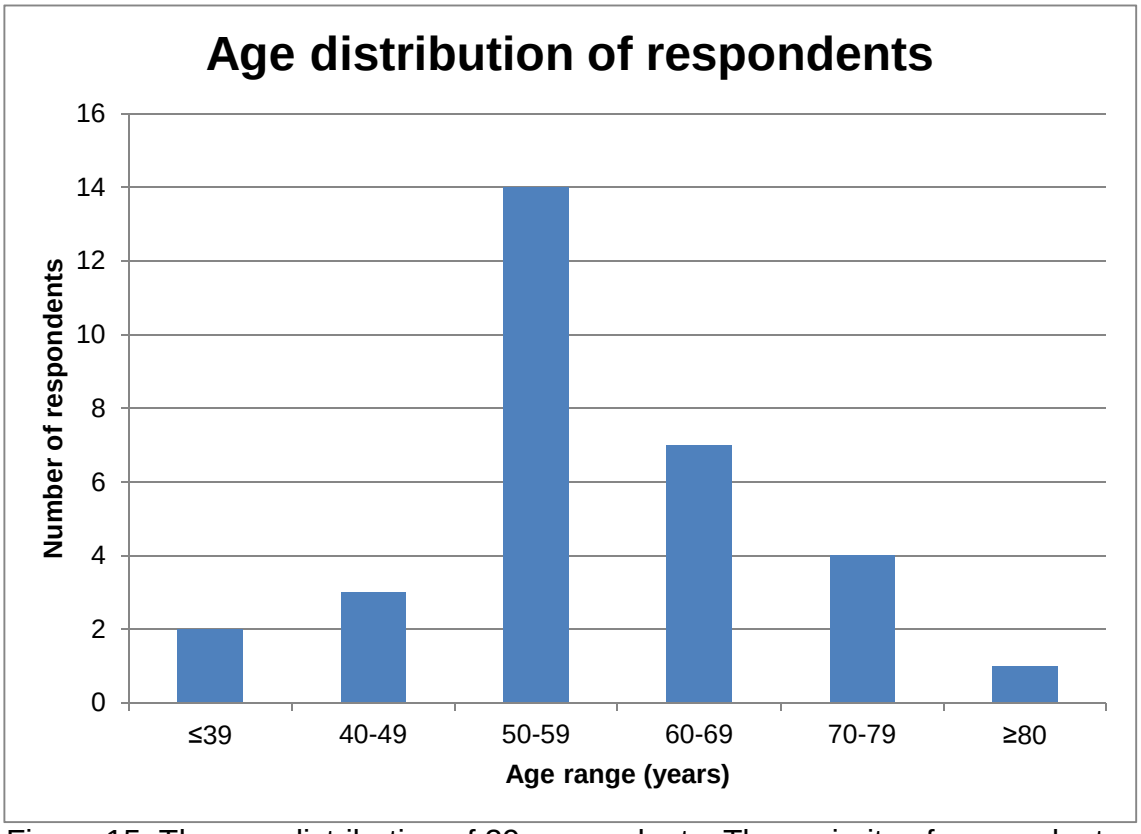

Figure 15. The age distribution of 29 respondents. The majority of respondents were between the ages of 50 and 69 years old.

Age was a barrier in some cases because older producers were averse to change, whereas in other cases because older growers were not expecting a return or willing to take a risk on an investment during their remaining tenure. One respondent expressed this concern as follows:

"Of course, more farmers around here are 50's, 60's, 70's. You know, I've heard others say that on a change of crops they want to maybe get out of onions or something. They said, I can't afford any of the equipment to go into any other crops. I gotta stick with what I am; I'm too old to start paying for new equipment."

Other producers suggested that at their age they were hoping to reduce their workload, and adopting a new CP meant a new learning curve or increased labor. Others expressed a general belief that their age or the age of other producers made them less likely to adopt new practices.

While there was a lack of consensus between focus group findings and individual interviews, we believe that the role of age as a barrier to adoption is a rich area for future study. Age has been considered in many previous studies as a potential driver of adoption and has been found to show positive, negative, and insignificant correlations with adoption (Knowler & Bradshaw, 2007). However, our study findings suggest that a producer's perception of their own age may encompass more than just the number of years they have lived. Producers may perceive that they are "too old" to make an investment or make a change based on a number of factors, for example, when they want to retire and if they are passing the farm on to another family member. One respondent described how their age impacts their adoption decision as follows:

"Oh yeah, that's really important to us right now. My husband is 66 and so long term investments would definitely have to be done taking into account our nephew, not just us because we're at the point where that isn't coming back to us, personally. But if he wanted to do something that was long term— it's like if he chose to do a pivot— that would be something we would work with him but it's nothing we want to try to do."

Two other respondents described their age as a barrier as follows:

“So we didn’t go through with the drip but I think that would be something I would like to try, but I think the older I get, why, the less chance that will be.”

“In fact, at this time in my life, if I can’t pay cash for a piece of machinery I just don’t buy it.”

These statements suggest that although past studies considering age have reached positive, negative, and insignificant results, how a producer perceives their own age is a factor that merits future study.

Evaluation of expected results derived from RAA/TPB adoption studies

The Reasoned Action Approach/Theory of Planned Behavior (RAA/TPB) has been used in a number of qualitative and quantitative adoption studies to effectively identify factors influencing adoption. Using the RAA/TPB, we were able to identify four perceived practice characteristics as drivers/barriers to adoption: relative advantage, complexity, compatibility, and observability. In addition, age emerged as a barrier to adoption (which would be considered a background factor within the context of the RAA/TPB) and lack of human agency (which would be considered a control belief). Here we will outline our findings in contrast to what we expected to find using RAA/TPB.

