Understanding agricultural perspectives of cover crop adoption and symbols of good farming in the inland Pacific Northwest

A Thesis
Presented in Partial Fulfillment of the Requirements for the
Degree of Master of Science
with a
Major in Environmental Science
in the
College of Graduate Studies
University of Idaho
by
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May 2020

Authorization to Submit Thesis

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Abstract

Globally, there is increased awareness of the environmental consequences of conventional agriculture and the need for viable economic and environmental options for farmers. In response to these problems, there has been increased promotion for conservation practices like cover crops and conservation tillage. Cover crops and conservation tillage can reduce erosion, improve soil and water quality, increase water holding capacity, and improve farming efficiency and productivity. However, the adoption of such practices varies widely across the nation; thus, research calls for a better understanding of how to support and sustain adoption of such practices. The two chapters of this thesis draw from semi-structured interviews (n=28) and focus groups (n=61) with crop and livestock farmers across the dryland, wheat-growing region of the inland Pacific Northwest (PNW). For chapter one, we draw from the diffusion of innovations theory to better understand farmers' perspectives on the perceived relative advantage (the degree to which an innovation is compatible with the current system) and trialability (how easily potential adopters can try an innovation) of cover crops. For chapter two, we draw from the 'good farmer' literature, grounded in Bourdieu's theory on field, habitus, and capital to understand the extent to which engagement with conservation tillage (CT) systems reinforce symbols of good farming and supports stewardship behavior. We find that cover crops are associated with perceptions of low relative advantage and low trialability. Results from chapter two suggest that engagement with CT systems allows farmers to demonstrate productivisit values, while simultaneously supporting stewardship values and conservation outcomes. Implications from this thesis can better inform practical recommendations for farmers, University researchers, decision-makers, and conservation practitioners. Stakeholders may consider approaches that between cultural, economic, and social factors shape farmers' response to on-farm conservation practices.

Acknowledgements

We would like to thank the University of Idaho Office of Research and Economic Development for funding this project. We would also like to thank our partner, the Palouse Conservation District, for collaborating with us and for hosting and helping to facilitate the focus groups at the Alternative Cropping Symposium. A special thank you to the crop and livestock farmers, University researchers, private industry employees and conservation staff who agreed to participate in interviews and focus group discussions. To my advisor Chloe Wardropper, Ph.D, for initiating this work and for providing invaluable feedback, patience and support and to Zackary Kayler, Ph.D and Jennifer Boie, Ph.D for providing feedback and for supporting this research.

Dedication

I dedicate this work to the farmers who shared their stories. I also recognize those who live and work to preserve the integrity of the soil and farmland. Thank you to my family, whose unconditional love and support have led me on this path — absolute gratitude for Terren and Buck, who offered continuous loving support. To my dear and sweet friends, your love, laughter and guidance has been a blessing. Thank you.

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Statement of Contribution

Dr. Chloe Wardropper directed the overall concept and design of this research. Dr. Zachary Kayler and Dr. Jennifer Boie contributed feedback for chapters one and two. Dr. Katie Dentzman provided invaluable feedback and chapter two. Dr. Chloe Wardropper assisted with detailed editing of chapters one and two.

Introduction

Across the Western U.S, there is increased promotion for conservation tillage (CT) and cover crops to improve soil and water quality and improve environmental and economic outcomes for farmers (Lin, 2011; Stubbs, 2014; Bista et al. 2017;). For example, CT is used to control erosion, improve crop productivity, and improve farm efficiency and profitability (USDA-NRCS, Bista et al. 2017). CT significantly reduces fuel use and carbon emissions (USDA-NRCS 2016). Cover crops, planted during the fallow or bare period, are used to improve soil health, nutrient cycling, moisture retention, and can reduce pest, weed, and disease pressure (Clark, 2015). Despite these benefits, adoption of conservation tillage and cover crops vary widely (Wade, Claasen and Wallander 2015; USDA-NRCS 2019). The lack of adoption contributes to widespread environmental degradation, reduced soil and water quality, and threatens farmers' livelihoods (Morrow, Huggins, Reganold, 2017; Balmford et al 2018).

In an attempt to improve adoption rates, researchers have sought to understand the factors that determine on-farm conservation adoption, but few variables are consistently associated with adoption (Knowler and Bradshaw 2007; Prokopy 2008; Prokopy 2019). Furthermore, policy makers have relied heavily on technological advancement and financial incentives to encourage adoption behavior. However, research has identified that the characteristics of the practice, local context, and other forms of capital—like social and cultural capital— are important in farmers' adoption process. Researchers have drawn from Rogers' (1995) diffusion of innovations theory and the "good farmer" literature, grounded in Bourdieusian concepts to better understand the adoption of cover crops and conservation tillage in the inland Pacific Northwest (PNW) (Rogers 1995;2003; Pannell 2006; Burton 2004; Burton et al. 2008).

The thesis uses qualitative social science methods to better the adoption of cover crops and conservation tillage across the PNW. For chapter one of this thesis we draw from semi-structured interviews (n=28) with crop and livestock farmers and focus groups (n=61) with agricultural stakeholders to understand farmers' perceptions on the adoptability of cover crops. For chapter two, we draw from the same semi-structured interviews with crop and livestock farmers.

Chapter 1

The diffusion of innovations theory (hereafter, diffusions) has been used extensively by researchers to understand the process through which an innovation is adopted amongst members of a social system over time (Padel, 2001; Rogers 2003). Rogers and Pannell (2006) assert that a practice is more readily adopted when it has a high relative advantage and high trialability. Relative advantage refers to the degree to which an innovation is economically and agronomically compatible within the current farming operation (Rogers 2003; Pannell 2006). Trialability refers to the degree to which an innovation is easy to experiment with and easy to learn from (Rogers 2003; Pannell 2006). We focus on understanding how the characteristics of the innovation impact its perceived adoptability

Recent research has used the diffusions literature to explore the adoption of organic management systems, cover crops, livestock integration, riparian buffers, and wetland restoration efforts Padel, 2001; Atwell, Schulte, & Westphal, 2009; Wu & Zhang, 2013, Senyolo, Long, Blok, & Omta, 2018). However, research on the adoption of cover crops has taken place primarily in the Midwest, with little consideration given to regions with different climate and cropping regimes, like the inland Pacific Northwest (Dunn et al., 2016; Bergtold, Ramsey, Maddy, & Williams, 2017; Roesch-McNally et al., 2017; Plastina, Liu, Miguez, & Carlson, 2018). Although efforts to quantify the agronomic and economic benefits of cover crops is ongoing (Atwell, Schulte and Westphal, 2009; Pavek, 2014a; Golden *et al.*, 2016), there is a lack of qualitative social science on how farmers perceive the relative advantage and trialability of cover crops in the PNW.

For chapter one, the research questions include: 1) how do farmers views on the relative advantage and trialability of cover crops contribute to perspectives on the feasibility of the practice region-wise?; and 2) How do stakeholders view potential pathways to improve the relative advantage and trialability of cover crops in the region? Results from semi-structured interviews with farmers suggest that cover crops, in the context of the PNW, are perceived as incompatible with the climate and cropping rotations of the region. Furthermore, a lack of easily observable benefits of the practice and a time lag between visible results contributes to perceptions of low trialability. Perceptions of economic feasibility were compounded by a lack of region and zone-specific agronomic and economic information. Focus groups with agricultural stakeholders suggest several ways to improve adoption strategies that we expand on in chapter one. Our results suggest that understanding the unique management goals of farmers within the environmental, social, and economic context in which they operate will better inform local conservation policies, practices, and future adoption strategies.

Chapter 2

For the second chapter, we draw from the 'good farmer' literature, which has emerged out of Bourdieusian concepts of field, habitus, and capital to understand how agricultural change occurs. Bourdieu (1986) contends the agricultural field consists of a network of social relations and that behavior is produced and reinforced through forms of capital; economic, social, cultural and symbolic capital. Symbolic capital, as representation of each form of capital, becomes important for how understanding how individuals evaluate themselves and each other. Within the agricultural field, symbols associated with good farming are consistent with the productivist ideals and include straight, weed free fields (Burton 2004; Burton et al 2008). Burton (2004) and Burton et al. (2008) posit that conservation practices often fail to become widely accepted amongst members of the farming community because they do not allow farmers to demonstrate and display symbols of good farming (Raedeke et al. 2003; Dentzman and Goldberger 2019; Thomas, Riley and Spees, 2019). However, researchers have identified that the transition to organic production systems has been more readily accepted by the farmer community because organic systems are considered profitable and more in line with productivist values (L. Sutherland and Darnhofer, 2012; Sutherland, 2013; Saunders, 2016). The good farmer lens has been applied to understand farmers' transition to organic system, but it has not been used to understand farmers' engagement with CT.

CT systems are increasingly adopted to reduce inputs costs, improve soil resources and improve farming efficiency and productivity (Bista, Prakriti, Machado, Stephen, Ghimire, Rajan, Yorgey, Georgine, Wysocki, 2017). Engagement with CT systems may also allow farmers to more effectively balance short-term productivist goals with long-term conservationist goals and improve farmers' relationship to soil resources (Coughenour, 2009; Roesch-McNally, Arbuckle and Tyndall, 2018).

For the second chapter, the primary research questions include: 1) How does the engagement with CT systems help farmers reconcile productivist and conservationist goals across economic, social, and cultural capital?; and 2) How have historical soil management trends shaped farmers' perception of symbols of good farming? Results from the same semi-structured (n=28) suggest that engagement with CT systems allow farmers to reconcile productivist goals and stewardship goals across cultural, economic, and social capital. In addition, symbols of good farming and farmers' habitus are shaped by, and reactive to, historical trends towards erosion and soil management. Engagement with CT allows farmers to demonstrate productivist symbols of good farming (e.g., weed free fields, straight rows), while simultaneously supporting farmers' efforts to reduce erosion. Therefore, farmers are able to demonstrate culturally relevant symbols that align with productivist and stewardship goals. Demonstration of such symbols are used to reinforce farmers' reputation amongst their peers, neighbors, and future generations. Farmers in our study realized that soil loss is inextricably linked to reduced economic capital. Engagement with CT also supports farmers' economic goals by reducing inputs associated with fuel, time, and labor, and reducing erosion. As stated above, farmers' engagement with CT was also linked to maintaining relationships with peers, landowners, and future generations. Thus, engagement with CT helps to reconcile farmers' productivist goals and stewardship goals. The results from this study contribute to the good farmer literature by suggesting that symbols of good farming are shaped by the cultural context. We recommend that conservation practitioners focus on devising approaches to support social and cultural capital development alongside economic capital development. University researchers can also include farmers as co-investigators in research efforts and focus on long-term conservation research outcomes.

Increasing the adoption of on-farm conservation practices like cover crops and conservation tillage can reduce erosion, improve soil and water quality, and improve economic outcomes for farmers. The results of this thesis demonstrate that leveraging farmers' and agricultural stakeholders' perspectives on such practices can better inform recommendations that are tailored to the unique cultural, social, and economic needs of the community. Lastly, results and methodologies described in this thesis can better inform research efforts that seek to support farmers' long-term engagement with on-farm conservation practices that can mitigate the effects of climate change, improve on-farm resilience, and improve soil and water quality across the nation.

Chapter 1: Using diffusion of innovations theory to understand agricultural farmer perspectives on cover cropping in the inland Pacific Northwest

Abstract

There is renewed interest in the promotion of cover crops on farms, planted during the fallow period or in place of a cash crop to improve soil and water quality. Despite extensive research suggesting that the practice can enhance on-farm resilience, cover crop use is not widespread, especially across the dryland wheat-growing region of the United States inland Pacific Northwest. Cover crops are being promoted across this region as a means to improve agronomic conditions and farmer livelihoods. Yet, there is a lack of agricultural farmer-centered social research to understand the regional and field-level challenges associated with the practice. To address this gap, we draw from the diffusion of innovations theory to examine the perceived relative advantage (the degree to which an innovation is compatible with the current system) and trialability (how easily potential adopters can try an innovation) of cover crops. We conducted interviews and focus groups with farmers to examine how cover crop characteristics may contribute to the lack of adoption in the region. In addition, we explored potential avenues for improving the integration of cover crops into existing cropping systems through focus groups with agricultural stakeholders. Analysis of interviews with dryland crop and livestock farmers (n=28) suggested that perceptions of low relative advantage, including low compatibility with common regional management systems, perceived lack of profitability, and increased cost of inputs act as deterrents to cover crop integration. Low trialability was associated with a lack of directly observable results, the complexity of experimentation, and inflexible regional policies. These perceptions were compounded by a lack of region- and zone-specific agronomic and economic information on cover crops. Analysis of focus groups (n=61) with crop and livestock farmers and agricultural stakeholders suggested that increasing relative advantage and trialability through multiple pathways will improve potential adoption strategies. Understanding the unique management goals of farmers within the environmental, social, and economic context in which they operate will better inform regional policies, outreach, and future adoption strategies.

