Literature Review Summary of the Influences to Soil Health Practice Adoption Behavior in the Midwest

Sarah Roth

Water Resources Center, University of Minnesota

November 16, 2022

Table of Contents

Executive Summary

Increasing voluntary adoption of conservation practices by producers is key to reducing agricultural pollution in Minnesota's waterways. In order to do this, we must understand producer adoption behavior including the drivers of and barriers to adoption. A literature review was conducted that was exclusive to studies in the Midwest, published since 2000, and focused on soil health practices of interest including cover crops, conservation tillage, perennials, and livestock integration. The major factors that influence producer behavior related to adoption were grouped into 5 main categories: farm characteristics, personal characteristics, perceived practice characteristics, social factors, and structural factors.

Farm characteristics refer to the unique aspects of each farm. Studies have shown that positive drivers of adoption include farms with higher crop diversity, that include livestock, and farms with existing conservation practices. Additionally, many studies show that the larger a farm (in acres operated), the more likely the producer is to adopt. Landownership and tenure characteristics also play a role in adoption – for example, renters are less likely to adopt compared to owner-operating producers.

Personal characteristics refer to the individual traits of the producer making adoption decisions. A key driver of adoption in numerous studies is whether a producer has strong stewardship values and believes being a producer means to be "conservation minded". Perceived efficacy – producers' beliefs about the effectiveness of a practice and their ability to implement it – is another important influence that can act as both a barrier to or driver of adoption.

Perceived practice characteristics refer to the way a soil health practice is perceived and evaluated from the producers' perspective. A top barrier to adoption in many studies is the perceived risk of a practice. The economic considerations of a practice can both be a barrier and driver of adoption, depending on the costs or cost savings a producer believes it will bring. Other important influences include observability, trialability, and compatibility of a practice.

Social factors refer to the outside influences of other stakeholders on producers. Many studies found participation in farmer networks or peer cohorts to increase likelihood of adoption due to the positive influence of those groups. Other concepts including social norms and trust can either act as a driver of or barrier to adoption. The types of outreach and engagement that are used around practices is also important. Messages need to be tailored and targeted to the local context; studies show broad messages are far less successful than specific ones for smaller segments of a community and the relevant impacts of a particular practice.

Structural factors refer to the broader agricultural system that affects decision making including the government and economic systems. Studies show that funding and incentives for practices alone will not drive adoption for most producers. They can help relieve economic barriers and decrease risk, but rarely act as the top driver to adoption. The current agricultural system, markets, and subsidies that exist for conventional crops act as a major barrier to adoption for many producers, feeling like they are stuck from making changes. Additionally, the policies, regulations, and structures around conservation programs often act as barriers to adoption due to their inflexibility, inconsistency, and red tape.

Critical gaps in the research include reasons for practice abandonment, the testing of intervention strategies & evaluation of current programs, longitudinal studies, and studies as producer tenure trends continue to change (e.g. increased renters, first generation producers, immigrant & BIPOC producers).

Introduction

When it comes to reducing agricultural nonpoint source pollution in our waters, producers' voluntary adoption of conservation practices is key to its success. While biophysical scientists – including soil scientists and agronomists - have studied the effectiveness of these practices and alternative crops, the human dimensions piece of the equation is often left out of the discussion.

The field of human dimensions, in the context of conservation practice adoption, has focused around three areas of study: policy analysis, economics, and adoption behavior. Policy analysis has focused on the political frameworks and regulations that these voluntary conservation practices exist in, what the rules around them are, and where there are opportunities – to evaluate the best policy options for advancing adoption. Economists have studied the costs and benefits associated with various practices and their adoption. Another branch of social science work around adoption has instead focused on human behavior: understanding producers' barriers to and drivers of adoption. The latter of these three areas of human dimensions is where this summary will focus. While the adoption of these practices remains voluntary, gaining a deep understanding of why adoption decisions are made is of utmost importance. We cannot make strides in encouraging adoption of these soil health practices – unless we understand what influences adoption behavior.