With the exception of a study conducted by Reimer, Weinkauf, and Prokopy (2012), previous RAA/TPB adoption studies have focused primarily on characteristics of people, rather than perceived characteristics of the practices themselves. However, a number of other adoption studies not using the RAA/TPB have cited characteristics of practices as important factors influencing adoption. Based on these studies, we expected that relative advantage, compatibility, and observability would emerge as important practice characteristics impacting adoption. Our study findings were consistent with these expectations. We also identified the complexity of a practice as an important factor influencing adoption in Northern Malheur County. Study findings also support conclusions of Reimer, Weinkauf, and Prokopy (2012) in that perceived practice characteristics play a role in adoption. However, we suggest that future

studies consider perceived practice characteristics not just as background factors, but as behavioral beliefs impacting producer's attitudes toward adoption. Fishbein and Ajzen suggest that "attitudes stem directly from belief about the attitude object" and that "one could solicit behavioral beliefs from an individual by asking the individual to list the advantages and disadvantages of performing the behavior in question" (Fishbein & Ajzen, 2009). We believe that the perceived advantages and disadvantages of adopting CPs in Northern Malheur County can be summarized using Roger's five characteristics of perceived practices. We encourage future studies to consider how perceived practice characteristics as behavioral beliefs impact attitudes toward adoption.

Our findings also suggest that conservation benefits and water quality improvements may be important attributes of a practice's relative advantage in addition to financial gain/loss. Relative advantage is defined by Rogers to include economic profitability, social prestige and other benefits. Previous adoption studies examining relative advantage have focused primarily on economic considerations (Pannell et al., 2006). Our study findings suggest that producers in Malheur County are taking water, soil, and nutrient conservation benefits and water quality improvement benefits into consideration when considering the relative advantage or disadvantage to adopting CPs. While these factors were largely secondary to financial gain/loss, we suggest that future studies consider the impact that perceived conservation and water quality benefits have on the relative advantage of adopting CPs.

Within the RAA/TBP, Fishbein and Ajzen define subjective norm as "an individual's perception that most people who are important to her think he/she should (or should not) perform a particular behavior. In order to measure the normative beliefs that influence the subjective norm surrounding adoption, Fishbein and Ajzen suggest asking participants what individuals/entities (referred to as "referents") might believe that the participant should or should not adopt CPs as means of evaluating social pressure. A limiting factor in this study is that

these questions were not asked explicitly during interviews, and as a result we were not able to identify the particular referent individuals or groups influencing the subjective norm to adopt or not adopt CPs. However, we were able to identify producer values that we believe to be influencing and/or a product of the specific subjective norm surrounding adoption. The values that emerged include expectations of stewardship, innovation, frugality, and fortitude, with stewardship having been identified amongst 11 respondents (38% of total participants). Generally, these four normative pressures were derived primarily from expectations from or about other farmers, neighbors, and family. Due to time and resource constraints, we were not able to re-evaluate other referent individuals or groups, but suggest that follow-up studies be conducted to identify these entities in Northern Malheur County.

The majority of past adoption studies that have used the RAA/TPB have focused on attitudes toward adoption of CPs (Burton, 2004). While some studies have used the RAA/TPB to explain behavior driven by social and personal norms (Harland, Staats, & Wilke, 1999), or used all three behavioral determinants (Fielding et al., 2005), the vast majority have focused on attitudes. As a result, perceived behavioral control has not been the primary focus of most adoption studies using RAA/TPB and was added to the TPB to take into account self-efficacy (Ajzen, 1985). In fact, the perceived behavioral control component of the RAA/TPB has only been evaluated in two adoption studies (Lynne, Casey, Hodges, & Rahmani, 1995; Fielding et al., 2005). In a synthesis of studies identifying determinants influencing adoption of CPs, perceived behavioral control could not be included as a variable because only one study had examined it within the context of TPB (Prokopy et al., 2008).

Perceived behavioral control is defined under the RAA/TPB as “people’s general expectations regarding the degree to which they are capable of performing a given behavior, the extent to which they have the requisite resources and believe they can overcome whatever obstacles they may

encounter" (Fishbein & Ajzen, 2009). The control beliefs that influence one's perceived behavioral control over adoption have been limited primarily to regulatory, financial, time, compatibility with current practices, and physical characteristics of the landscape in previous studies. Our study findings identify a rich area for future study that may be influencing the perceived behavioral control that producers have over CPs, specifically those intended to improve water quality. We identified this barrier to adoption as "lack of agency". In our study, this term refers to participant's perceived lack of control over the political decision making process which can result in perceived unattainable water quality standards. Some study participants reacted to these water quality standards with a fatalistic attitude toward CPs. For example, study participants suggested that it did not matter what practices they adopted, they would never be able to meet water quality standards. While there was not consensus between focus group participants and interview results, we believe that future studies could evaluate whether or not these control beliefs exist outside of Northern Malheur County farmers and whether or not these beliefs have a sizeable impact on adoption decisions. Factors that could foster a sense of lack of agency among farmers deserve special attention.

Variables that are categorized as background factors within the RAA/TPB have been a major focus of previous adoption studies. In the RAA/TPB, it is assumed that beliefs are not innate, but based on personal experiences, personal characteristics, social and cultural factors, and exposure to media and other sources of information. The number of background factors that could be considered for any given behavior is practically unlimited (Fishbein & Ajzen, 2009). Based on past study results, we anticipated that education levels, farm capital, farm income, farm size, access to and quality of information, environmental awareness, social networks, and social capital would be salient background factors in our study as well. Our results include a wide range of personal characteristics, farm characteristics, informational factors, contextual

factors, and general attitudes that were impacting adoption in Northern Malheur County (Figure 16). However, producer age emerged as barrier for 11 study participants (38% of total respondents). The role of age in adoption decisions has produced positive, negative, and insignificant results in past adoption studies (Knowler & Bradshaw, 2007). However, we suggest that how a producer perceives their own age or the age of those around them (based on other factors such as retirement plans, financial security, and plans to pass on the farm) may be an important background factor influencing behavioral, normative, and control beliefs. We suggest that the role of producer age in belief formation is a critical area for future study that may help us identify why age has emerged as a significant factor in some adoption studies and insignificant in others.