Keywords: agricultural farmer perspectives, cover crops, diffusion of innovations, relative advantage, trialability.

Introduction

A renewed emphasis on sustainable agriculture and soil health by federal agencies, farming, and environmental stewardship groups has led to the increased promotion of cover crops in the United States (Hamilton, Mortensen and Allen, 2017). Cover crops, planted on farms during the fallow period or in place of a cash crop, are used to improve soil and water quality, decrease erosion, reduce weed and pest pressure, and build on-farm resilience (Lin, 2011; Larkin, 2015). Cover cropping also helps to mitigate the projected effects of climate change, which could exacerbate issues of erosion and drought and lead to reduced cropping system flexibility (Huggins *et al.*, 2013; Kaur *et al.*, 2015, 2017; Morrow, Huggins and Reganold, 2017). Although the number of cropland acres planted in cover crops has increased by nearly 50% in the past five years, adoption is low across the dryland wheat-growing region of the inland Pacific Northwest (iPNW) (USDA-NASS, 2019). Historically used as forage for livestock and as a nitrogen supplement in the iPNW, the practice became less popular during the 1950s-1960s as the use of synthetic fertilizers increased (Schillinger and Papendick, 2008; Pan et al., 2017). More recent efforts to improve fallow practices, increase rotational diversity, and mitigate erosion have influenced more agronomic and economic feasibility studies of cover crops (Kirby *et al.*, 2017). Yet farmers across the iPNW are constrained in their ability to incorporate cover crops into their existing systems by a lack of sufficient regional support and information to make informed decisions about the practice. This work response to calls for research on processes leading to the adoption of agricultural innovations, and for research on region-specific factors affecting diffusion of innovations (Nowak, 1991; Smit and Skinner, 2002; Pannell *et al.*, 2006; Hamilton, Mortensen and Allen, 2017).

We draw on the diffusion of innovations theory to explain cover crop adoption in the region; a theory has been used extensively to examine the process through which agricultural innovations are adopted across time. In more recent work, diffusion of innovations has been used to explore the adoption of organic management systems, cover crops, pasture, riparian buffers and restored wetlands (Padel, 2001; Atwell, Schulte, & Westphal, 2009; Wu & Zhang, 2013, Senyolo, Long, Blok, & Omta, 2018). Important for our study is the examination of how the characteristics of an innovation impact the process of adoption (Ryan and Gross, 1943; Fliegel and Kivlin, 1966; Wejnert, 2002; Senyolo et al., 2018). Cover cropping may be considered an innovative practice by some farmers, given the renewed promotion of the practice across the region. Additionally, as Rogers (2002) posits, whether an innovation is taken up depends on how the practice is perceived by farmers across the region, rather than the novelty of the innovation. Rogers (2003) identifies five characteristics of an innovation to help explain the varying rates of adoption. In this paper, we focus on two main components: relative advantage (the degree to which an innovation is compatible with the current system) and trialability (how easily potential adopters can try an innovation). Pannell et al. (2006) consider relative advantage and trialability to be the two significant characteristics that affect the rate of adoption. We describe these two characteristics further in the literature review section.

Social science research to examine the feasibility of cover crops has taken place mainly in the Midwest, a region with significantly higher precipitation than the iPNW, and different primary crops (e.g., corn and soybeans) (Dunn et al., 2016; Bergtold, Ramsey, Maddy, & Williams, 2017; Roesch-McNally et al., 2017; Plastina, Liu, Miguez, & Carlson, 2018). In contrast, the dryland wheat-growing region of the iPNW is characterized by a Mediterranean-like climate that consists of three major agroecological zones defined by average annual precipitation and percent fallow (Schillinger et al., 2003). Crop rotations, topography, and soil type differ across the iPNW, although crop diversity is low (Huggins, Pan, Schillinger, & Young, 2013; Schillinger & Papendick, 2008). There are significant agronomic challenges to cover cropping, including weed competition, moisture availability, and planting and termination timing. Economic challenges include the potential increased cost of seed, time and labor, short growing seasons, and uncertain effects of cover crops on cash crop yield (Pavek, 2014; Thompson & Carter, 2014; Kirby et al., 2017). Research efforts to quantify the agronomic and economic efficacy of the practice are ongoing, yet little social science research has been conducted to understand how farmers perceive the characteristics of the practice and mechanisms for overcoming barriers (with the exception several studies: Mallory et al., 2001; Sowers et al., 2011, 2012; Lorent et al., 2016; Yorgey et al., 2017).

It is critical to understand farmers' perspectives on an innovative practice so that information and implementation strategies can be tailored to make the practice as feasible as possible within farmers' particular environmental and socioeconomic contexts (Vanclay, 2004; Ahnström et al., 2008; Knapp & Fernandez-Gimenez, 2009; Lemke et al., 2010; Prokopy, Morton, Arbuckle, Mase, & Wilke, 2015; Yorgey et al., 2017; Prokopy et al., 2019). The failure to identify and acknowledge differences in individual production systems and barriers contribute to low perceptions of feasibility by farmers and thus prevent practice adoption (Barr and Cary, 2000; D. J. Pannell et al., 2006; Adger et al., 2009). The broad aim of this research is to understand farmer perceptions of the relative advantage and trialability of cover crops and to co-produce actionable recommendations for farmers and other stakeholders. In partnership with a soil and water conservation district in eastern Washington, we conducted semi-structured interviews and focus groups to explore the following questions:

1. How do farmer views on the relative advantage and trialability of cover crops contribute to perspectives on the feasibility of the practice region-wide?

2. How do stakeholders view potential pathways to improve the relative advantage and trialability of cover crops?

Literature Review

Socio-demographic and socio-psychological factors are frequently examined to determine whether or not a farmer is likely to adopt conservation practices (Knowler & Bradshaw, 2007; Prokopy, Floress, Klotthor-Weinkauf, & Baumgart-Getz, 2008). Yet research from the past decade suggests that these factors are inconsistently used and measured (Baumgart-Getz, Prokopy, & Floress, 2012; Prokopy et al., 2008). A recent meta-analysis indicated that variables including environmental attitudes, a positive attitude towards a particular program promoting a practice, and previous adoption of other conservation practices, are positively associated with conservation practice adoption (Prokopy *et al.*, 2019). Lack of stable predictors of adoption leads to a need for social science research that is more flexible, context-specific, and capable of uncovering unanticipated factors that have been overlooked or not previously identified (Sayre & Fernandez-Gimenez, 2004).

Diffusion of innovations theory describes the process through which an innovation is adopted over time among the members of a social system (Rogers 2003). Historically, this theory has been employed to help extension researchers target activities that facilitate and promote agricultural innovations (Padel, 2001; Rogers, 2003). There are two major frames used to describe and evaluate the process of adopting an innovation. The first frame characterizes farmers on a spectrum from innovators to laggards and is interested in the rate at which an innovation is adopted (Rogers, 2003). The second frame describes the characteristics of the innovation to better understand how its relative advantage, compatibility, trialability, complexity, and observability (defined below) impact the processes associated with adoption (Ryan and Gross, 1943; Fliegel and Kivlin, 1966; Barr and Cary, 2000; Rogers, 2002; Marra, Pannell and Abadi Ghadim, 2003). Adoption of an innovation is described as a learning process that includes the collection, integration, and evaluation of new information to inform the decision-making process. As Pannell et al. (2006) state, “early in the process, uncertainty about the innovation is high, and the quality of decision making may be low. As the process continues, if it proceeds at all, farmer uncertainty may be reduced, and more informed decisions can be made.” Availability of and access to quality information are deemed important factors in determining the adoptability of a practice (Genius, Pantzios, and Tzouvelekas, 2006; Baumgart-Getz, Prokopy and Floress, 2012). Perceived risk, the effect of regional government policies and institutional factors like land tenure also contribute to perceived adoptability of a practice (Lockie et al., 1995; Marra, Pannell, & Abadi Ghadim, 2003; D. J. Pannell et al., 2006; Rodriguez, Molnar, Fazio, Sydnor, & Lowe, 2009; Ranjan et al., 2019). Determining ways to integrate cover crops that are practical for the farmer, economically feasible and suitable for the region may be a more effective strategy than broadly promoting a practice without consideration of farmer goals and regional constraints (Vanclay, 2004; Ahnström et al., 2008; Knapp & Fernandez-Gimenez, 2009; Lemke et al., 2010; Prokopy, Morton, Arbuckle, Mase, & Wilke, 2015; Yorgey et al., 2017).

Pannell et al. (2006) posit that relative advantage and trialability to be the two major categories that affect the rate of adoption (Pannell et al., 2006), and we follow their suggestion by focusing on these two characteristics in this study. Relative advantage describes the degree to which an innovation is compatible with and is superior to the current system and depends on regional economic, social, and environmental factors. Trialability refers to how easily it is to learn from the experimentation phase and move to the adoption phase (Rogers, 2003). Seminal work by Ryan and Gross (1943) suggests that if an innovation is deemed as less risky, more economically feasible, and directly relatable to the needs of the farmer, it may be more readily adopted. More recent research suggests that short-term input costs, impact on long-term profitability and compatibility with the current management system affect adoption (Geurin & Geurin, 1994; Marsh, Pannell, & Lindner, 2000; Ghadim, Pannell, & Burton, 2005; Pannell et al., 2006; Melorose, Perroy, & Careas, 2015; Plastina et al., 2018). An innovation with a delay in desired outcomes or results may be perceived as having low short-term advantage and thus have a slower rate of adoption than innovations that have clear positive impacts on management outcomes in the short-term (Pannell et al., 2006).

Challenges related to relative advantage and trialability

Specific to relative advantage in cover crops, current research has found that they incur significant direct and indirect costs that contribute to their perceived low levels of adoptability. These costs include the direct cost of seed, fertilization, and termination and the potential cost associated with loss or reduction of the following cash crop (Snapp, Swinton, Labarta, & Black, 2003; Bergtold, Duffy, Hite, & Raper, 2012; Bergtold et al., 2017). Dunn et al. (2016) note that farmers who perceive an increase in management difficulties and costs associated with integration tend to discontinue use. Across the iPNW, preliminary research indicates considerable economic challenges associated with cover crops that include the cost of seed, labor, and impact on subsequent cash crops (Thompson & Carter, 2014; Kirby et al., 2017).

Trialability often includes the relative complexity of integrating the practice and the degree to which results of the implementation are easily observed as successful in the field, to an adopter, and other observers. High observability reduces the uncertainty of the practice and improves peer to peer learning by stakeholders, especially if it is deemed successful by the farmer and the peer group (Shampine, 1998; Pannell *et al.*, 2006)

Research on the adoption of conservation practices indicates that factors like low observability of results and a time lag between treatment and observed effect contribute to the lack of adoption (Rodriguez et al., 2009). Roesch-McNally et al. (2017) found, in interviews with farmers trying to cover crops, found that the most frequently mentioned field-level challenges were associated with determining the most effective planting and terminating times. The choice of cover crop species depends on the "existing rotations, field conditions, weather, and costs" (Plastina et al., 2018). Across the iPNW, significant field-level management challenges include weed competition, moisture availability, planting and terminating time, and uncertainty regarding best cover crop species types (Pavek, 2014; Thompson & Carter, 2014; Kirby et al., 2017). See Table 1 for a summarized list of potential benefits and challenges to integrating cover crops.

Pathways to increase relative advantage and trialability

The diffusion literature considers the adoption of any innovation a process that takes time and may be viewed as a kind of "uncertainty-reduction." As Rogers (1995) states, "when individuals …pass through the innovation-decision process, they are motivated to seek information to decrease uncertainty about the relative advantage of a practice." Uncertainty is reduced through the acquisition of knowledge and experience. To be more readily adopted, a practice should ideally have a low degree of complexity and have a high degree of observability (Geurin & Geurin, 1994; Rogers, 2003). Improving field-level observability, understanding of benefits, and reducing the perceived complexity of the practice helps to strengthen perceptions of trialability (Dunn et al., 2016). Öhlmér, Olson & Brehmer (1998) note that farmers prefer a "quick and simple vs. detailed and elaborate analysis, small tests, and incremental implementation…" (pp. 273).