Many researchers have compiled in-depth meta-analyses and literature reviews of the influences to adoption over the last 2 decades (Campbell & King 2022, Carlisle 2016, Baumgart-Getz et al 2012, Knowler & Bradshaw 2007, Liu et al 2018, Ranjan et al 2019, and Prokopy 2008, 2019). They've analyzed both qualitative and quantitative papers from all over the US and the world on a variety of conservation practices. This report does not attempt to re-create their work or build on existing frameworks or theories. Instead, it aims to give a high-level summary on a specific set of literature: studies taking place in the Midwest US, focused on key soil health practices of interest (cover crops, conservation tillage, perennials, extended rotations, and livestock integration), and published since 2000. The summary serves to illustrate the depth and complexity of these factors – and where existing knowledge gaps still exist.

Background

The majority of academic studies focused on understanding producer decision-making around conservation practices adoption have drawn from several theories or frameworks that focus on individual-level behavior: Theory of Planned Behavior (TPB; Ajzen 1991), Reasoned Action Approach (Fishbein & Ajzen 2011), Diffusion of Innovations (Rogers 2003), and Value-Belief-Norm (VBN) Theory (Stern 2000). These theories or frameworks attempt to incorporate the many complex factors that affect behavior change.

- **Theory of Planned Behavior**: Ajzen's TPB says one's intention to perform a behavior is central to influencing behavior. The stronger an intention, the more likely an individual is to engage in that behavior. Intention is influenced by three key factors: perceived behavioral control, attitudes of the behavior, and subjective norms. *Perceived behavioral control* refers to the extent an individual believes they have the skills, abilities, resources, and opportunity to perform a behavior. It is similar to Bandura's (1977) concept of perceived self-efficacy: confidence in one's ability to perform an action. *Attitude towards a behavior* refers to ones positive or negative

appraisal of the behavior. *Subjective norm* refers to the "social pressure to perform or not perform the behavior".

- **Reasoned Action Approach**: Fishbein & Ajzen's RAA is similar to TPB in that perceived behavioral control, attitudes towards a behavior, and subjective norms determine one's intention about a behavior, which in turn influences behavior. The key difference in RAA is that three types of beliefs inform those three respective factors (*control beliefs, behavioral beliefs, and normative beliefs*) – which are all influenced by one's *background factors*, at the individual level, socially, and the available information one has access to. These background factors can include things like personality, values, perceived risk, education, culture, and knowledge – among many others.
- **Diffusion of Innovations**: Rogers DOI aims to communicate how ideas (such as practice adoption) spread or gain momentum across a system, geography, or population. DOI describes how a population moves through adoption through time and the stages in which an individual adopts a behavior or practice. DOI also describes five main factors that influence adoption. *Relative advantage* refers to how a practice is seen compared to other practices or former practices (e.g. conventional methods or crops). *Compatibility* describes how the practice fits in with the needs, experiences, and values of the potential adopter. *Complexity* refers to how difficult the practice is – both to use and to understand. *Trialability* refers to the extent to which a practice can be tested prior to committing to adopting. *Observability* describes the extent to which a practice provides tangible results.
- **Value-Belief-Norm Theory:** Stern's VBN is a moral choice theory - individual actions have consequences for others and morals influence those actions. VBN suggests that one's values and beliefs activate a personal norm which influences behavior. The *personal norm* is the internalization of social norms (like TPB's subjective norm) – how the social pressure an individual feels influences feelings of personal obligation. The beliefs that influence this personal norm are *awareness of consequences* of one's actions and *ascription of responsibility* – beliefs about who is responsible for those consequences. Beliefs are influenced by the values an individual holds (e.g. biospheric, altruistic, egoistic).

Scholars have grouped these factors in a variety of ways as there are many views of how to categorize them. Most of the literature chooses one theory or approach in which to frame the study. Some studies use other frameworks altogether. For this summary, factors from all of the above theories – as well as additional theories – have been used and grouped into 5 categories:

- **Farm characteristics:** the unique aspects of each farm including their past use of crops, livestock, and conservation practices, landownership, farm size, and land quality.
- **Personal characteristics:** the individual traits of the producer making decisions including values, attitudes, and perceived abilities
- **Perceived practice characteristics:** the way a practice is perceived and evaluated from the producers' perspective including its risk, economic implications, benefits, and fit with current farming system
- **Social factors:** the outside influences of other farmers, resource managers, and ag-business players – and how they communicate, engage, and level of trust
- **Structural factors:** the broader agricultural system that affects decision making including markets, policies, program structures, subsidies, and incentives

The literature summarized in this report focuses on how these diverse and complex factors play a role in behavior change. Some factors appear in the literature more than others as seen in Figure 1. The darker the color, the more often the concept appears in the literature that was reviewed.