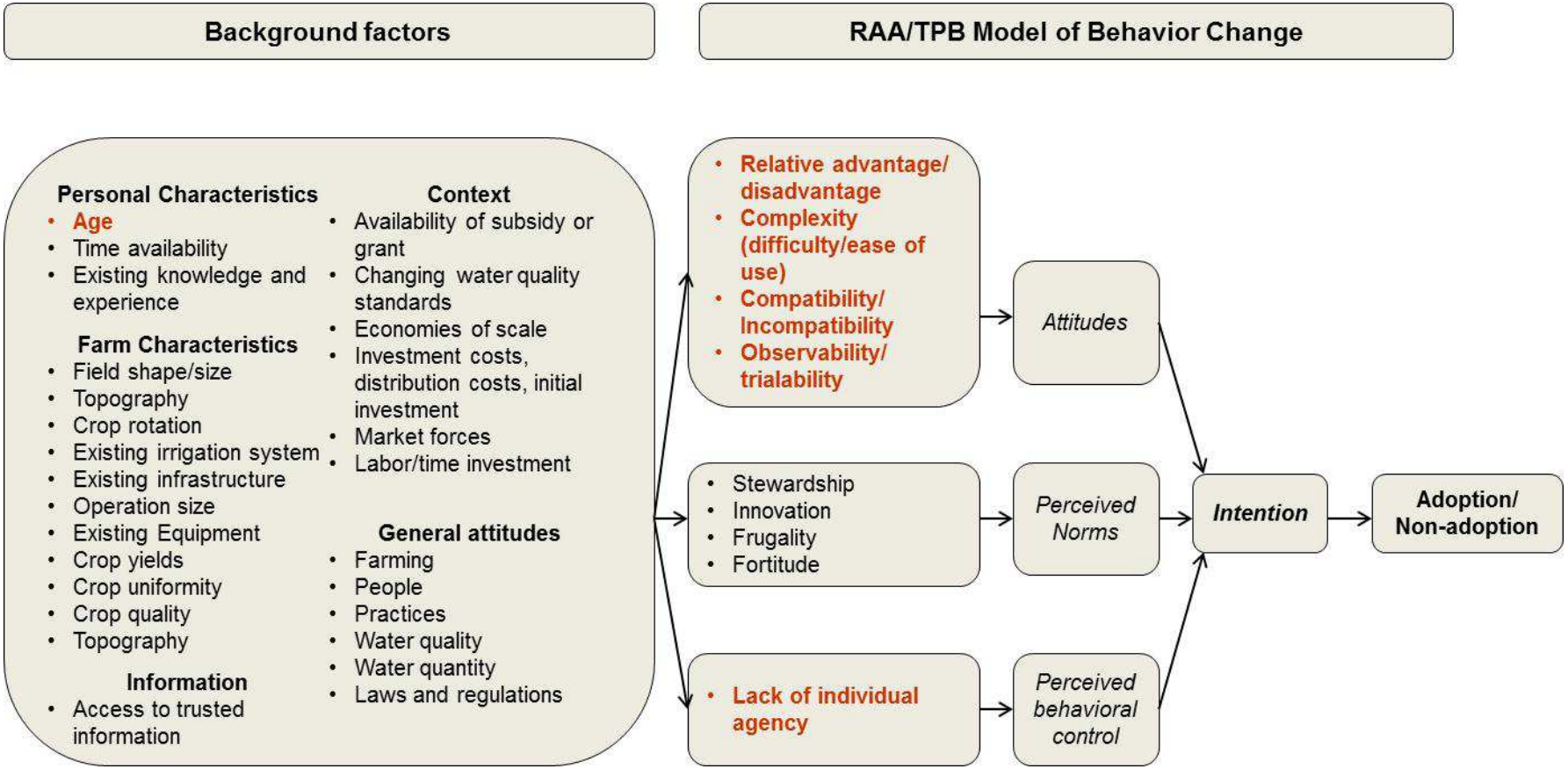

Figure 16. The Reasoned Action Approach/Theory of Planned Behavior adapted to include study findings. In this study, the attitudes and norms were supplemental to the perceived behavioral controls, which seemed to be impacting adoption more directly.

Overall, the RAA/TPB was an effective framework for identifying barriers and incentives to adoption in Northern Malheur County. By integrating perceived practice characteristics, we were able to incorporate major findings from a wide range of past study. Some limitations that we discovered in the use of the RAA/TPB are the difficulty to organize and evaluate the importance of various background factors and the difficulty of defining adoption versus non-adoption. It is difficult to identify which background factors are most salient in influences beliefs and overall adoption. Quantitative studies may be better suited to identify which factors are most pertinent to adoption. In addition, adoption of CPs forms a continuum rather than an either/or decision; there are varying degrees of adoption that are not necessarily captured by the RAA/TPB. However, this limitation may not be unique to the RAA/TPB and is likely an issue for other behavioral theories considering adoption. We suggest that future studies consider measurements that attempt to take the continuum into account rather than simply adoption vs. non-adoption, or adoption based on the number of CPs adopted because not all practices have equal impact on water quality.

Recommendations for greater and expanded adoption of CPs

This section will outline recommendations for practitioners and policymakers seeking to increase adoption of water quality improving practices through the use of incentives and focused education and outreach programs.

Practitioners and outreach agents

The results of this study suggest that farmers are practical, rationally-minded individuals who want to see the success of a practice before adopting that practice. Educational materials, workshops, and other outreach should be enhanced to reflect these desires. Study respondents expressed that they want to see that a practice is compatible with their operations and will either make them money or save them money. Outreach should focus on the practicality of CPs which frequently have the ability to improve profits or cut costs. In addition,

efforts should be focused towards the sources which producers trust the most: neighbors, other farmers, and OSU research and extension staff. We recommend that new practice trials be run on research farms or on private land by producers as a tool to spread information about new practices. Identifying early adopters and providing incentives for them to test practices might also be a good strategy to enhance and encourage adoption of CPs.

Education and outreach that better defines water quality could help inform farmers about the multi-faceted nature of water quality. Study results suggest that farmers perceive overall water quality based on “availability” of a particular concept of water quality; i.e., whatever parameter they associate with the word. This might lead them to perceive water quality as having improved in the last couple of decades if they equate nitrate levels in groundwater as the primary manifestation of water quality. However, if they equate water temperature with water quality, they may be turned off from the concept entirely because of their frustration with what they perceive as unreasonable and unattainable temperature standards. Modifying education and outreach to inform farmers about ways in which they can positively impact water quality might influence the behavior of the group of farmers who currently perceive water quality as something they do not control.