Identifying strategies that increase relative advantage and trialability can reduce uncertainty about a practice and improve the decision-making process (Rogers, 1995). Dunn et al. (2016) and Burnett, Wilson, Heeren, & Martin (2018) found that farmer's belief in the agronomic benefits of cover crops like reduced soil erosion, nutrient loss, and improved soil productivity positively predicted use. Offering incentives to adopters may be one way to improve the relative advantage of a practice. For example, the U.S. Department of Agriculture's (USDA) Environmental Quality Incentives Program (EQIP) offers direct payments for adopting certain conservation practices, although these payments are on a limited time scale (Stubbs, 2014), and might not ensure long-term adoption (Rogers, 1995; Riley, 2016). Atwell, Schulte, and Westphal (2009) suggest that for perennial crop systems to be readily adopted, the practice must be compatible with individual profitability goals, priorities, methods, and technologies. Cover crop adoption, in particular, was associated with high compatibility with the current management system, an understanding of advantages over alternative practices and the availability of cost-share payments (Singer, Kaspar, and Pedersen, 2007; Reimer, Thompson, & Prokopy, 2012; Arbuckle J.G, Roesch-McNally, 2015). To improve short-term economic feasibility, farmers in Iowa suggested an increase in on-farm crop diversification and through the integration of livestock (Singer, Kaspar, and Pedersen, 2007; Roesch-McNally et al., 2017). Other factors that bolster adoption strategies include developing external network links with peers. By building and enhancing relationships between landholders, scientists, extension agents, landholders, and private companies, stakeholders may better reach regional conservation outcomes and goals (Sobels, Curtis, & Lockie, 2001). Improving access to knowledge organizations and shifting federal policies to account for the regional environmental, social, and economic context also supports adoption strategies (Knapp & Fernandez-Gimenez, 2009; Blesh & Wolf, 2014).

Pan et al. (2017) examined the complex factors that affect the adoption of best management practices across the iPNW. Their research suggests that regional biophysical, socio-economic, and policy drivers affect the adoption of reduced tillage practices, residue management, organic carbon recycling, and increased crop diversification and intensification. The authors point to the need for "win-win scenarios" across the iPNW that promote "short-term improvements in farm economics, markets diversification, resource efficiency and soil health," and that account for the diversity of production zones. For example, integrating livestock and increasing crop diversification is one way to reconcile short and long-term economic profitability and meet soil health goals (Finkelnburg, Hart, & Church, 2016; Roesch-McNally et al., 2017). Beyond profitability, Tosakana et al. (2010) contend that maintaining long-term observation sites is essential for shifting perceptions of conservation practices.

Table 1.1. Agronomic benefits and challenges associated with the relative advantage and trialability of cover crops.

Practice	Agronomic Benefits	Challenge: relative advantage	**Challenge: Trialability**
Cover crops (overall)	Wind and water erosion reduction, increased soil organic matter, nitrogen fixation, redistribution, increased biodiversity, reduced soil compaction	Requires fitting into current management practices and crop rotations, highly variable across the iPNW, increase cost, time, labor	May depend on rotation, species and agro-ecological zone
Specific cover crop type: Legumes (clovers, vetch, peas, beans),	Nitrogen fixing, erosion control, support beneficial insects and pollinators, increase organic matter	Highly variable adaptability to climate and soil conditions across the iPNW, increase cost, time, labor	Highly complex: differ in their productivity and adaptability to soil and climatic conditions
Non-Legumes (rye, wheat, barley, oats, triticale, forage grasses, broad leaf species (buckwheat, sunflower, mustards, brassicas)	Nitrogen scavenging, erosion control, suppress weeds, increase organic matter	Species and functions vary depending on climatic conditions, uncertain economic impact, potential increase cost, time, labor	Lack of observable results: nitrogen scavenging plants may take multiple, consistent trials to be able to reduce nitrogen fertilizer inputs, depends on soil conditions
Mixtures / "cocktails" (combined grasses and legumes)	Biomass and nitrogen increase, combined benefits of legumes and non-legumes	Mixes are costly and require more complex management practices due to the diversity of species and function, can create too much residue	Highly complex: meeting multiple objectives at once and variability in biomass production and moisture absorption
			Summarized from: (Clark, 2007 and Pavek,2014)

Methods

Study Area

Characterized by a Mediterranean-type climate with warm, dry summers and cool, wet winters, the iPNW encompasses the semi-arid portion of Central Washington, Northeast Oregon, and Northern Idaho (Figure 1.1) (Eigenbrode et al., 2013). Precipitation gradually increases from West to East and can be a significant limiting factor for increasing crop diversity across the three agro-ecological classes (AEC's) in the iPNW (Kruger et al., 2017). Cropping system diversity increases from the grain-fallow (40% fallow) to the annual crop-fallow transition (10-40% fallow) and the continuous cropping region (<10% fallow). The primary purpose of the fallow period is to store winter precipitation, ensure economic crop yield, and reduces the risk of crop failure (Schillinger et al., 2003). Winter wheat is the most profitable crop grown and accounts for 40-45% of crop area across the region. Barley, pea, lentil, chickpea, canola, and condiment mustard are produced in smaller acres across the region (Schillinger et al., 2003). Crop diversification in the iPNW is lower across the three agro-ecological classes than other areas with similar climate types (Schillinger et al., 2003; Karimi, Stöckle, Higgins, Nelson, & Huggins, 2017; Maaz et al., 2018). Farmers in this region are experimenting with a diverse range and mix of cover crop species, including, brassicas (e.g., turnips, daikon radish), legumes (e.g. peas, vetch, clover, alfalfa), some grass species (e.g. millet, rye, oats) and oilseeds (e.g. sunflower, canola).

We utilized a mixed-methods qualitative research design to examine farmer and stakeholder perspectives on the relative advantage and trialability of cover cropping. We conducted semi-structured interviews with crop and livestock farmers to understand the challenges associated with the characteristics of cover crops. We also ran focus groups with agricultural stakeholders across the dryland wheat-growing region of Northern Idaho and Eastern Washington to examine how challenges to adopting cover crops may be reconciled. These qualitative social science methods can allow understanding of the unique experiences and opinions of farmers, which may not be represented clearly in other methods like surveys (Sayre, 2004; Warr, 2005). We sought to interview both farmers who are currently experimenting with cover crops and those who have not previously integrated cover crops. Local conservation district staff provided an initial list of crop and livestock farmers. We then used snowball sampling to identify more relevant interviewees. We conducted on-farm, face-to-face interviews during Fall 2018 and Spring 2019. Interviews were digitally recorded with farmer consent (with Internal Review Board approval, 2018), each ranging from 30 minutes to 2.5 hours. Farmers were asked to describe their agronomic management practices, including crop rotation and tillage systems, experience with conservation practices, and experience with cover crop integration.

Questions about cover crops included current practices, perspectives on barriers, and resources needed to facilitate adoption. Farmers were also asked about where they went for information and about their response to adverse pest, weed, and weather events. See Appendix A for relevant sections of the interview guide.

We conducted eight focus groups at the Alternative Cropping Symposium on February 27th, 2019 in close collaboration with the Palouse Conservation District. Recruitment of participants was done by District staff, and attendance was open to the public. The eight focus groups (n=61) consisted of a diverse set of stakeholders, including local and federal conservation staff, University researchers, industry agronomists, crop advisors, and crop and livestock farmers. Each focus group lasted approximately 1 hour. Participants were asked to describe the primary differences between a cover crop and alternative crop, the primary purpose of a cover crop, and what it would take to be able to integrate a cover crop within their current management system. Lastly, participants voted on the idea that most resonated or mattered to them using a prioritization process (Appendix A).

Interview and focus group data were transcribed verbatim and analyzed using the NVivo 12 software package. We analyzed interview and focus group data using a thematic analysis approach (Bernard, Ryan, and Wayne, 2010). We conducted an initial round of descriptive coding and memo writing, followed by a second round and iterative round of thematic coding (Bernard, Ryan, and Wayne, 2010). The codes corresponded to the questions from the interview guide. We then grouped themes from the initial round of coding into themes according to the innovations framework, and these included relative advantage, compatibility, short-term economic profitability, trainability, complexity, and observability. We report our subjects using anonymized numbers.

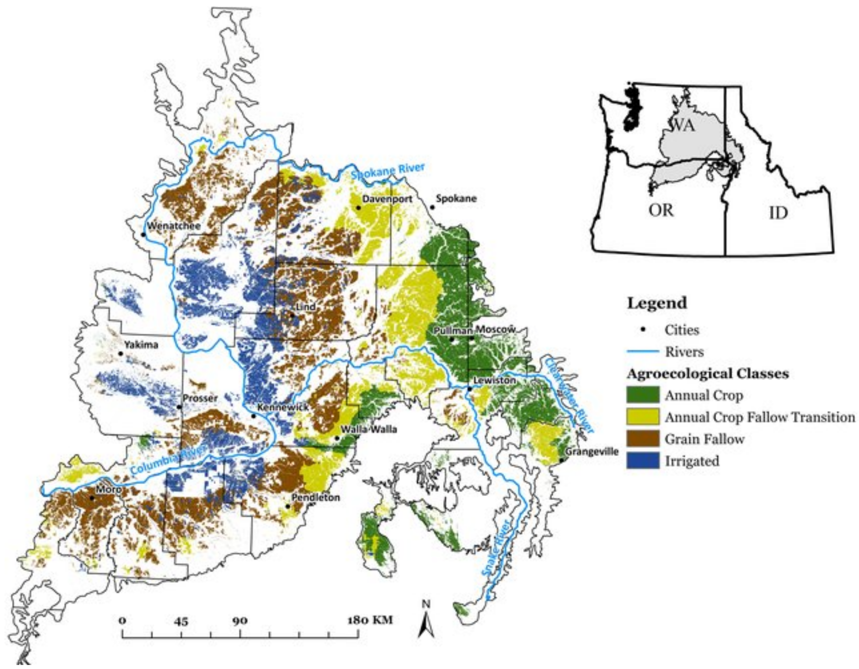

Figure 1.1. The three primary agroecological classes of the PNW of eastern, Washington, northern Idaho, and northern eastern Oregon. We do not include the irrigated cropping region as part of our study area. Map created by Harismran Kaur and used with permission.

Results

We conducted semi-structured interviews with 28 crop and livestock farmers, all of whom were male. Farm and farmer characteristics have been summarized in Table 2. Crop rotations practiced on participants' farms were diverse across the three agroecological zones[1]. All of the farmers grew and harvested winter wheat, spring wheat, and barley within their rotation, consistent with regional trends (Huggins et al., 2013). Farmers within the annual crop-fallow transition zone produced the highest diversity of crops, with the dominant rotation consisting of a cereals, legumes, and oilseed. Farmers in the grain-fallow region had the least diverse rotation of a cereal and oilseed crop, though one farmer in our sample integrated legumes. A majority of farmers in the focus groups (n=21) were currently using cover crops in their operations and farmed in the annual-cropping zone.

Due to the limited adoption of cover crops in this region and the wide range of farmer experience, we consider an individual to be an adopter if they experimented with cover crops over more than five acres for more than one season, and either self-funded or with support from a program. Our sample of interviewees included 18 adopters. Non-adopters pertain to those farmers who have not

[1]. Reporting of harvested crops is grouped into broad categories for simplicity but does not reflect the diversity of crop rotation for individual farms.

experimented with or participated in cover crop trials. Most cover crop adopters in our sample experimented with summer, fall, and spring plantings of a diverse range of cover crop species (both individual species and mixes) for between 1 and 6 years. Adopters reported experimenting with a diverse range of warm and cool-season cover crop mixes, including brassicas, legumes, some grass species, and oilseeds. Farmer perceptions of the relative advantage and trialability of cover crops have been summarized in Table 3. This table includes potential pathways for improving perceptions of adoptability, as identified during farmer interviews and focus group discussions.

Table 1.2. Interview participant and farm characteristics

Interviewee Group	**Interviewee Number**	**Total**	**Livestock Integration**	**Average Acreage**	**Cover crop Trial experience**	**Cover crop trial Acreage (range)**
Adopters	1-11, 13, 16, 18, 19, 23, 24, 26	18	10	3,805	1-6 years	5-300 acres
Non-adopters	12, 14, 15, 17, 20-22, 25, 27, 28	10	2	2,590	0	-
Total		28	12	3,197.5*	-	-

*regional average is 3,500 acres (Schillinger & Papendick, 2008)

Farmer perceptions of relative advantage

Farmers within our study region perceived cover crops as having a low relative advantage, given two major environmental and economic factors. First, farmers perceive low compatibility of cover crops within the current agronomic systems due to 1) the specific climate in which they operate, and 2) a lack of perceived short-term profitability. These challenges were often described as compounded by a lack of current region-and site-specific research and information. Farmer 11, who operates in the annual-crop zone, explained that given the recent interest in cover cropping, farmers are still in the process of determining the most effective strategies for integrating cover crops in the region:

> I mean, in the short term, the last five years I would say, is where things have really started to change in the advent of cover cropping in the Northwest. Five years ago, it wasn't part of the discussion at all. So that's evolving as well around here. We're still trying to figure it out (11).