Farm Characteristics	Personal Characteristics	Perceived Practice Characteristics	Social Factors	Structural Factors
farm diversity & existing conservation practices	stewardship values	perceived risk	influencing groups	funding / incentives for new practices
farm size & income	perceived efficacy	economic considerations	outreach, engagement, & communication	conventional crop subsidies & markets
landownership characteristics	other personality factors	observability, trialability, & compatibility	social norms	policies, regulations & program structures
labor access	adaptation	perceived benefits	trust	
land quality		perceived barriers		

Figure 1. Depth of concepts in literature summary

Summary

Factors that emerged as important drivers or barriers of soil health practice adoption in these studies can be grouped into 5 categories that will be elaborated on:

- Farm characteristics
- Personal characteristics
- Perceived practice characteristics
- Social factors
- Structural factors

1. Farm Characteristics

The unique characteristics of each farm can play a role in adoption of soil health practices. The diversity of crops & practices, existing conservation practices, farm size & income, landownership characteristics, labor access, and land quality all can impact adoption.

Farm Diversity & Existing Conservation Practices

Many studies suggest that farms that have higher crop diversity are more likely to adopt soil health practices (Arbuckle & Roesch-McNally 2015, Gardezi & Arbuckle 2019, Prokopy et al 2008, Prokopy et al 2019, Singer et al 2007). Producers with livestock can be more likely to adopt practices as well (Morris & Arbuckle 2021, Prokopy et al 2019, Singer et al 2007). However, in contrast, some studies found that livestock owners adopted fewer soil health practices overall compared to crop producers (Kalcic et al 2014, Prokopy et al 2008). Specific to livestock, producers with larger herd size are more likely to adopt rotational grazing (Che et al 2022).

Additionally, it is well documented that producers with existing soil health practices are more likely to adopt additional ones (Baradi 2009, Carlisle 2016, Morton et al 2015, Plastina et al 2020, Prokopy et al 2019, Prokup et al 2017, Sawadgo et al 2021, Singer et al 2007, Thompson et al 2021, Wilson et al 2014 & 2018), so that may be a target audience for future outreach. In Iowa, Morris & Arbuckle (2021) found producers with an existing NRCS conservation plan were 1.7 times more likely to adopt no-till than those without a plan. Ranjan et al (2019) found studies with producers who thought of their farm and managing their practices as a "system" was always a driver of adoption. Roesch-McNally et al (2018) expanded and found producers who utilize a "systems approach" in cover crops management are more successful after adoption. However Carlisle (2016) found incremental change is easier than trying to transform all systems on a farm.

Farm Size & Income

Farm size is a well-studied factor that is usually positively associated with adoption. The larger a farm (in acres operated), the more likely that producer is to adopt (Baradi 2009, Burnett et al 2018, Dunn et al 2016, Parker et al 2007, Prokopy et al 2008, Prokopy et al 2019, Ryan et al 2003, Sautter et al 2011, Sawadgo et al 2021, Soule et al 2000, Wang et al 2020, Wilson et al 2019). Typically, this is associated with larger farms bringing in greater on-farm income which can be used to adopt new practices. Importantly, Thompson et al (2021) points out that while an increase in farm size is associated with an increase in adoption, the largest farms in the sample typically have not adopted. Studies have found that producers with higher income are also more likely to adopt (Cutforth et al 2001, DeDecker et al 2022, Prokopy et al 2019, Ryan et al 2003, Sheeder & Lynne 2011). However, a few studies have found smaller farm owners are more likely to adopt (Kalcic et al 2014).

Landownership Characteristics

The landownership of a farm also can play a role in adoption – whether it is owner-operated or rented out by a non-operating landowner or by an absentee landowner.