Policymakers

We recommend that policymakers continue to encourage adoption of CPs through subsidy programs and technical support programs because our study results indicate that producers are adopting practices that make financial sense. Malheur County growers expressed a strong desire for development of practices that are affordable and easy, and cited technical support programs and extension services as trusted sources of information. Provision of costshare funding is an important incentive that has successfully engaged producers in the past. We also recommend considering use of market incentives as a solution to improving water quality given the emphasis that producers made on practicality and

economic cost/benefit analysis. Study results suggest that Malheur County farming practices are highly heterogeneous and that farmers have many different ways of producing the same product. As a result, incentives should be tailored to the individual needs of the segmented farming community. Some respondents suggested that funding is only available for certain practices, like pivot systems, which are not compatible with every farm. Policymakers should consider programs that provide funding, guidance, and technical support for more basic practices that are still an improvement over those currently used. Examples might include funding for lining dirt canals with cement, piping water canals, funding for wheelines or sediment ponds. These practices might not reflect the latest technology, but they are needed by farmers with diverse soils, topography, crop rotations, and infrastructure built in the early 20th century.

It may be important to open up discussion between farmers and policymakers regarding the feasibility of attaining some current water quality standards, particularly TMDL standards set for Malheur County. Oregon has chosen to attain TMDL water quality standards through an outcome-based system in which water quality standards are set, but producers are not told exactly how they can meet them. While this gives desired autonomy to farmers, some farmers can also become frustrated because they are unsure of how to meet the standards. Study results suggested that some Malheur County farmers believe that the standards are unattainable through reasonable means. Farmers and policymakers would benefit from more focused discussions about whether current standards are attainable, and the specific practices it is reasonable to expect farmers to use in order to reach such goals. By opening up communication between farmers and policymakers about TMDLs in Malheur County, we can work toward development of shared water quality goals. We recommend that policymakers provide accessible resources that can be used to build trust with producers and help them reach water quality goals. One

respondent expressed his frustration with what he perceived as unattainable water quality standards as follows:

> “I’ve written both [the EPA] and the DEQ which is the state equivalent about setting objectives that are not attainable! People may initially sign on to them but when there’s no way of ever meeting them, they’re gonna not be on the team anymore!”

This excerpt highlights the need to build trust with producers and encourage them to adopt practices through open dialogue. We recommend striving towards a landscape in which farmers feel they have control over their operations and believe that their actions will have a positive impact on water quality and food production. In an effort to address concerns over lack of agency, change agents and policymakers alike can encourage farmers to be advocates for themselves and their resources. Empowering farmers who feel largely outnumbered and insignificant compared to the densely populated city centers is not an easy task, but there are some solutions that may help diffuse some of these tensions. Expressing to farmers that we value their profession and American grown food is important. We can also continue to provide educational programs for children and schools about growing their own food, educating them on where their food comes from, and we can encourage everyone to learn more about the farmers and farms that produce the food that is consumed in our country. Expanding upon existing reward programs for farmers who adopt conservation programs might be another solution as well. In addition, many farmers may feel empowered if they are trusted to make good stewardship decisions through continued use of voluntary adoption programs.

Finally, it is important to remember that Malheur County producers have shown that they are open to innovation and change and thrive through autonomy and being actively engaged in stewardship decisions. Our results suggest that showing farmers practical, profitable ways of irrigating, and fertilizing is an effective method of infusing change into the Malheur farming community.

Farmers are willing to change if they observe a successful innovation, and are always looking for more efficient and effective ways to produce a crop at a profit.

CONCLUSION

Study outcomes

This study provides unique insights into the barriers and incentives driving adoption of water quality improving practices through engagement of Northern Malheur County farmers based on discussions about how and why they make decisions. Financial gain and loss, ease of use, farm compatibility, and observability emerged as the primary factors driving adoption in Malheur County. Soil, water, nutrient conservation and water quality were important perceived benefits of practices that producers consider in addition to primary factors driving adoption. Producer age and a lack of human agency were reported as impeding adoption in some instances, and were identified as key areas for future study. Recommendations were made for change agents and policymakers to take advantage of the drivers of adoption and to tackle impediments to adoption. Recommendations for change agents include enhancing education and outreach materials to focus on the practicality of water quality improving practices and increased use of field trials in farmer's fields or OSU research and extension. In addition, it is recommended that policymakers consider the diverse nature of farming practices, the need for incentive systems that fit the segmented farming market, and the need to build trust with producers through open communication and shared water quality goals. The following study objectives were accomplished:

1) The current irrigation, fertilization, and nutrient management practices of study respondents were identified;
2) It was determined that the relative advantage of a practice (derived from economic gain/loss, conservation and water quality), ease of use, farm compatibility, and observability are the primary factors influencing

adoption. Producer age and lack of agency are barriers that may be rich areas for future study;

3) Relative advantage, complexity, and compatibility are perceived practice characteristics that emerged as important behavioral beliefs. Future academic studies might consider the role that age plays in impacting producer beliefs about practices and to what extent, if any, lack of agency reduces perceived behavioral control;
4) Policy recommendations were made for change agents and policymakers in order to encourage further adoption of practices intended to improve water quality.

Future Research

Future studies in Malheur County might consider using the results of this qualitative study in a more quantitative survey of all Malheur County growers. Results from this study could be used to tailor survey questions around the barriers and incentives identified in order to validate the findings of this study and clarify the role that age and lack of agency are playing in adoption. Other future studies might include designing pilot education and incentive programs and testing their utility. It might also be valuable to repeat the methods used in this study in other Oregon watersheds. Many of the policies and water quality standards that are impacting Malheur County farmers are statewide programs. It would be beneficial to see how farmers in other areas in the state (on both irrigated and rainfed farms) perceive similar policies. Such study results might paint a clearer picture of what is needed in state water policy to better incentivize conservation practices and improve water quality.

Broader Implications

This study sought to answer the question, “what are the factors influencing the adoption of water quality improving practices in Northern Malheur County, Oregon?” Our study identified four standalone factors driving and/or impeding adoption: relative advantage derived primarily from financial benefit in addition to

conservation and water quality, farm compatibility, ease of use, and observability. Age and lack of agency were also barriers to adoption in some instance. Of all of these factors, financial benefit or loss was the most frequently cited factor influencing adoption.