With regard to environmental compatibility, farmers often expressed how the lack of timely, seasonal moisture limited their ability to integrate an additional crop that is outside of the current crop rotation. Moisture availability was identified as a challenge for all farmers in our study, regardless of their agroecological cropping zone. The climatic regimes, especially given the short window for planting and the potential for winter freeze, increases the risk of trial failure and uncertainty. These challenges were often discussed in comparison to the midwestern states, where a majority of research on cover cropping takes place. Notably, the midwestern climate and cropping rotations are significantly different from the iPNW. Farmer 11, for example, had experimented with cover crops for three years in the annual cropping zone. He discussed how these regional climatic characteristics and current management practices limited adequate cover crop growth and thus posed a challenge to cover crop integration:

> When harvest ends at the end of August…we, haven't had rain for three months, for the most part. And so putting a cover crop on that ground that's going to be idle through the winter is tough, because most of them need a month or two to grow, so they don't freeze out in the winter around here. And we may not have a month or two where they will actually grow, because of moisture. It's pretty dry right now. I don't see any rain in the forecast for several weeks yet, and we're already freezing. So there's two different things that are a challenge for growing cover crops (11).

Many farmers across the region, regardless of the agroecological zone, expressed uncertainty regarding which cover crop species would be suitable for the region and their unique management goals. One farmer, operating in the annual crop-fallow transition zone, had experimented with cover crops "on and off" for six years. Despite his experience utilizing cover crops, he had yet to determine which species might flourish in low moisture and harsh winter regime. He expressed uncertainty regarding what he will be able to integrate within his unique operation, especially given the lack of regional moisture availability:

> …We need something that germinates on low moisture and is winter-hardy. And I just don't know what that is…If what we go from planting something in the fall and

> harvesting next year, it can be done. What is it? That's the question I want answered because fall establishment, to me, is what's going to make it work…(1).

In addition to low environmental compatibility, cover cropping is associated with a lack of economic feasibility. Cover crops were often associated in interviews with the displacement of a crop cycle, a lack of net returns and increased inputs costs (e.g. seed, fertilizer, time and labor). These challenges were often discussed in tandem with regional concerns about the rising cost of inputs such as fertilizer, land, and equipment. Commodity market fluctuations also led many farmers to stay conservative when contemplating additional financial risk. This barrier was articulated by Farmer 6, in the annual cropping zone, who has experimented with cover crops and livestock integration. He explained that the displacement of a crop cycle and the uncertain impacts on the subsequent cash crop is a challenge for long-term integration. This farmer also noted the discrepancy that occurs between widespread promotion and regional feasibility of the practice:

> We displaced a crop cycle…we're still spending money and having to cover the land cost hoping we get it back in some form the following year in the winter wheat. It was a long way away from happening. And it's frustrating for us. We're being pushed to go to cover crop rotations and so on because it works elsewhere (6).

Farmer 10, in the annual cropping region, has been trialing cover crops with livestock for three years. He discussed the risk associated with displacing the crop cycle, especially when lease agreements constrain farmers. He articulated how the lack of economic feasibility and additional management requirements often constrain farmers that have limited options, to begin with.

> …You do forego a crop. Because if you're going to do a cover crop and you do it in sequence to whatever, put it into your rotation, but not use it as a nurse crop, you forego income on that. And if there are rents, if you're answering to landlords, yeah. Yeah. It just it's not feasible economically for a lot of people. And it takes a different type of management that a lot of the farmers don't even have the time and wherewithal to do (10).

Cover crops were frequently associated with a lack of environmental and economic feasibility in our interviews. While some farmers were in the midst of overcoming significant challenges, they repeatedly expressed a willingness to continue experimenting to improve soil health, increase crop diversity, and mitigate erosion. However, some non-adopters perceived these challenges as intractable.

Farmer perceptions of trialability

Farmers associate cover cropping with low trialability because numerous management decisions are required to integrate them into a farm system. Farmers discussed having to manage many field-level management decisions, including the function and purpose of the cover crop; the most effective establishment methods (i.e., equipment type); the species type (e.g., single or blended mix); planting and termination times; and potential additional weed, pest and disease pressure. Farmer 13, operating in the annual-crop, fallow transition zone, has experimented with cover crops on a five-acre trial in partnership with a local conservation district. He described the complexity of determining planting and terminating times when also navigating potential weeds (i.e., cheatgrass) issues. This quote also illuminated the possible increase of chemicals needed to reduce the proliferation of weeds:

> …we put some in, in the fall…but what happens too is [that] it gets full of cheat grass. So we have to spray it out first thing in the spring anyway. So you can't really let it go. You got to spray it out…[they] wanted us to keep it longer but it's like, you have to spray it out...We got cheat grass in it we can't let go to seed, so we have to spray it out. And so we did. So we weren't a big help…you know (13).

In addition to complex management decisions, farmers discussed the lack of directly observable outcomes from short-term trials as a challenge to trialability. Given the wide variety of cover crop species and mixes available, farmers expressed uncertainty about which species were best for their farms. Short-term and small acreage trials may be more economically feasible for both farmers and researchers but were often discussed as yielding inconsistent and inconclusive results. The potential time lag of soil health benefits also contributed to perceptions of low trialability. Farmer 24, a crop and livestock farmer operating in the annual crop-fallow transition zone, had experimented with cover crops as a means to improve moisture retention on his farm. He described observing above-ground crop failure initially, but closer inspection revealed potential moisture retention, a benefit for his operation:

> You want to see something fascinating? Around the 1st of September… this was another failure: dry, dry, dry. I would have told you everything was dead until you got down on your hands and knees…You could squeeze just a little bit of something out of [the soil], juice, moisture, I don't know. Don't quote me on scientific terms (24).

The perceived failure of the cover crops to meet the intended purposes of the practice, i.e., moisture retention, contributed to perceptions of low observability. The inability to discern benefits in the short-term adds to increased uncertainty for implementing the practice long-term. As this farmer suggests, cover crops may have significant below-ground impacts that are not highly observable in short-term trials.

The role of federal crop insurance policies

Field-level trialability challenges are further impeded by a lack of regionally appropriate crop insurance policies. Cover crops are recognized through crop insurance as a tool for erosion control, or for other conservation purposes. However, regional crop insurance policies do not currently have an approved list of cover crop species. To address this issue, farmers have consulted with local agricultural insurance agents. For example, Farmer 19 operates in the grain-fallow region and has been trialing cover crops to improve moisture retention. He described a lack of clear protocol for determining how to ensure his trial:

> …I'm trying to be honest with [the crop insurance agent], I marked out this spot. I said, "I seeded cover crop here." They couldn't find it in the damn chart of-- "What did you seed?" They're clicking through all these different-- "Was it apples?" "No." "Cherries?" "No." "Was it--?" … They finally found something that was close like a forage legume or something. And I said, "Well, it's not really forage and it's not really a legume, but close enough." So, yeah, it's not really in the government's system yet as an alternative crop. And it's obviously not an insurable crop. It's not a program crop…(19).

Some adopters experimented with cover crops despite the lack of clear protocol for cover crops in crop insurance policies. Many of these farmers experiment on their land to reduce the agronomic and economic risk associated with cover cropping. However, these farmers still navigate feelings of uncertainty because their cover crop trials are not currently validated as an insurable practice. Farmer 4, a crop and livestock farmer in the annual-cropping zone, had integrated cover crops over approximately 500 acres. When asked how he managed a cover crop trial without the security of crop insurance, he replied:

> Pray. When that big storm came through this summer, I was worried about we had clover and other crops out that were, you know, we were worried they were going to get pounded. And we just didn't have any insurance on them (4).

As this farmer expressed, there is a high level of risk and uncertainty associated with integrating cover crops without security from crop insurance. The lack of regionally appropriate crop insurance policies keeps farmers from experimenting with cover crops because of the agronomic and economic risk and uncertainty they present. Many farmers discussed this issue as an overarching barrier to integrating cover crops at a farm-level.

The role of lease arrangements

Inflexible lease arrangements and a lack of support from non-operating landowners also limit a farmer's ability to experiment with cover crops. Farmers often experimented with cover crops on their land, rather than taking risks on their leased land. Farmer 23, in the annual-crop zone, clearly articulated the challenges of experimenting with cover crops on leased ground, because some landowners are not familiar with the economic feasibility of cover cropping:

> …I won't experiment on the landlord's ground. Because most of them don't know this stuff. They don't care and that's fine. I have to prove to them that I can make them money, and then we'll start doing things like cover crops if that works on their ground… (23).

Inflexible crop insurance policies and rigid lease arrangements contribute to perceptions of low relative advantage and trialability. However, the low rate of adoption and early stages of experimentation suggest that these factors act as an initial barrier to implementation and constrain long-term trialability in the region.

Stakeholder-identified pathways to improve relative advantage and trialability

Interviews and focus group discussions generated a variety of pathways that could improve regional adoptability of the practice. To improve relative advantage and trialability of cover crop adoption, focus group participants identified the need for regionally appropriate strategies and ways to reconcile short and long-term economic profitability. Many participants suggested increasing farmer-driven research trials to improve region and site-specific research outcomes. It was apparent during discussions that each farmer has unique management goals that need to be considered when conducting research. Additionally, the following statement from an NRCS employee also emphasized the need to provide farmers with a sense of financial security by improving regional insurance policies.

> The issue I have is that every farmer is different, every farmer has different goals, every year is different, so you have to customize a trial or a goal of theirs to…their goals and have a proven method to show that this cover crop is beneficial to them… then you can say 'Ok, here's a packet that covers your cost to plant this.' If it fails,

> insurance pays for it, so let them try it, prove to themselves that it works. But once again, it has to be customized for them (Group D).

The role of collaboration and information sharing

To support cover crop expansion, stakeholders suggested increasing collaboration between farmers, University researchers, industry professionals, and landowners. Supporting farmer-driven research and improving collaboration strategies improve farmers' perceptions of the adoptability of cover crops. Farmers highlighted the importance of collaboration and information sharing between peers. Farmer 2 described the value of engaging with a group of other local farmers, who each have slightly different management goals. He emphasized the importance of experimenting in somewhat different ways to share information and build from each other's experiences. He also expressed the concern of building on both successes and failures:

> The best bang for my buck has damn sure been the peer advisor groups because everyone can try something a little bit different, different times of the year, and then we all compare notes because we're all essentially farming in the same area. And all of us would love to try everything under the sun, but we can't. And so everybody does just a little bit. And then we all report back. And once a year we do a crop tour. All of us rent a van and drive around and look at every individual's farm and the good, the bad, and the ugly (2).

Building capacity for farmers to engage in research and collaborate more effectively together may improve perceptions of adoptability at the regional level. However, increasing perceptions of adoptability requires strategies that reduce potential financial risks.

Implications for financial feasibility and reconciling terminology

Stakeholders identified the need to reconcile the short and long-term financial viability of cover cropping. Generating income from cover crops could help to meet regional conservation goals, reduce the financial risk associated with cover cropping, and improve perceptions of relative advantage and trialability. Cover crops serve similar agronomic purposes as alternative cash crops (e.g., canola, peas, chickpeas). Alternative cash crops and cover crops improve soil and water quality, reduce weed management and nutrient management. Yet the term "alternative crop" is more frequently associated with economic feasibility than "cover crop." A local farm laborer and private agricultural contractor in the focus groups discussed how alternative crops are often associated with short-term financial profitability. Cover crops, on the other hand, are more commonly associated with long-term soil health benefits. Understanding these discrepancies in terminology can help agricultural stakeholders make more specific recommendations for farmers:

> Since they're both better for the field it seems like but cover crop may be like you're saying leads to a more sustainable business, as in there's less inputs in the future, you know, science or whatever. Alternatives, it's more about that trying to make money now, instead of not spending as much money tomorrow, next year… (Group)

The role of livestock in integrated systems

A potential pathway for improving financial feasibility is to incorporate livestock into current management practices. Stakeholders suggested this be done through direct integration or by connecting livestock and crop farmers. Ten of the eighteen adopters interviewed had incorporated cattle to some degree. Yet crop farmers also expressed a need for assistance connecting with livestock and with infrastructure needs such as fencing. In one focus group, a conservation staff member discussed the need to connect crop and livestock farmers to reduce management challenges associated with cover crop adoption:

> Anybody that comes into my office, [I ask]. 'do you have cattle?' If no, go find somebody that has cattle because you can rent out your cover crops, I got a guy that's looking for land that he can rent, to put up the fence, he'll put in the water, he'll do everything if he can graze your cover crops (Group H).

Improving perceptions of relative advantage and trialability will require increased collaboration between stakeholders at the regional level, targeted research approaches, increased understanding of financial feasibility, and more regional flexibility of crop insurance policies. Supporting on-farm diversification through livestock integration or alternative methods may reduce risk and uncertainty associated with cover cropping.

Discussion

Barriers to cover crop adoption in the PNW

The diffusion of innovations theory clarifies several perceived barriers to cover crop adoption in the iPNW. Our results suggest that low perceptions of relative advantage and trialability impact the perceived adoptability of cover crops (Guerin, 2000; D. J. Pannell et al., 2006; Atwell, Schulte, and Westphal, 2009; Prokopy et al., 2019). Farmers perceived cover crops as having low relative advantage due to environmental and economic constraints while incorporating cover crops into existing systems increases operational complexity, which increases the difficulty of trialing the practice. The lack of region- and site-specific information for the region were compounded by the low relative advantage and low trialability. Focus groups identified regionally appropriate strategies that would specifically reconcile short- and long-term profitability. Potential pathways towards adoption include livestock integration and long-term research trials. These recommendations are consistent with suggestions by Tosakana et al. (2010) that long-term observation sites may help to shift farmers' perceptions of the adoptability of certain conservation practices.