Compared to landowners, several studies show that renters are less likely to adopt a variety of soil health practices including rotational grazing (Campbell & King 2022), silvopasture (Mayerfeld et al 2016), and conservation tillage (Parker et al 2007, Soule et al 2000). A study by Roesch-McNally et al (2018) in Iowa demonstrated that renters do not benefit as much as landowners from cover crops with regards to the improved soil resources. Therefore, it makes sense that a key barrier to adoption of both no-till and cover crops is due to a tenant or renters' decision (Sawadgo et al 2021). One study found that among producers who had discontinued cover crops, they generally had more rented land, suggesting that over time the practice either became less profitable or less effective for their goals (Beestra et al 2022).

However, for renters who adopt practices, they are most likely to use no-till than any other practice (Sawadgo et al 2021). Once a renter does adopt a practice, having a supportive landowner is key to the continuation of that practice (Dunn et al 2016). For some renters, they only adopted and continued to use cover crops to maintain their lease (Plastina et al 2020). Some landowners are willing to increase lease lengths or even contribute to renters' cost of cover crop adoption. In particular, producers who have already adopted no-till are most likely to help cover those costs for renters (Sawadgo et al 2021). However, non-operating landowners are less likely to have lease provisions about soil health practices when compared to owner-operators (Ulrich-Schad et al 2016).

For absentee landowners, the main barrier to adoption is the lack of communication with natural resource agencies and instead relying on renters for information about practices like conservation tillage (Petrzelka et al 2009). Even in Iowa where non-operating landlords own the most land in the state, owner-operators are the most likely to adopt soil health practices (Sawadgo et al 2021). Non-operating landowners who visit their land more often were more likely to encourage adoption of conservation tillage and cover crops to their renters; the farther they lived from their rented land, the less likely they are to encourage conservation tillage (Ulrich-Schad et al 2016).

Landownership being passed down between generations also can be a factor in adoption. Non-operating landowners who inherited their land were less likely to encourage cover crops (Ulrich-Schad et al 2016). Additionally, farms without a succession plan in place are less likely to adopt conservation tillage – and also more likely to be rented out (Parker et al 2007).

Labor Access

For any kind of producer, but especially those who have livestock related practices, access to labor can be a major constraint. If skilled labor is required, producers perceive practices as more difficult and have lower perceived efficacy around them (Campbell and King 2022). Plastina et al (2020) also identified labor availability as a barrier to cover crops adoption due to the experience required. One study found that more educated producers perceive labor access as a bigger barrier than less educated producers. However, producers who had already adopted rotational grazing did not perceive labor as barrier (Wang et al 2020).

Land Quality

The actual quality of the farmland was an important factor in adoption for some producers. Che et al. (2022) found that when land quality is poor, producers are more likely to adopt rotational grazing.

However, another study on rotational grazing found just the opposite. Wang et al (2020) found that producers with higher quality land perceive fewer barriers and are good targets for adoption. Producers with lower quality land described higher investment costs and greater risk of recouping their investment, and were less likely to adopt.

For producers with highly erodible land (HEL), land quality was also found to be a factor in adoption. Producers with HEL fields were more likely to adopt conservation tillage practices (Kara et al 2008, Sawadgo et al 2021). In Indiana, producers with HEL were also motivated to control erosion by adopting cover crops (Yoder et al 2021).

2. Personal Characteristics

The personal characteristics of producers play a huge role in influencing adoption of soil health practices. The types of values producers hold, their attitudes, identities, and habits all influence their willingness to adopt. Additionally, the perceived efficacy of a practice – such as their ability or control to use a practice and their beliefs of its expected outcomes– all play an important role in whether they adopt, maintain, or discontinue a practice.

Stewardship versus Business Values

Whether a producer has strong stewardship values (being a producer means to protect soil and water quality or be "conservation-minded") or "farm as business" values (being a producer means to get high yields and profits) is a very influential factor affecting adoption. Producers with strong stewardship values are more likely to adopt a variety of soil health practices including cover crops (Burnett et al 2018, Plastina et al 2020, Prokup et al 2017, Ramsey et al 2019, Ulrich-Schad et al 2016), rotational grazing (Campbell and King 2022), conservation tillage (Kalcic et al 2014, Morris and Arbuckle 2021, Ryan et al 2003, Sautter et al 2011), diversified livestock & crops (Parker et al 2007) and other conservation practices more broadly (Pradhananga & Davenport 2022, Prokopy et al 2019 Floress et al 2017, Liu et al 2018). Stewardship values in producers are generally considered a main driver of adoption.