The information gathered in this study is meant to increase our understanding of farmer decision-making behavior for practitioners and outreach personnel seeking to enhance educational materials, policymakers seeking to provide better incentive systems, as well as for academic researchers who want to better understand how and why farmers make decisions. While adoption of CPs is a widely studied topic in academic literature, it is still not well understood. It is our hope that this study provided some insight into the life and perceptions of the American farmer today. Our results suggest that growers speak a language of practicality, observability, and profitability. Understanding how farmers perceive their social, cultural, regulatory, economic, and ecological surroundings is necessary to better shape education and incentives in an effort to ultimately improve water quality for economic, social, and environmental sustainability.

BIBLIOGRAPHY

Ahnström, J., Höckert, J., Bergeå, H. L., Francis, C. a., Skelton, P., & Hallgren, L. (2008). Farmers and nature conservation: What is known about attitudes, context factors and actions affecting conservation? *Renewable Agriculture and Food Systems*, *24*(01), 38. doi:10.1017/S1742170508002391

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckman (Eds.), *Action-control: From cognition to behavior* (pp. 11–39). Heidelberg: Springer.

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179–211.

Ajzen, I., & Albarracin, D. (2007). Predicting and changing behavior: A reasoned action approach. In *Prediction and change of health behavior: Applying the reasoned action approach* (pp. 1–328). Psychology Press.

Alberta Research Council. (2006). *Study on identifying rural sociological barriers to adoption* (pp. 1–121).

Atwell, R. C., Schulte, L. A., & Westphal, L. M. (2009). Linking Resilience Theory and Diffusion of Innovations Theory to understand the potential for perennials in the U.S. corn belt. *Ecology and Society*, *14*(1), 30.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/847061

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, *44*(9), 1175–1184. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2782727

Bandura, Albert. (1977). Social learning theory, 305–316.

Baumgart-Getz, A., Prokopy, L. S., & Floress, K. (2012). Why farmers adopt best management practice in the United States: a meta-analysis of the adoption literature. *Journal of Environmental Management*, *96*(1), 17–25. doi:10.1016/j.jenvman.2011.10.006

Beedell, J. D. C., & Rehman, T. (1999). Explaining farmers' conservation behaviour: Why do farmers behave the way they do? *Journal of Environmental Management*, *57*, 165–176.

Beedell, J., & Rehman, T. (2000). Using social-psychology models to understand farmers' conservation behaviour. *Journal of Rural Studies*, *16*(1), 117–127. doi:10.1016/S0743-0167(99)00043-1

Bentley, J. W. (1994). Facts, fantasies, and failures of farmer participatory research. *Agriculture and Human Values*, 140–150.

Berg, B. L., & Lune, H. (2012). *Qualitative research methods for the social sciences* (8th ed.). Pearson Education, Inc.

Bloor, M. (1997). Techniques of validation in qualitative research: A critical commentary. In *Context and method in qualitative research* (pp. 37–50). Sage Publications, Inc.

Boston University School of Public Health. (2013). Behavioral change models. Retrieved from http://sph.bu.edu/otlt/MPH-Modules/SB/SB721-Models/SB721-Models.html

Burton, R. J. F. (2004). Reconceptualising the "behavioural approach" in agricultural studies: a socio-psychological perspective. *Journal of Rural Studies*, *20*(3), 359–371. doi:10.1016/j.jrurstud.2003.12.001

Campbell, J. L., Quincy, C., Osserman, J., & Pedersen, O. (n.d.). Coding in-depth semi-structured interviews: problems of unitization and inter-coder reliability and agreement, *Sociologic*.

Carolan, M. S. (2005). Barriers to the Adoption of Sustainable Agriculture on Rented Land: An Examination of Contesting Social Fields. *Rural Sociology*, *70*(3), 387–413. doi:10.1526/0036011054831233

Carpenter, S., Walker, B., Anderies, J. M., & Abel, N. (2001). From metaphor to measurement: Resilience of what to what? *Ecosystems*, *4*(8), 765–781. doi:10.1007/s10021-001-0045-9

Cary, J. W., & Wilkinson, R. L. (1997). Perceived profitability and farmers' conservation behaviour. *Journal of Agricultural Economics*, *48*(1), 13–21. doi:10.1111/j.1477-9552.1997.tb01127.x

Chouinard, H. H., Wandschneider, P. R., Ohler, A. M., & Paterson, T. (2008). Will farmers trade profits for stewardship?: Heterogeneous motivations for farm practice selection. *Land Economics*, *84*(1), 66–82. doi:10.1353/lde.2008.0046

Conner, M., & Armitage, C. J. (1998). Extending the Theory of Planned Behavior: A review and avenues for further research. *Journal of Applied Social Psychology*, *28*(15), 1429–1464. doi:10.1111/j.1559-1816.1998.tb01685.x

Creswell, J. (2012). Standards of validation and evaluation. In *Qualitative inquiry and research design* (3rd editio., pp. 243–267). Sage Publications, Inc.

Dzurik, A. (2003). *Water resources planning* (3rd ed.). Lanham: Rowman & Littlefield Publishers, Inc.

Emerson, R. M., Fretz, R. I., & Shaw, L. L. (1995). *Writing ethnographic field notes*. University of Chicago.

Ervin, C. A., & Ervin, D. E. (1982). Factors affecting the use of soil conservation practices: Hypotheses, evidence, and policy implications. *Land Economics*, *58*(3), 277–292.

Feather, P. M., & Amacher, G. S. (1994). Role of information in the adoption of best management practices for water quality improvement. *Agricultural Economics*, *11*, 159–170.

Fielding, K. S., Terry, D. J., Masser, B. M., Bordia, P., & Hogg, M. a. (2005). Explaining landholders' decisions about riparian zone management: the role of behavioural, normative, and control beliefs. *Journal of Environmental Management*, *77*(1), 12–21. doi:10.1016/j.jenvman.2005.03.002

Firestone, W. (1993). Alternative arguments for generalizing from data as applied to qualitative research. *Educational Researcher*, *22*(4), 16–23.

Fishbein, M., & Ajzen, I. (2009). *Predicting and changing behavior: The reasoned action approach* (pp. 1–538). Psychology Press.

Foley, K.M., & Shock, C. C. (2013). *ODEQ final performance report: Benefits of introducing reduced tillage to improve farming practices and protect water quality*.

George, A. L., & Bennett, A. (2005). *Case studies and theory development in the social sciences*. MIT Press.