Lack of environmental and economic compatibility

Farmers in our interviews identified a lack of environmental and economic compatibility with current management systems contributed to the low perceived relative advantage of the practice. This finding is consistent with previous research suggesting that despite potential long-term benefits, low agronomic compatibility is a challenge for farmers across the nation (Snapp *et al.*, 2005; Atwell, Schulte, and Westphal, 2009; Plastina *et al.*, 2018). A lack of short-term profits, the additional cost of inputs, and potential impacts on the following cash crop are barriers to adopting cover crops (Snapp *et al.*, 2005; Bergtold *et al.*, 2019). As other studies posit, these barriers are compounded by a high level of economic risk and uncertainty associated with the practice (Vanclay and Lawrence, 1994; Ghadim, Pannell, and Burton, 2005).

As Rodriguez et al. (2009) suggests, low observability and a time lag between treatment and observed results contribute to low levels of adoption. Non-adopters may be motivated by an increase in financial incentives to reduce economic risk; however, adopters of the practice will require additional agronomic and economic support (Singer, Kaspar, and Pedersen, 2007). Promoting cover crops through the integration of livestock can improve relative advantage by reconciling the short and long-term economic profitability associated with cover crop adoption (Roesch-McNally et al., 2017). Reconciling short and long-term financial profitability may improve the perceived relative advantage and reduce the risk associated with integration (Ghadim et al., 2005; Marsh et al., 2000; Snapp et al., 2003: Bergtold et al., 2017). While farmers and stakeholders discussed this opportunity frequently, focus group discussions also suggest the need to examine methods for connecting crop and livestock farmers, measuring economic impacts, and the need for infrastructural support. Beyond financial incentives, many farmers we interviewed discussed interest in and the potential for alternative crops, inter-seeding, and companion cropping as a means to diversify their crop rotations, improve soil quality and meet short-term economic goals. The integration of cover crops may increase as the crop rotations become more diverse across the region (Stuart and Gillon, 2013). Therefore, encouraging and supporting crop intensification and diversification should be heavily considered as a viable alternative to the widespread promotion of cover crops (Huggins et al., 2013; Kirby et al., 2017; Pan et al., 2017).

Impacts of trialability on cover crop adoption

Our finding of low perceived trialability is also consistent with past research (Pannell et al., 2006). Farmers discussed the high frequency of failed trials and the uncertainty regarding planting and terminating time, species type and function, which has been found elsewhere (Dunn et al., 2016; Roesch-McNally et al., 2017; Plastina et al., 2018), and specifically in the iPNW. A lack of regionally appropriate crop insurance programs and inflexible lease arrangements contribute to the low perceived trialability of the practice (Plastina et al., 2018; Bergtold et al., 2019; Ranjan et al., 2019). The 2015 Cover Crop Survey Report (CTIC, 2015) found that 35% of survey respondents would use cover crops if it lowered their crop insurance premiums. This finding suggests the need for more flexible crop insurance programs to better facilitate cover crop integration by non-adopters and current adopters of the practice.

To increase trialability, our participants suggested more field trials across the region to increase understanding of best practices and thereby reduce perceived agronomic risk. There is a need to focus on long-term, geographically scalable research to meet the short and long-term economic and environmental goals of farmers in the region (Robertson et al., 2008). Increasing the visibility of these trials across the region acts as one way to increase observability and reduce the complexity of the practice (Pannell et al., 2006). Dunn et al. (2016) suggest that “promoters of cover crops should attempt to combat negative perceptions by showcasing local examples where limitations have been successfully overcome.” Clarifying or amending lease agreements was also identified as a means to increase trialability on rented farmland. Maaz et al. (2018) found that land because leases tend to be renewed every one to five years, growers rely on “less risky” traditional crops to appease absentee landowners. To improve relationships between landowners and operators, Ranjan et al. (2019) recommend encouraging flexibility with lease terms and multi-year leases, enhancing communication between landowners and operators, and educating landowners about conservation practices and programs.

There are several limitations to this study. We bounded the case to the dryland farming region of the iPNW, which limits the generalizability of the study due to the small sample size geographic specificity. Further, while we sought to engage with a spectrum of farmers and agricultural stakeholders across the region, our findings are not representative of all perspectives. In addition, all participants were male, which is consistent with the majority of wheat farmers in the iPNW, yet future work should include female perspectives to provide a greater understanding of the perceived barriers and pathways to the adoption of cover crops.

Recommendations

Cover cropping is one management practice that can be used to improve soil health, mitigate the effects of climate change, and improve farmer livelihoods (Lin, 2011; Maaz et al., 2018). Yet, farmers face complex challenges when deciding to integrate cover crops. Our findings suggest that farmers have legitimate reasons for not adopting – or discontinuing – the practice, given the environmental, economic and social context in which they operate (Berry et al., 2006; Adger et al., 2009), especially when there is limited regional data to support long-term economic and agronomic feasibility. Addressing cover crop adoptability at the regional level has important implications for addressing broader concerns of building and maintaining soil health. Improving soil health is essential for ensuring long-term agronomic and ecosystem function, supporting farmer livelihoods, and mitigating the projected effects of climate change (Sherwood and Uphoff, 2000; Larkin, 2015; Ball, Hargreaves, and Watson, 2018).

Based on our findings and literature review, we recommend the following options for increasing cover crops:

- Recommendations for increasing cover crops across the region be issued for specific agro-ecological zones, and suit the unique field-level goals of the farmer (Plastina et al., 2018).
- Engage with diverse agricultural stakeholders to better understand the complex factors inherent in the agricultural decision-making process (Prokopy et al., 2015).
- Improve collaboration between agricultural stakeholders; this will solidify these efforts and improve communication between stakeholder networks Wu & Zhang, 2013; (Kalcic, Frankenberger, Chaubey, Prokopy, & Bowling, 2015).
- Future cover crop research should be conducted in close collaboration with farmers to build the capacity to demonstrate site-specific trials and disseminate information to peers (Pannell et al., 2006; Dolinska and d'Aquino, 2016).
- Address regional crop insurance policies and collaborate with landowners to address institutional challenges (Maaz et al., 2018; Ranjan et al., 2019).

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Chapter 2: Good farming and the role of capital in the adoption of conservation tillage: insight from the inland Pacific Northwest, USA

Abstract

The “good farmer” literature, grounded in Bourdieu’s concepts of field, habitus, and capital, has provided researchers with a socio-cultural approach to understanding conservation adoption behavior. The good farmer literature suggests that conservation practices may not be widely accepted because they do not allow farmers to demonstrate symbols of good farming. However, this lens has not been applied to the adoption of conservation tillage (CT) systems, a practice increasingly used to improve conservation outcomes, farming efficiency and crop productivity. Drawing from in-depth interviews (n=28) with dryland wheat and livestock farmers across the US inland Pacific Northwest (PNW), this research seeks to understand how farmers’ engagement with CT is shaped by notions of good farming. Interviews show that cultural symbols of erosion are embedded in, and reactive to historical trends towards soil management, and helped shape farmers response to CT. Farmers were motivated demonstrate erosion control improve the long-term viability of farming operations and to improve economic capital by reducing inputs like fuel, time, and labor. Farmers also sought to preserve social capital by maintaining and strengthening relationships to peers, landowners, and future generations. Further, results from this study demonstrate that engagement with CT can successfully link productivist values and stewardship values within the good farming mindset. The findings from this research have wider implications for conservation practices that may not be widely accepted amongst the farmer community.

Key words: Good Farming, Capital, Conservation Tillage, Productivisim, Stewardship, Bourdieu

Introduction

Globally, soil erosion and soil organic matter depletion threatens the long-term economic and environmental sustainability of farming systems, especially when compounded by adverse weather, weed, pest, and disease events (Bista, Prakriti, Machado, Stephen, Ghimire, Rajan, Yorgey, Georgine, Wysocki 2017). In response to this problem, governmental and non-governmental organizations have promoted conservation tillage (CT) systems to improve soil and water quality, increase farming efficiency and profitability, and increase crop productivity (Bowman and Lynch 2019). CT is a general term used a range of tillage practices that leave 15% to 30% of crop residue after planting. CT can include variations such as ridge tillage, mulch tillage, no-till, direct seed, and reduced and minimum tillage (Bista et al. 2017). To support adoption of CT, the United States Department of Agriculture (USDA) has provided more than $250 million through the Environmental Quality Incentives Program (EQIP) towards conservation tillage (Wallander et al. 2017). Across the US, wheat farmers have increased their use of conservation tillage from less than 40% in 2004 to more than 60% in 2017 (Claassen, Bowman, McFadden, Smith, and Wallander 2018). Research has shown that CT systems are becoming part of mainstream agricultural practice, and support integration of other soil health management practices like crop diversification and cover crops (Coughenour 2009; Roesch-McNally, Arbuckle and Tyndall 2018). Yet there is limited research on how the mainstreaming of CT systems shapes or is shaped by socio-cultural values. To better understand this important dimension of CT adoption, we draw from the "good farmer" literature to understand how and why CT systems contribute to the evolution of symbols of good farming.

Drawing from Bourdieu's concepts of field, habitus, and capital (Bourdieu 1986), the good farmer literature considers how shifts in the agricultural field (e.g., consumer demands for organic products, increased emphasis on conservation policy – as distinct from a physical field where crops are grown) contribute to the evolution of good farmer identity and symbols of good farming (Burton, 2004; Burton, Kuczera and Schwarz 2008; Riley 2016). Central to Bourdieu's theory is that all forms of cultural, economic, and social capital becoming important for producing and reinforcing norms and practices amongst members of a social groups. Symbolic capital, as a physical representation of capital types, are often shared amongst members that operate within a shared cultural context , or habitus (Bourdieu 1986; Adams 2006). In the context of the agricultural field, cultural symbols are largely framed around productivist values, like straight and weed-free fields, narrow rows, and a tidy farm appearance (Burton, 2004; Burton, Kuczera and Schwarz 2008). Yet, research points to a broadening of good farming symbols in response to new technology, demand for organic products, government policies, and adoption of voluntary conservation practices (Darnhofer, Schneeberger and Freyer 2005; Sutherland and Darnhofer 2012; Sutherland 2013). Agriculture in the United States (US) inland

Pacific Northwest (PNW) offers insight into how CT systems and their symbols become embedded and accepted in a farming community. CT is continuing to increase across the region as farmers realize reduced input costs, fuel savings, and improved soil conditions (Schillinger et al. 2003; Schillinger 2010). According to a survey of wheat growers across Washington, Idaho and Oregon in 2012, approximately 70% of growers are using a form of conservation tillage (Bista, Prakriti, Machado, Stephen, Ghimire, Rajan, Yorgey, Georgine, Wysocki, 2017). However, there is a dearth of qualitative social science to provide a nuanced understanding of farmers' motivations for, or reservations about, adoption of CT systems.

Given the influence of all forms of capital on farming practice (Bourdieu 1986; Burton 2004; Burton et al. 2008), we sought to understand how all three types of capital – and symbols – influence the adoption of CT, a conservation practice that has become increasingly widespread. Our primary research questions include, (1) How does engagement with CT systems help farmers reconcile productivist and stewardship goals across cultural, economic, and social capital? and (2) How have historical soil management trends shaped farmers' perception of symbols of good farming? These questions are grounded in the good farming literature and Bourdieu's conceptualizations of field, habitus, and capital. We draw from in-depth interviews with crop and livestock farmers across the PNW to better understand farmer engagement with CT systems. We begin by reviewing Bourdieu's work on field, habitus, and capital within the context of US agriculture. We then describe symbols of good farming in relation to conservation practices and discuss how these symbols may influence behavior change over time

Literature Review

Field, habitus and capital within the context of US agriculture

According to Bourdieu (1986), a field consists of a network of social relations, where actors seek to maintain their social position through the accumulation of resources relevant to the field. In the context of the US, the agricultural field consists of a network of economic relations, and future and past rental and family relations; to this list, we can add relations between farmers and producer cooperatives, conservation agencies, university researchers, and extension services (Raedeke et al. 2003) (Fig. 1). Economic capital is considered one of the most valuable resources as it is easily converted to money; economic capital can include accumulated property like equipment as well as institutionalized forms of capital such as property rights (Bourdieu 1986; Bourdieu 1997; Burton and Sutherland 2011). Cultural capital exists in three forms – the embodied state consisting of demonstrated skill, efficiency, and knowledge, the objectified state consisting of physical symbols and accumulated cultural goods, and the institutional state consisting of educational qualifications. Access to social capital depends on the accumulation of economic and cultural capital, which influence one's access to trusted social networks and membership groups (Bourdieu 1986). Central to Bourdieu's theory is that social exchanges are not reducible to economic capital alone. More recent literature contends that converting capital is a multifaceted process that involves multiple forms of capital (Pret, Shaw and Drakopoulou Dodd 2016). Bourdieu (1986; 1997) contends that all forms of capital may be produced and reinforced by way of symbolic capital (Bourdieu 1986). Symbolic forms of capital, associated with prestige or positive reputation, become shared amongst members of a social group that operate within the same cultural context, or that share similar habitus (Bourdieu 1986; Adams 2006). Habitus is determined by the transfer of skills, experiences, and personal values across generations (Bourdieu 1984).