Gillespie, J., Kim, S., & Paudel, K. (2007). Why don't producers adopt best management practices? An analysis of the beef cattle industry. *Agricultural Economics*, *36*, 89–102.

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report*, *8*(4), 597–607.

Gosling, E., & Williams, K. J. H. (2010). Connectedness to nature, place attachment and conservation behaviour: Testing connectedness theory among farmers. *Journal of Environmental Psychology*, *30*(3), 298–304. doi:10.1016/j.jenvp.2010.01.005

Gray, D. E. (2009). *Doing research in the real world* (2nd Editio., pp. 11–596). Great Britain: Sage Publications, Inc.

Griliches, Z. (1957). Hybrid corn: An exploration in the economics of technological change. *The Econometric Society*, *25*(4), 501–522.

Gunderson, L. H., & Holling, C. S. (2001). *Panarchy: Understanding transformations in human and natural systems* (pp. 1–536). Island Press.

Harland, P., Staats, H., & Wilke, H. A. M. (1999). Explaining proenvironmental intention and behavior by personal norms and the Theory of Planned Behavior. *Journal of Applied Social Psychology*, *29*(12), 2505–2528.

Khanna, M., Epouhe, O. F., & Hornbaker, R. (2012). Site-specific crop management: Adoption patterns and incentives. *Review of Agricultural Economics*, *21*(2), 455–472.

Knowler, D., & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy*, *32*(1), 25–48. doi:10.1016/j.foodpol.2006.01.003

Lofland, J., Snow, D., Anderson, L., & Lofland, L. H. (1984). *Analyzing social settings: a guide to qualitative observation and analysis*. Wadsworth.

Lombard, M. (2005). Practical resources for assessing and reporting intercoder reliability in content analysis research projects. Retrieved from http://www.temple.edu/sct/mmc/reliability/

Lubell, M. (2004). Collaborative Watershed Management: A View from the Grassroots. *Policy Studies Journal*, *32*(3), 341–361.

Lynne, G. D., Casey, C. F., Hodges, A., & Rahmani, M. (1995). Conservation technology adoption decisions and the theory of planned behavior. *Journal of Economic Psychology*, *16*, 581–598.

Lynne, G. D., Shonkwiler, J. S., & Rola, L. R. (2012). Attitudes Behavior and Conservation, *70*(1), 12–19.

Malheur County Court. 1981. *Two-Year Sampling Program, Malheur County Water Quality Management Plan.* Malheur County Planning Office, Vale, Oregon.

Environmental Protection Agency (EPA). (n.d.). Managing nonpoint source pollution from agriculture. *EPA Nonpoint Pointers Series*. Retrieved from http://water.epa.gov/polwaste/nps/outreach/point6.cfm

Marshall, M. N. (1996). Sampling for qualitative research. *Family Practice*, *13*(6), 522–5.

Mason, M. (2010). Sample size and saturation in PhD studies using qualitative interviews. *Forum: Qualitative Social Research*, *11*(3).

Maxwell, J. A. (2004). *Qualitative research design: An interactive approach*. SAGE.

Michel-Guillou, E., & Moser, G. (2006). Commitment of farmers to environmental protection: From social pressure to environmental conscience. *Journal of Environmental Psychology*, *26*(3), 227–235. doi:10.1016/j.jenvp.2006.07.004

Morgan, D. L. (1996). Focus groups. *Annual Review of Sociology*, *22*, 129–152.

Napier, T. L., Tucker, M., & McCarter, S. (2000). Adoption of conservation production systems in three midwest watersheds. *Journal of Soil and Water Conservation*, 123–134.

National Agricultural Statistics Service (NASS) FY 2003 and Revised FY 2002 Annual performance plans. (2005) (Vol. 1946, pp. 1–19).

Nowak, P. (1992). Why farmers adopt production technology. *Journal of Soil and Water Conservation*, 14–16.

Ogden, J. (2003). Some problems with social cognition models: A pragmatic and conceptual analysis. *Health Psychology*, *22*(4), 424–428. doi:10.1037/0278-6133.22.4.424

Oregon Department of Agriculture. (2012). *Oregon agriculture: Facts and figures*.

Malheur River basin agricultural water quality management area plan (pp. 1–43).

Pannell, D. J., Marshall, G. R., Barr, N., Curtis, a., Vanclay, F., & Wilkinson, R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture*, *46*(11), 1407. doi:10.1071/EA05037

Prokopy, L. S., Floress, K., Klotthor-Weinkauf, D., & Baumgart-Getz, a. (2008). Determinants of agricultural best management practice adoption: Evidence from the literature. *Journal of Soil and Water Conservation*, *63*(5), 300–311. doi:10.2489/63.5.300

QRS International Pty Ltd. (2011). NVivo qualitative data analysis software.

Ragin, C. C. (2000). *Fuzzy-set social science*. University of Chicago.

Reimer, A. P., Weinkauf, D. K., & Prokopy, L. S. (2012). The influence of perceptions of practice characteristics: An examination of agricultural best management practice adoption in two Indiana watersheds. *Journal of Rural Studies*, *28*(1), 118–128. doi:10.1016/j.jrurstud.2011.09.005

Richardson, P. (2010). *Third Northern Malheur County Groundwater Management Area Nitrate Trend Analysis Report* (pp. 1–7).

Rodriguez, J. M., Molnar, J. J., Fazio, R. a., Sydnor, E., & Lowe, M. J. (2008). Barriers to adoption of sustainable agriculture practices: Change agent perspectives. *Renewable Agriculture and Food Systems*, *24*(01), 60–71. doi:10.1017/S1742170508002421

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed., pp. 1–471). New York: Free Press.

Saltiel, J., Baunder, J. W., & Palakovich, S. (1994). Adoption of sustainable agricultural practices: diffusion, farm structure, and profitability. *Rural Sociology*, *59*(2), 333–349.

Sassenrath, G. F., Halloran, J. M., Archer, D., Raper, R. L., Hendrickson, J., Vadas, P., & Hanson, J. (2010). Drivers impacting the adoption of sustainable agricultural management practices and production systems of the Northeast and Southeast United States. *Journal of Sustainable Agriculture*, *34*(6), 680–702. doi:10.1080/10440046.2010.493412

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

Shock, C.B., Shock, M.P., & Shock, C.C. (2007). *Lower Owyhee Watershed Assessment: Historical conditions* (pp. 41–43).

U.S. Department of Agriculture National Agriculture Statistics Service. (2007). *2007 Census of agriculture county profile*. *Area*.

United States Environmental Protection Agency. (2009). *National water quality inventory: Report to Congress 2004 Reporting Cycle* (p. 15).

United States Government Accountability Office. (2012). *Nonpoint source water pollution: Greater oversight and additional data needed for key EPA Water Program* (pp. 1–80).

USDA Economic Research Service. (2012). Irrigation and water Use. *Farm practices and management*. Retrieved from http://www.ers.usda.gov/topics/farm-practices-management/irrigation-water-use/background.aspx#.UZw49rWcFrp

Valentin, L., Bernardo, D. J., & Kastens, T. L. (2004). Testing the empirical relationship between best management practice adoption and farm profitability. *Review of Agricultural Economics*, *26*(4), 289–504.

Vanclay, F. (2004). Social principles for agricultural extension to assist in the promotion of natural resource management. *Australian Journal of Experimental Agriculture*, *44*(3), 213. doi:10.1071/EA02139

Weiss, R. S. (1995). *Learning from strangers: The art and method of qualitative interview studies*. Simon and Schuster.

Yapa, L. S., & Mayfield, R. C. (1978). Non-adoption of innovations: Evidence from discriminant analysis. *Economic Geography*, *54*(2), 145–156.

APPENDICES

Appendix A. List of semi-structured interview questions

Each interviewee was asked similar questions, but there was not a standard set of questions used across interviews. The following provides an example of the types of questions that were asked of respondents.

Pseudonym: (i.e., Producer NN)
Topographic Boundary: (i.e., SW Vale-Little Valley)
Date/Time:

1. Tell me how it is that you came to be a farmer in Malheur County?
2. What do you think have been the biggest changes in farming practices around here since you began farming?
   (ex: drip irrigation, reduced tillage)
   - Did you start to use drip irrigation/land leveling?
3. How did you find out about that?
   - Is this where most producers go for information?
4. What kinds of irrigation/fertilization/tillage systems do you use?
   - Have you always done it that way?
5. Why did you decide to_____?
   - Were your neighbors also ____?
   - What impact did _____ have on the environment?
6. Do you think that your farming practices are representative of operations in this region?
   - Is there a technique or practice that you employ that is unconventional?
7. Do you feel there are water quality problems in this area?
   - What are the main sources of this pollution?
   - Does farming contribute to this problem? How?
   - Are you concerned about future environmental issues?
8. How do you feel about the push for environmentally friendly practices in this area?
9. Are there management practices that you would like to implement but do not or cannot currently?
10. What time frame would you consider to be economically viable for paying off your _____?
11. If you were informed about a fertilization practice that leads to lower nutrient runoff or nutrient leaching than the practices you are currently using, what might influence you to use that practice?
    - Who would you trust for information about this new method?
12. What do you perceive as the greatest challenge farmers in this area will face in the future?

Appendix B. Interview codebook

Primary Code	Keywords	Secondary Code	Keywords	Teritary Code	Keywords
Descriptive attribute: Something about the farmer and/or his farm that describes him/her or their personal history in farming	Background information, farming history (unless this history acts as a driver, in which case code as "driver"), demographic information, representativeness (This section will be used to describe the participants demographically and to provide context if there is time at the end)	**Farming history:** How and why they settled here. Do not code here if the historical context acts as a driver (i.e. my dad did it this way, so I did too)	How long they've been farming, family, personal educational/professional history, drawn to lifestyle, like driving tractors, etc.	None	None
		Demographics: attributes of the participant that could be quantified statistically either as a binary, categorical, or continuous variable	Generally at the beginning and end of the interview. Interviewer will generally start out asking about what crops are grown and acreage, and at the end more formal demographic information is asked such as income and education	**Age**	Integer
				Acreage	How many acres are they farming?
				Education	Highest level of education received?
				Primary Income	Is farming the primary income?
				Supplemental Income	Do they have an income that is supplemental to farming
				Irrigation District	Where do they get their water?
				Water rights	Acre-feet
				Dacthal Use	Did they use dacthal?
				Grower Assoc.	Are they a member of a grower association?
		Representativeness: An assessment of whether or not the respondent feel's his/her farm is representative of those in the area or whether or not they employ something unconventional.	Generally probed by the question: "Do you think what you do is fairly representative of the folks around you?"	None	None

Primary Code	Keywords	Secondary Code	Keywords	Teritary Code	Keywords
Practices: Anything about irrigation, fertilization, pest management, or nutrient management practices that has stayed the same or changed over time. Note that this section is just to provide a description of what practices are being used/not used. -Should not include any other context about practices (how they feel about them, why they started using them) -Does not include machinery or biological engineering which are considered drivers of change	Fertilizer rates, number of passes over a field, drip, sprinkler, furrow, gravity, flood irrigation, PAM, sediment ponds, reduced tillage, strip tillage, soil sampling, fall fertilization	**Irrigation**	Sprinkler, furrow, drip, scheduling, frequency	None	None
		Fertilization	Application rates, amount applied, application method	None	None
		Tillage	Number of passes over a field, number and type of operations used	None	None
		Crops grown	Alfalfa, barley, beans, cattle, corn, grain, hay, milk cows, mint, onions, pasture, peas, pigs, potatoes, seeds, sugarbeets, triticale, wheat	None	None
		Conservation practices	Bubblers, compost, filter strips, laser leveling, manure, PAM, petiole testing, pumpback system, sediment ponds, soil sampling, split applications, straw mulch	None	None

Primary Code	Keywords	Secondary Code	Keywords	Teritary Code	Keywords
Information: Information sources for producers about farming practices and water quality. Sometimes information sources can act as drivers, in which case they should not be coded here. They way a respondent feels about information sources should be coded under attitudes.	Neighbors, family, observation, publications, conferences, suppliers, extension, field agents, studies, membership in associations or organizations, coffee shops, soil tests	**Agencies**	None	None	None
		Auctions			
		Coffee shops			
		Education			
		Employment			
		Experimentation			
		Extension			
		Fair			
		Family			
		Farm Bureau			
		Field men			
		Internet			
		Meetings			
		Neighbors			
		Newspaper & Magazines			
		Observation			
		Publications			
		Suppliers			
		Water board membership			
		Watershed council			
		Word of mouth			