For farmers, habitus develops as a result of interactions between the farm structure, farming heritage, and personal experiences with farming (Burton et al. 2008). Farming habitus has historically centered around productivist ideology, i.e., "the utilitarian approach to land use based on intensive forms of agricultural production" (Wilson and Hart, 2001; Burton, 2004, pg. 198). Productivist symbols of good farming include preferences based on aesthetics like the physical appearance of the crop, weed-free fields, straight rows, and tidy landscapes (Burton 2004; Burton et al. 2008). The demonstration of productivist symbols of good farming become important for preserving one's reputation amongst peers, family members, landowners, and other social networks (Burton 2004; 2008; 2012). As Burton (2004) and Burton et al. (2008) contend, feedback from peers – or "roadside farming" – is essential for securing one's status amongst members of a social group. Burton et al. (2008) posit that there are three conditions needed to demonstrate cultural symbols of good farming. First, an action must display or demonstrate good farming practices that are culturally relevant to the farmer. Secondly, there must be readily observable results from the action that are visible, and third, demonstratable results or skill associated with the action must be easily accessible or visible to other members of the farming community. The failure to demonstrate symbols of good farming can result in a loss of cultural, social, and eventually economic capital (Burton 2012).

According to Burton (2004) and Burton et al (2008), current conservation practices and policy are not widely accepted in the farming community because outcomes of conservation and alternative land management practices do not allow farmers to demonstrate symbols of good farming (Burton 2012). This assertion is supported by recent empirical studies. For example, Raedeke et al (2003) uses the concepts of field and habitus to examine the role of agroforestry within conventional farming. The authors found that tension exists between conventional and alternative land management practices – such as agroforestry – because components of forestry do not align with the symbols associated conventional farming. Other research on riparian areas, biodegradable mulch, and cover crops suggest that adoption is low when outcomes do not align with farmers' current perceptions of good farming (Thomas et al. 2019, Dentzman and Goldberger 2019; Lavoie, Wardropper, and Dentzman, in review).

Broadening of symbols associated with good farming

While many conservation practices have historically fallen outside good farming symbols, these symbols are shaped reflexively by local context, meaning they are subject to redefinition within a given community (Burton 2004; Burton and Wilson, 2006; Hunt 2010; Riley 2016). Farmers may consider themselves natural conservationists and practice stewardship behavior depending on access to capital, prior experience, management goals, social context, and feedback from peers (Burgess, Clark, and Harrison 2000; Burton and Paragawewa 2011; Blesh and Wolf 2014; McGuire et al. 2015; Raymond et al. 2016; Riley 2016). Stewardship behavior is defined as the "responsible use (including conservation) of natural resources in a way that takes full and balanced account of the interests of society, future generations, and other species, as well as of private needs, and accepts significant answerability to society" (Worrell and Appleby, 2000). Although previous research suggests a potential loss of capital with the integration of conservation practices, scholars suggest that the symbols associated with good farming may be broadening in scope (Burton and Wilson 2006; Reganold and Wachter 2016).

Sutherland and Darnhofer (2012) demonstrate how changes in agricultural policy and market regulations have led to a broadening of good farming ideals amongst conventional and organic farmers. Their work indicates that farmers are transitioning to organic farming because organic is deemed financially viable and because it is now culturally accepted. Sutherland (2013) finds that the mainstreaming of organic methods "has created the opportunity for conventional farmers to shift their practices in a more environmentally oriented direction while limiting the loss of cultural capital" (439). Saunders (2016) finds that while the dominant productivisit narrative persists amongst farmers, there is a diverse range of perspectives about what implies good farming practices. The exploration of how food farming symbols have changed in reaction to organic agriculture has implications for our understanding of farmers' engagement with CT systems, which may be altering the breadth of good farming symbols in the PNW.

Previous research indicates that transitioning to CT systems is a complex transition process that requires investment into new resources, increased financial inputs and significant changes to management practices (Ledermann et al. 2010; Bossange, Knudson, Shrestha, Harben, Mitchell, 2016). Yet, shifts away from the traditional plowing culture (Coughenour 2000), improved CT equipment, and increased technical and financial incentives from cost-share programs continue to support farmers' transition to CT systems. CT systems are increasingly adopted to reduce input costs (e.g., fuel, labor, time) and improve soil resources by reducing erosion, increasing soil organic carbon, and improving water holding capacity (Bista et al. 2017). CT systems have been found to reduce annual input costs associated with fuel usage (USDA-NRCS, 2016). In addition, advances in CT drill technology have increased efficiency for farmers by streamlining precise seed and fertilizer placement and reducing passes over the field (Bista et al. 2017). Furthermore, engagement with CT systems helps to shape farmers' relationship to soil resources and balance short-term productivist goals with long-term conservation goals (Roesch-McNally 2018; Coughenour and Chamala 2000; Coughenor 2009). Coughenour (2009) states the engagement with CT systems "denotes the presence of new agricultural systems; i.e., new value-orientations, including soil and cropping goals, new knowledge, and a new repertoire of cropping techniques" (296). Coughenour (2009) examined Kentucky farmers experience with CT systems and found that producers who had adopted CT could improve the management of soil resources and began to see their soils as living ecosystems. Additionally, the mobilization of social networks promoting the utilization of CT systems leads to an activation of conservation identities (Coughenor 2009). This research suggests that engaging with CT systems allows farmers to reinforce productivist values associated with good farming, while simultaneously strengthening their relationship to stewardship values and conservation outcomes.

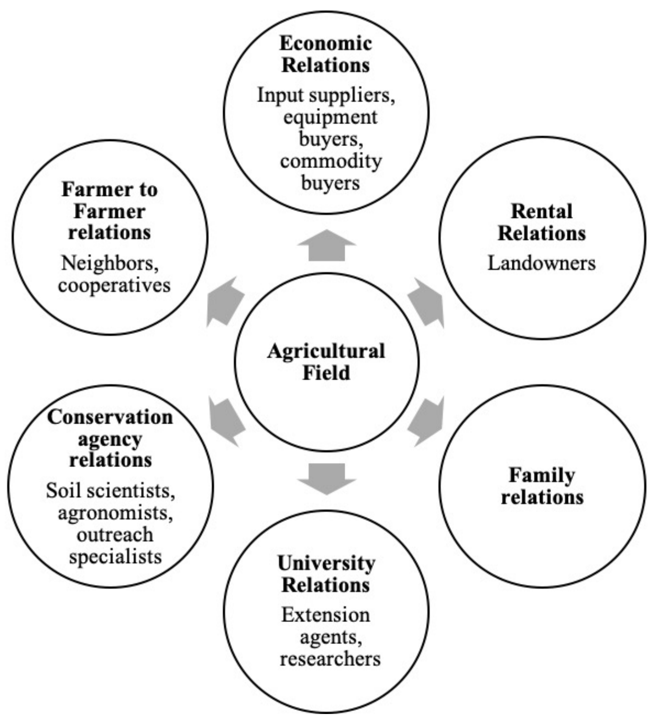

Figure 2.1. The social structures within the farming field, adapted from Raedeke at al (2003). Current relations may be informed by connections between previous and future generations.

Methods

Study site

The case of farmers in the PNW, offers insight into agricultural change in the US. The dryland wheat-growing region of the PNW is defined by three agroecological zones. The three major production zones include the wheat-fallow region, annual crop-fallow transition, and annual cropping region. The fallow period is used to retain moisture during the winter months (Schillinger, Papendick, McCool 2010; Pan et al. 2017). Due to the diversity in cropping systems, precipitation regimes, and soil types, CT practices also vary across the region and include ridge tillage, mulch tillage, and no-till, direct seeding, and minimum tillage (Unger and McCalla, 1980; Bista, Prakriti, Machado, Ghimire, Rajan, Yorgey, Wysocki, 2017). Dryland wheat farmers in the PNW have historically dealt with severe soil loss due to wind and water erosion and intense tillage practices (Schillinger et al. 2003; Schillinger and Papendick, 2008; Schillinger, Papendick, McCool 2010). Efforts to mitigate erosion issues and support farmers date to the 1930s when the Palouse soil erosion experiment station began operating in Pullman, WA. Despite improved technology and increased financial and technical support for farmers transitioning to CT systems, wind and water erosion continue as a significant agricultural concern across the PNW (Kaur et al. 2017; Kirby et al. 2017; Pan et al. 2017; Maaz et al. 2018; Schillinger 2010; Bista et al. 2017). Beyond historical trends, impacts from climate change have the potential to exacerbate issues of poor soil and water quality by shifting agroecological zone stability. Kaur et al. (2015) notes a 46% decrease in annual crop-fallow transition and annual crop zones, which could result in increased use of fallow rotation and increase risk of erosion. Recent emphasis on conservation tillage in the region offers a unique opportunity for examining farmers' evolving relationship to stewardship behavior (Bista et al. 2017).

Data collection

This qualitative research draws from semi-structured interviews (n=28) with crop and livestock farmers across the PNW. We used interviews to better understand the unique experiences and knowledge of crop and livestock farmers in this region (Sayre, 2004). The Palouse Conservation District, a partner on this project, supplied an initial list of interviewee names. Researchers then utilized purposive snowball sampling to recruit additional interviewees. We sampled for farmers who represented a broad range of conservation management practices that included cover crops, diversified crop rotation practices, and conservation tillage practices like strip-till, mulch-till, no-till, direct seed and reduced tillage systems.

Interviews were held on farms (*in situ)* from the fall of 2018 through spring of 2019. Interviews were digitally recorded with the participant's consent (IRB Protocol 18-130**)**. Interviews ranged from 30 minutes to 2.5 hours. All participants were assigned a number during analysis to protect their anonymity. We designed the interview protocol to elicit responses about farmers' current management practices and history of their farm, what it means to be a good farmer, and their main priorities and concerns in the farming field (in the Bourdieusian sense). We used open-ended questions to ask farmers about their practices, priorities, concerns, and reasons for transitioning to a CT system, if they had done so, and any additional conservation practices that they used in the past or were currently using (Appendix A). We also asked farmers to describe their relationship with landowners and where they go for information on pest, weed, and weather events. These questions were chosen to generate insight into what management approaches farmers view as culturally appropriate, and what capital types – economic, social, and cultural – contribute to perspectives on good farming.

Data analysis

Interviews were transcribed verbatim and were analyzed using NVivo 12 software. We applied a thematic coding approach (Jennings 2012) to analyze interview data. In-process coding memos were used to track and ground our research findings (Jennings 2012). We completed a round of descriptive coding to evaluate what it meant to be a good farmer, and to understand why farmers decided to transition to CT systems. We grouped codes into themes based on our understanding of economic, social and cultural capital and symbolic representations of capital. We then compared how farmers discussed symbols of good farming with their reasons for integrating CT systems. We use direct quotations from farmer participants to increase the transparency of our findings as discussed by Prokopy (2011).

Results

Participant and farm characteristics

All 28 crop and livestock farmers across the region, aside from one, were male with an age range from 29 to 78. The primary commodity crops produced were winter wheat and spring wheat, with additional small acres of either cereal, legume or oilseed. Fifteen farmers operated within the annual cropping region, nine operated within the transition zone, and four farmers operated in the grain-fallow zone. There was higher crop diversity on the farms in our sample in the annual cropping region and lower diversity in the annual crop-fallow transition and grain-fallow regions, which is consistent for the region (Huggins et al. 2013). Nineteen farmers self-identified as using no-till systems, and nine farmers described their operation as minimum tillage (Table 2.1). Although no-till farming is commonly referred to as direct seeding in the PNW, farmers in our study frequently used the term no-till or used the two terms interchangeably (Bista et al. 2017). Farmers described the tillage practices they used most frequently, but some farmers described amending their tillage practices to manage weeds. Farmers did not explicitly state that they were leaving between 15%-30% crop residue (Bista et al. 2017).

Table 2.1. Farmers using predominantly no-till or minimum till systems across the annual-crop, annual crop-fallow transition, and grain fallow zones.