Primary Code	Keywords	Secondary Code	Keywords	Teritary Code	Keywords
Attitude: General attitude toward practices, water quality, water quantity, laws and regulations, and information about practices	I feel, my theory is, like I say, my vision is, I don't like, I'm scared of, to me this is really important, I think (sometimes)	**Water quality**	opinion or concern or lack of concern for water quality or pollution in the area; is there a water quality problem? Sources of pollution;importance of a practice; impact of his/her practices on water quality	None	None
		Laws and regulations	opinion about a law and/or government rules and regulation		
		Environmental practices	Opinions or feelings about environmental practices		
		Farming	How he/she feels or thinks about other farms or the conditions of farming in general		
		Information	how he/she feels or thinks about information sources or people who serve as information sources		
		Practices	how useful he/she believes a practices to be, opinion about a practice		
		People	Regulators, environmentalists, politicians, general public, city folks, policy makers, other farmers, younger/older farmers, etc.		

Primary Code	Keywords	Secondary Code	Keywords	Teritary Code	Keywords
Social norms: Institutionalized way of behaving	Have to do, supposed to do, ought to do, made me do it, that's the way it's done, you use, generalizations where "we" when we is > myself and family doing something on the farm. Be careful to consider the context within which we is being used. Sometimes they are just describing themself and their wife/brother/farm partner.	**Regulations**	Chemical use regulations, food safety, fumigation, labor, shipping, water quality, water quantity	None	None
		Social & Professional	Clean field, continued learning, creativity, family farm, fortitude, frugality, good management, honesty, innovation, patience, predicability, stewardship, timeliness		

Primary Code	Keywords	Secondary Code	Keywords	Teritary Code
Drivers: positive or negative controls on management practices	I did it because, I don't do that because, anything that caused the respondent to change their practice/adopt a new practice or something that stopped them from adopting a practice	Barriers: Reasons why something cannot be done	Difficult to use	Timing
				Excessive paperwork
				Maintenance
				Learning curve
				Labor intensive
			Financial	Lost acreage
				High risk
				Expense
				Economies of scale
				Denied subsidy
			Farm compatability	Topography
				Size of operation
				Field size
				Field shape
				Existing irrigation system
				Existing infrastructure
				Existing equipment
				Crop rotation
			Lack of agency	Unattainable or changing standards
				Inability to make own decisions
				Inability to make a difference or believe that respondent has no impact on problem
			Age	Won't receive payoff on investment
				Averse to change due to age
			Other	Aversion to change, lack of access to information, rent, water quantity

Primary Code	Keywords	Secondary Code	Keywords	Teritary Code
Drivers: positive or negative controls on management practices	I did it because, I don't do that because, anything that caused the respondent to change their practice/adopt a new practice or something that stopped them from adopting a practice	Incentives: Reasons why something has been done	Easy to use	Weed control
				Maintenance
				Labor savings
			Financial	Subsidies (i.e. EQUIP)
				Market forces
				Low risk
				Increased yield
				Increased uniformity
				Increased crop quality
				Higher production
				Expense
			Conservation	Water savings and efficiency of use
				Soil savings and preservation
				Nutrient savings and precision
			Farm compatability	Topography
				Size of operation
				Field size
				Field shape
				Existing machinery
				Existing irrigation systems
				Existing infrastructure
				Crop rotation
			Observability	Other farms
				Neighbors
				Experimentation
				Experiment station and extension
			Water quality	Sediment load
				Recreation
				Fish
				Consumption
				Clean water
			Other	Working together, weather, social pressure, positive past experience, laws and regulations, improved seed stand, dislike chemicals, desire for latest technology, autonomy, age

Appendix C. Focus group protocol

Interview respondents were presented with 7 preliminary themes from the individual interviews. Respondents were asked to validate or refute those themes through a series of probes. The themes and probes are presented below.

1. In the face of increasing costs and shrinking profit margins, growers in this area are frugal and interested in practicality and practices that utilize common sense. As a result, the cost/benefit of a practice, its ease of use, and farm compatibility are important factors influencing the adoption/non-adoption of conservation practices.
    a. Do you agree with this statement?
    b. What's missing? Are there other reasons for why finances, farm compatibility, and ease of use are important factors in adoption?
2. A strong stewardship ethic amongst growers in the area makes soil, water, and nutrient conservation a major incentive in the adoption of sustainable practices.
    a. Do you agree with this statement?
    b. What's missing? Are there other factors that make conservation and major incentive in adoption?
3. Growers in the area tend to trust their neighbors, the experiment station/agricultural extension, and observation of other farmers the most when gathering information about new practices. As a result, it is important to growers that they can observe the success of a practice before adopting that practice.
    a. Do you agree with this statement?
    b. What's missing? Why is it so important that grower's observe the success of a practice before adopting it?
4. When it comes to water quality, most growers perceive that there is a problem but it is better than it was 20-30 years ago. As a result, water quality is a factor in the adoption of conservation practices, but rarely the main reason for adoption.
    a. Do you agree with this statement?
    b. What's missing? Why is water quality not more important in the adoption of conservation practices?
5. Many growers perceive that natural contaminant levels of pollutants (arsenic, mercury, temperature, and phosphorus) present in waterways above the dam reduce their ability to impact water quality problems.
    a. Do you agree? Do most growers feel this way?
6. Growers perceive that the power of the vote is in the Willamette valley where the population is most dense. They see this population is largely

uneducated as to where their foods comes from and in turn, approve many impractical regulations and laws that make food production more difficult in the Treasure Valley. As a result, water quality standards are constantly changing and largely unattainable, reducing the incentive to adopt conservation practices.

   a. Do you agree?
   b. What's missing? Are there other reasons why growers feel that they have little to no control over water quality?

7. An aging population of growers in this area reduces the incentive to adopt new, conservation practices because older growers do not expect that those practices will pay off in their remaining tenure or they are more conservative and averse to change.
   a. Do you agree?
   b. What's missing? Are there other reasons why age is a barrier to adopting conservation practices?