Tillage Type	**Annual crop**	**Annual crop-fallow transition**	**Grain-fallow**	**Grand Total**
Minimum	3	4		7
No-till	12	5	4	21
Grand Total	**15**	**9**	**4**	**28**

Productivist goals and stewardship goals

All of the respondents were asked to describe what it means to be a good farmer. The responses varied between farmers, but many of the themes demonstrated how productivist and stewardship values can co-exist across cultural, economic, and social capital. Productivist values embedded in cultural capital included; maintaining the appearance of the farm (e.g., weed free fields, straight rows), and demonstrating skill and efficiency (e.g. reducing inputs costs, fuel, time, labor), and using up-to-date equipment and technology. Stewardship values embedded within cultural capital included; reducing erosion, and demonstrating erosion management techniques to peers, neighbors, and past and future generations. Other stewardship values included; stewarding the land, improving soil quality and reducing erosion, and improving the land for future generations. To improve economic capital, farmers sought to balance the short-term profitability and long-term viability of their farm by reducing erosion and improving farming efficiency by reducing inputs like fertilizer, fuel, labor, and time. Farmers' demonstrated productivist ideals in their discussion of forms of social capital and sought to preserve their reputation as a good farmer by preserving relationships with landowners, peers, and future generations. Yet, farmers also sought to sustain relationships with landowners, peers, and future generations by demonstrating their ability to manage soil resources. To supper the transition to CT systems, farmers often relied on peers, direct seed networks and meetings, university extension agents, and close relationships to NRCS agents. We describe how engagement with CT required consideration of cultural, economic, and social capital below.

Cultural capital

Objectified cultural capital

Farmers described traditional symbols of good farming that included appearance of the farm, weed-free fields, and straight rows. Yet, more frequently, farmers referenced erosion and soil management as symbols of good farming. The visible signs of erosion, historically embedded in PNW farmers' habitus, has become an important indicator for good farming in the region. One farmer described how productivist symbols of good farming (e.g., yield) are traditional indicators of good farming. Yet, clearly emphasizes how soil management and erosion are integrated within his perspective of good farming.

> So traditionally around here, it is all about the look... We say it's about yields, but people driving by in the car are the people who make the statement of who's the good farmer... In my perspective, it'd be more toward soil management…and erosion (15).

A majority of farmers shared this perspective on erosion and soil management as a symbol of good farming. Displaying symbols that were easily observable, like erosion reduction, reinforced farmers' decision to transition CT. Farmers also described how maintaining the appearance of the farm was important for preserving their reputation as a good farmer, good neighbor, steward of the land, and tenant.

> To be a good farmer, take care of what you have, treat it like it's your own even if it's not, be a good neighbor, a good steward...And whether it's yours or leased doesn't matter. And what it looks like is little to no erosion, weeds controlled, general upkeep and appearance of the property is just the quick-- you can drive by and say, "Hey, somebody cares about what's going on here." It's not just wild and uncontrolled (21).

PNW farmers sought to display symbols of good farming that were consistent with regional, and historical trends towards soil management in the region. Engagement with CT allowed farmers to display culturally relevant symbols of good farming that are embedded in farmers' habitus, and reinforced their reputation within the good farming community as a good farmer, good neighbor, good land steward, and good tenant.

Embodied cultural capital

Engagement with CT allowed farmers to demonstrate objectified symbols of good farming, i.e., erosion reduction, and embodied cultural capital. Farmers described the transition to CT as a way to improve efficiency of their farming operation by streamlining their operation and reducing passes over the field. Farmer 23 described how transitioning to CT helped to reduce fuel and time. Adopting CT was demonstrated this farmers skill and ability by increasing efficiency of his farming operation, and by reducing inputs, reducing erosion and improving soil quality. The failure to adopt efficient farming practices could result in a loss of status in the farming field or loss of livelihood entirely.

> I'm not wasting fuel; I'm not wasting time; it's all about efficiency. And so that is a huge thing to me in everything we do…Because my thought process is if I'm more efficient than the other nine guys around well as me, and things get tough or stay tough like they are, I'm still going to be around, and those guys won't be (23).

Integrating CT systems allowed farmers to demonstrate important cultural symbols associated with good farming, i.e., erosion reduction, and helped farmers to display embodied cultural, as skill and efficiency. The demonstration of objectified and embodied types of capital was associated with sustaining economic capital, as farmers were motivated to integrate CT to reduce erosion and to reduce fuel, time, and labor.

Economic capital

Farmers often described how cultural symbols of good farming, like erosion, were linked to the loss of economic capital. For many farmers, losing soil was linked to reduced economic capital, and threatened the long-term viability of the farming operation. Farmers engaging in CT recognized how reducing erosion and improving conservation outcomes is directly linked to sustaining economic capital.

> And the older you get, and the more of these meetings you go to, and you try to pass something on, it's true. I mean, it is the bank. It is your biggest asset and you're sitting there watch it melt away. It's like having a leak in your wallet and you're not plugging it (19).

Farmers engaged with CT often emphasized the connection between reduced erosion, reduced fuel, time, and labor. Farmer 5 has been operating in a no-till system for 20 years to, in his words, save "soil, toil, and oil." He stated, "you know what, that's pretty much it is to… remain sustainable and profitable in the long-term without going broke in the short-term" (5). Engagement with CT helped farmers to connect productivity values and stewardship values by realizing how CT could reduce erosion and reduce fuel, time, and labor inputs.

Farmer across the PNW recognized how their engagement with CT acted as a way to support conservation outcomes and meet productivity goals.

> Stop erosion, make a living, and do things…So not only are we doing it with the soil, we're doing it through less trips across the field, less fuel, and I think we're doing our part. I think agriculture as a whole has to do that… Not only is it a profit-maker, but it's helping the environment too (13).

This farmer also alluded to a shift occurring in the agricultural field, where farmers are recognizing the connection between the soil and economic and environmental outcomes. Transitioning to CT enabled farmers to demonstrate symbols of good farming and helped farmers to realize the connection between soil resources and economic capital. In many cases, transitioning to CT systems allowed farmers to balance productivity goals and conservation outcomes.

> Well, I think you have to take the long view to be a good farmer. It's a balancing act. You have to operate with the goal of long-term success while keeping the money flow working in the short-term. And I really truly believe that if you keep on the long-term success, the short-term stuff will come together after a period of time…(6).

Many farmers discussed needing to maintain a balance between short-term profitability and long-term viability of the farm. Thus, transitioning to CT helped farmers realize the interplay between productivity goals and conservation outcomes. Displaying cultural symbols of good farming, and developing economic capital was closely linked to farmers' ability to sustain relationships with landowners, peers, and future generations.

Many farmers in this study also discussed how the previous generation recognized the connection between soil loss and economic capital, yet the lack of technology and equipment limited their ability to shift towards more sustainable management practices. However shifts in CT technology and equipment has improved considerably over time, and as a result, there is increased access to equipment that can manage increased crop residue. Farmer 14 described how his father recognized the direct connection between soil loss and reduced economic capital. The lack of viable alternatives at the time limited his ability to reduce soil erosion.

> [My father] didn't like ditches. He didn't like seeing that topsoil go down the hill. And plowing, to me, is the biggest visual, especially if you're plowing it downhill, which they were back then. It's the only way they could do it. They didn't have nice equipment that they have now, so everything was plowed down the hill. So here you are taking your soil, rolling it down the hill, and you can sit there and watch that all day long…(14).

Many farmers described how CT equipment is expensive, but that access to equipment through cost-share programs and farmer cooperatives has improved over time. In addition, farmers balanced the cost of equipment with improved soil control and long-term benefits of the practice, as described above. Although farmers were wary of the potential for reduced yields as a result of transitioning to CT systems, farmers mentioned that they did not frequently experience significant yield loss.

Social capital

Sustaining relationships with peers, landowners, and future generations

Sustaining one's relationships with peers, as well as landowners and future generations was important for farmers transitioning to CT. Several farmers described how their landowners supported their transition to CT, or their landowners were motivated to reduce erosion. Farmer 6's primary motivation for transitioning to a CT system was to improve economic capital by reducing labor and to reduce erosion. Yet, his landowner was also motivated to control erosion.

> Our reason for getting into that is it's two-fold. It was how do we farm larger acreage with less labor, improve our soil health, and the original reason that we got into it, and she is now since turned the landlord, but she was actively farming with us. She wanted to see her ground, which before she quit farming, would be to stop eroding. So that was the main driver was how do we eliminate erosion (16).

In other cases, farmers were able to transition to CT because they were supported by the landowner. Farmers with good relationships with their landowners were more able to communicate about the agronomic and economic benefits of CT practices.

Farmers were also motivated to support the next generation of farmers. Farmer 2 is a no-till farmer and an active participant in local conservation programs. He is also closely involved in an informal farmer-farmer networking group. He described how being a good farmer includes supporting the next generation of farmers.

> And my long-term goal of my definition of being a good farmer is probably making sure that it's a generational farm for hundreds of years, thousands of years if possible. I don't just try to be a good farmer for my career; it's my kids' careers and my grandkids' careers that are going to be determined on how I treat the land. …And I want them to be glad that I took such good care of the land (2).

For farmer 2, being a good farmer requires making decisions that consider the long-term impacts on the land, and the economic livelihood of his children and grandchildren. As he states, the management decisions he makes now, impact the next generation of farmers.

Engaging with social networks

To transition to CT, farmers relied on peer-peer groups, neighbors, regional direct seed networks, extension agents and University resources, and attended grower meetings. The most important types of information sources were other farmers, and the "one's who had been through it." A strong peer network helped support several farmers in our study, and helped reinforce the agronomic and economic benefits of the practice.

> You really listen to those guys and boy when you listen to the one that-- you know they're enthusiastic about it, it's change and it's different, and it's improved their land, and they're proud of it, and more time with their families, and everything. All those plus, plus things, and I became convinced…I went to the meetings and just listened to the people who were ahead of me (18).

Several of the farmers were engaged in a local peer-peer networking groups and emphasized the importance of being able to share information, resources, and equipment with each other.

> Peer-to-peer, in this area, dad and three other farmers started a group...And we have meetings and get together, and it's a great group, because it is open and honest… (1).

As these two farmers described engagement with peer groups when integrating CT and experimenting with new practices helped reinforce farmers' commitment to transitioning. Transitioning to CT helped farmers to maintain relationships with peers, landowners, future generations, and helped to reinforce the value of social capital when transition to new management practices.

Discussion

The primary purpose of this paper is to evaluate how farmers' engagement with CT is shaped by notions of good farming. Interviews further emphasized how the cultural context, or shared habitus towards soil management in the region helped shape farmers' response to CT. When describing tenants of good farming, farmers often described productivist values alongside stewardship values, indicating that they can co-exist within the good farming mindset. Farmers were motivated to integrate CT because they were able to demonstrate objectified cultural symbols of good farming, like erosion control, and embodied cultural capital in the form of increased farming efficiency and skill. As our interviews suggest, CT systems are associated with increased farming efficiency because farmers are able to streamline seed and fertilizer placement, passes over the field, and reduce time, and labor (Bista et al. 2017). Demonstrations of cultural capital are directly linked to sustaining economic capital, where farmers are able to reduce erosion and inputs, which supports long–term profitability. Linked to cultural, and economic capital farmers were motivated to sustain relationships with peers, landowners, and future generations. Farmers drew from these important relationships to help support their transition to CT and reinforce symbols of good farming.

Good farming and CT systems

Many of the farmers in our study cited erosion as a highly visible symbol used to evaluate themselves, and others as good farmers. Therefore, integrating CT allowed farmers to demonstrate objectified and embodied cultural capital by reducing erosion, and by demonstrating efficiency and skill. The demonstration of cultural capital in this case, is directly linked to economic capital. Clearly, transitioning to CT required additional investments in financial capital, yet PNW farmers realized how the investment in CT and reduced erosion was connected to the long-term viability of their farming operation. As Sutherland and Darnhofer (2012) suggest, cultural capital to sustain the farming lifestyle and economic viability of the operation. According to our interviews, farmers' engagement with CT stems from the need to improve economic viability of the farm by reducing inputs like fuel, labor, and time. Further, PNW farmers were motivated to balance short and long-term profitability goals by reducing inputs and saving soil. One farmers' comment about transitioning to CT to save "soil, toil, and oil," emphasizes this point. As Roesch-Mcnally (2018) and Coughenor (2003) discuss, engagement with soil resources can help farmers reconcile productivist values with conservation outcomes.

We also found evidence that suggests that the shift in the agricultural field, and access to improved CT equipment supports farmers' transition to CT, while supporting productivist ideals of improving farming efficiency. Increased access to technology and equipment would also demonstrate farmers' economic stability and secure their reputation as a good farmer amongst members of the farming community. Our results contradict findings that suggest that integration of conservation practices may be linked to a loss of capital, rather, use of CT allows farmers to reconcile short-term economic goals with long-term conservation outcomes. This is supported by prior research from Coughenour (2009) and Roesch-McNally et al. (2018) that suggest that farmers' experience with CT and soil management helps to reconcile short-term productivist goals with long-term conservation goals.

As Bourdieu contends (1986) cultural, economic, and social capital are interconnected. Our interviews revealed that farmers' engagement with CT stems from the motivation to preserve their reputation as good farmers by demonstrating cultural and economic capital, and by sustaining relationships with peers, landowners, and future generations. Engagement with peer groups, direct seed networks, and trusted extension agents supported farmers transition to CT. The importance of social networks and social capital has been emphasized in previous research (Floress, Prokopy and Allred 2011; McGuire, Morton and Cast 2013).

Our results demonstrated that engagement with cultural symbols with CT systems like reduced erosion and improved soil management may be more widely accepted by members of the farming community because they allow farmers to demonstrate productivist values, while simultaneously supporting stewardship values and conservation outcomes. We also demonstrate how other forms of cultural and social capital cultural, economic, and social capital forms of capital are interconnected (Pret, Shaw and Drakopoulou Dodd 2016).

Broadening symbols of good farming

Symbols of good farming are shaped by the habitus of the region, and in response to changes in agricultural policy, regulations, and demand for environmentally sound products (Burton 2004; Burton and Wilson 2006; Hunt 2010). Previous research contends that some conservation practices have not become embedded in farming habitus because they do not allow farmers to demonstrate symbols of good farming (Raedeke et al. 2008; Dentzman and Goldberger 2019; Thomas et al. 2019), with the exception of organic systems (Sutherland and Darnhofer 2012; Sutherland 2013). Our findings demonstrate how engagement with conservation practices like CT lessen the tension between productivist and conservationist goals. Similar to Saunders (2016) our research also demonstrates that the productivist narrative persists amongst the farming community, but there is a diverse range of perspectives about what implies good farming practices. Farmers' engagement with CT systems can successfully link productivist values with stewardship behavior. This suggests a broadening of farmers' conservation mindset such that alternative and traditional symbols of good farming co-exist.

CT practices and systems are increasingly becoming a part of mainstream agricultural systems, especially with the transition away from plow culture (Coughenour and Chamala 2000; Schillinger at al 2008; Bossange et al. 2016). The transition to CT systems are supported by productivist farming values that are predominantly shaped by economic drivers. However, farmers' engagement with CT systems is shaped by valued cultural and social capital. Conventional farmers not currently engaged with conservation practices may find that transitioning to CT systems helps to reconcile productivist goals with stewardship behavior. In addition, the transition to CT systems may support the sustained and future adoption of other conservation practices, like cover crops, given that the observation of soil erosion and management can act as a catalyst for future adoption behavior (Roesch Mc-Nally et al. 2018).

Limitations

This study is not generalizable to all farmers, instead it offers a unique perspective on the evolution of good farming symbols from dryland-farmers across the PNW. Our research participants were purposively selected to include a broad range of CT systems. Interviewees often self-identified as no-till or direct seed and others described their tillage systems as minimum till but were not explicit in the types of equipment that was being used. Therefore, we chose to focus on CT systems broadly to better understand how engagement with all types of CT systems may act as a catalyst for broadening symbols of good farming. We interviewed farmers from across the three agro-ecological zones, although we found consistency in the ways that farmers talked about good farming practices across zones, more research is needed to examine how perspectives might differ across the regions. Transitioning to CT systems may be meeting farmer goals of reducing erosion and improving soil quality. However, there is concern that CT, and especially no-till systems, do not give farmers the flexibility to manage weeds in ways that are practical for their operation. A number of farmers expressed concern about increased weed proliferation and the potential for increased herbicide resistance occurring within no-till systems. Future work needs to examine how increased adoption of no-till systems may impact farmers' ability to manage weeds and potentially increased instances of herbicide resistance.

Recommendations

Conservation adoption is a process that depends on the unique management goals of the farm and farmer. Decisions are based on economic considerations, and social and cultural relevance. Based on our findings and literature review, we recommend that practitioners focus on devising approaches that recognize cultural symbols of good farming, and support social and cultural capital, alongside economic capital development (Burton 2004; Burton et al. 2008). To support and acknowledge the role of cultural capital, conservation agency staff may acknowledge "champion" farmers in the field, and high light examples of successful implementation of conservation practices and outcomes. Conservation agency and University extension staff can provide rewards or certificates of achievement. To connect cultural and economic capital, we follow the suggestion from Burton, (2004; Burton et at 2008; Burton and Paragahawewa 2011) to provide 'payment by results', which would fit with the productivisit goals of farmers and connect to valued cultural symbols of good farming. Connecting erosion management to improved economic outcomes through messaging may also incentivize behavior change amongst farmers (Roesch-McNally 2019). To support social capital development, conservation agencies can promote peer-peer networking groups to encourage information sharing amongst peers, neighbors and landowners. In the broader context of agricultural decision-making, improving communication between landowners and farmers about land management decisions can reduce barriers to integrating conservation practices on rented land (Ranjan et al. 2019).

To support sustained conservation adoption, we recommend that university researchers focus on long-term approaches to agricultural research (Robertson et al. 2008; Roesch McNally, Arbuckle, Tyndall 2018). We also recommend that university researchers include farmers in the development of research questions and grant proposals, which may support long-term farmer engagement in conservation outcomes on their farms. Lastly, we recommend that decision-makers focus on supporting policy approaches that are more flexible to the needs of local farmers. We have emphasized how to support conservation adoption across cultural, economic, and social capital below.

Cultural capital:

- Encourage and acknowledge "champion" farmers or innovators in the farming field.
- Provide rewards or certificates of achievement for innovators.

Economic capital:

- Compensate or pay farmers for performance and reward farmers for stewardship practices they incorporate currently.
- Demonstrate and develop long-term research with farmers and emphasize long-term environmental and economic outcomes.

Social capital:

- Build and support communication between and amongst farmers, landowners, and future generations about the importance of stewardship behavior and conservation outcomes.
- Develop feedback assessment tools to provide specific feedback for farmers about successful conservation outcomes.

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Conclusion

This research engaged crop and livestock farmers and agricultural stakeholders across the PNW to better understand perspectives on cover crops and conservation tillage.

Chapter one was grounded in the diffusion of innovations literature and sought to understand how farmers view the relative advantage and trialability of cover crops. Interviews with dryland crop and livestock farmers suggested that farmers associate cover crops with low relative advantage, including low compatibility with common regional management systems, lack of profitability, and increased cost of inputs act as a deterrent to cover crop integration. Farmers' also associated cover crops with low trialability due to the lack of directly observable cover crop benefits, complex experimentation trials, and inflexible regional programs and policies to support long-term adoption. Farmers' perceptions of low relative advantage and trialability were compounded by a lack of region and zone-specific agronomic and economic information. To support cover crop adoption, focus group results suggest increasing collaboration between producers, university researchers, industry professionals, landowners. Stakeholders also identified the need to reconcile short and long-term financial viability for cover crop. Based on these findings, we recommend that practitioners focus on understanding the unique management goals of the farmer within the environmental, social and economic context in which they operate. This work also supports the need for increased long-term, farmer driven research on the agronomic and economic feasibility of cover crops. In addition, improved collaboration and information sharing between diverse stakeholders that include farmer networks, University researchers, industry professionals, and federal and local agency staff may support cover crop adoption.

Chapter two, drawing from the good farmer literature, sought to better understand how farmers engagement with conservation tillage reconciles productivist goals and stewardship goals across cultural, economic, and social capital. Drawing from interviews with crop and livestock farmers, we found that farmers integrated CT systems to reduce agronomic and economic inputs, reduce erosion, and maintain relationships with landowners, neighbors, and future generations. This suggests that engagement with CT systems allow farmers to demonstrate productivisit symbols of good farming while supporting stewardship goals behavior. Results from chapter two also consider how PNW farmers' historical relationship to erosion, as a cultural symbol, has shaped their response to CT systems. This work contributes to our understanding of how symbols of good farming are shaped by shifts occurring in the agricultural field towards conservation policy, increased consumer demand for sustainably produced product, and the local cultural context (Sutherland and Darnhofer 2012; Riley 2016). Based on findings from chapter two, we suggest that the adoption of conservation practices may be more successful when social and cultural capital are considered alongside economic incentives. Local and state agencies can emphasize culturally relevant symbols of good farming, like erosion and erosion management, that may help farmers reconcile productivist goals and stewardship goals. As Burton and Paragawewa (2011) suggest, providing farmers with “payment by results”, but also help to meet productivist goals, while supporting stewardship behavior. Conservation agency staff can also support the development of farmer-farmer networks, and University researchers can include farmers as co-investigators and increase emphasis on long-term conservation outcomes.

This thesis demonstrates the importance of understanding the local economic, social and cultural expectations that drive farmers’ decisions to adopt and sustain the adoption of on-farm conservation. Understanding the context in which farmers operate can better inform regionally appropriate strategies that align with farmers’ goals and improve economic and environmental outcomes for the region. However, promotion of conservation practices needs to expand beyond financial incentives and focus on approaches that support the development of social and cultural capital. Leveraging farmers’ perspectives in the development of research efforts will help focus these efforts. Lastly, the results and methodologies described in this thesis can be used to support farmers, conservation practitioners, policy-makers, and researchers across the country seeking to increase the adoption of on-farm conservation practices, improve on-farm resilience, and mitigate the effects from climate change.

Appendix A - Interview Questions for Chapter 1

Could you describe what cover crops are?

What types of cover crops do you use, and what reason did you have for using them?

What were some of the barriers associated with implementation?

What are the successes?

How did you navigate those challenges associated with cover crop adoption?

What are the short term vs. long term effects of cover crop usage?

How does your use of cover crops factor into your short and long term management decisions?

What motivates you to continue using cover crops?

How do you think other farmers perceive your use of cover crops?

IF relevant: Does your landlord support the use of cover crops? (only if leased)

What would you suggest for other farmers thinking about adoption?

Grazing:

Grazing cover crops is seen as one viable conservation practice in this region, what are your thoughts on this?

Do you see cover crops being a viable practice without grazing them?

Category 4 Non-Use

There has been some research that shows that cover crop use builds organic matter and decreases erosion. However, it's not clear how widely they are used in the Palouse. I'm interested in hearing your perspective on cover crops in this region.

Could you describe what cover crops are and if you've ever used them? If not, why?

What are your main concerns about the use of cover crops?

What resources would allow you to try cover crops?

What resources or information would be helpful if you were interested in using cover crops?

Focus Group Questions:

What words do you think of [or what comes to mind] when you hear the term "alternative crop" versus "cover crop"? Take the next two minutes to write down your thoughts about alternative crops on one side of the notecard and your thoughts on the term "cover crop" on the other side.

What do you consider a primary reason for using a cover crop?

If you were to consider using a cover crop, what would it take to integrate them into your current management practice?

Prioritization Process: For the last question, you've been given three colored dots that you will use to show which ideas you agree with / care about the most. We'll give you a couple of minutes to place your sticky dots on the statement that you agree with the most; you can place up to two sticky dots on one idea.

For those of you that chose this idea (greatest number of votes), can you describe why you went with that choice?

Can someone share about why they did not agree with this statement (lowest number of sticky dots)

Does anyone have anything else to add about why they chose what they did?

Probing ideas: Only bring these up if discussion lulls ***(2-3 minutes).***

What do you think about…?

Intermediaries for connecting livestock and crop farmers

Equipment co-op or rental

Network development/information sharing

Direct payment-Economic inventive

Appendix B Interview Questions for Chapter 2

Category 1-Farm Characteristics

I'd like to start with some background information about your farm. This will help me understand some characteristics of your farm and how it operates.

Prompt:

1. Can you give me some background information about your farm?
2. How many total acres of farmland do you operate on?
3. How many years have you been farming the land you lease/own?
4. Do you operate on leased or owned farmland?
5. How many acres to you lease? How many acres do you own?
6. How many landlords to you lease from? Do you lease from family?
7. What crops do you grow on the land you lease/own?
8. Do you operate under a cash or crop share agreement?
9. Do you do anything different on your own land vs. the land you lease? Why/Why not?
10. Are you passing your farm onto your children?

Category 2-Motivations for Farming

This next question will help me to understand what it is that is important to you about farming. I want to re-iterate that I'm not looking for any particular answer and you're free to respond in any way.

1. What does it mean to be a good farmer?
2. What are your top three priorities when it comes to farming?
3. What are your top three main concerns when it comes to farming?
4. What do you think threatens farming as a livelihood the most?

Category 3-Crop and Soil Management:

These questions will help me understand how you make decisions regarding crop choice and soil management.

1. What types of conservation practices do you implement on your farm? (no-till, direct seed, grass filter strips, grassed waterways, pest management, precision agriculture)
2. Have you or your landlord participated in any conservation programs (e.g. EQIP, CSP, CRP HFRP, WRP)? If so, what was your experience like?

3. Next, can you tell me about how you define soil health?
    a. How do you manage soil health?
4. I've heard that soil erosion has been a consistent issue is this region because of wind, water, and the steep terrain, how do you manage for widespread issues like this?