Economic-driven, farm-as-business values can be either a barrier to or a driver of adoption for producers. Some studies showed producers with higher business values are less likely to adopt compared to those with stewardship values (Campbell and King 2022, Floress et al 2017). However, if a practice is perceived as profitable or "good for business" by a producer who has stronger farm as business values, those values can be a driver of adoption, as seen with conservation tillage in Kansas (Baradi 2009) and Michigan (Ryan et al 2003).

A study in western Illinois found that producers often have competing stewardship and business values, as well as other values, that depend on the context and situation as to which one comes out on top (Thompson et al 2015). Similarly, Wilson et al (2014) found that rather than a value acting as purely a driver or barrier, the main value for a producer can determine other factors that more affects their adoption decision including perceived efficacy (for business valuing producers) and risk perception (for stewardship valuing producers).

Perceived Efficacy

Perceived efficacy refers to producers' beliefs about effectiveness of a conservation practice in achieving its outcomes, as well as producers' ability to implement them on their farms (Perry & Davenport 2020)

and can be broken into two sub-categories. Self-efficacy, often referred to as behavioral control, refers to a producers' own ability to implement a practice (Bandura 1994). Whereas response efficacy refers to a producers' belief that by adopting the practice, it will achieve certain results or intended outcomes (Ajzen 2002). Both of these (self-efficacy and response efficacy) play an important role in adoption decisions.

Self-efficacy – or behavioral control – is important for producers considering a practice. If producers do not believe it is feasible in their current system (whether individual farm or broader agricultural context) or that they have the ability to implement it, they will be less likely to adopt, even if they desire to (Atwell et al 2009, Wilson et al 2019, Arbuckle & Roesch-McNally 2015). A study by Perry & Davenport (2020) showed producers have low self-efficacy when it comes to perceived control in the broader agricultural system, but feel less constrained by their self-efficacy when it comes to their ability to do the practice personally. When producers feel they have more control, they will be more likely to adopt (DeDecker et al 2022, Pradhananga & Davenport 2022).

Producers with higher perceived response efficacy (believe the practice will achieve its intended environmental outcomes) are more likely to adopt cover crops (Burnett et al 2018, Prokup et al 2017, Wilson et al 2018), conservation tillage (DeDecker et al 2022, Wilson et al 2018), and other conservation practices (Pradhananga & Davenport 2022, Wilson et al 2014). In fact, Burnett et al (2018) found response efficacy was a good predictor of both current and future adoption behaviors.

A study by Beestra et al (2022) showed that producers who discontinued cover crops had a decrease in perceived-efficacy over time. On this vein, Wilson et al (2018) recommended outreach strategies that aim to increase perceived efficacy are more ideal solutions than financial changes.

Adaptation

Adaptation of producers' production systems – both as an ability to and a goal – can play a role in adoption. Producers who believe they have higher capacity to adapt their system (practices, crops, methods, etc.) are more likely to adopt cover crops (Gardezi & Arbuckle 2019). Experience with previous flooding and erosion – and wanting to adapt – was positively correlated with adoption of cover crops and planting of HEL (Morton et al 2015). Knutson et al (2011) found that long-term adaptation for drought was a driver of adoption in Nebraska for a variety of practices including cover crops, conservation tillage, and integrated livestock.

Other Personality Factors

A variety of other personality factors can affect adoption decisions including attitudes, desire for control, and empathy.

Producers who hold attitudes around the importance of environmental quality and protection have been found to be more likely to adopt practices (Prokopy et al 2008). However, other attitudes have not been found to be good predictors of adoption on their own. A study in Michigan found that producers with strong attachment to their land – and strong attitudes about conserving it – are more likely to adopt conservation tillage (Ryan et al 2003). Similarly, having a sense of personal responsibility to protect water quality was found to be a driver of adoption in several studies (Kalcic et al 2014, Burnett et al 2018, Pradhananga & Davenport 2022).

Several studies have identified feelings of empathy and sympathy as being drivers of adoption. Sautter et al (2011) found producers who are more empathetic are more likely to adopt. Sheeder & Lynne (2011) also found empathetic producers are more likely to adopt – as well as those who are more sympathetic; producers with feelings of empathy are less likely to be motivated by self-interest.

Maintaining a sense of control around their land can be an important feeling for producers. One study found producers who see adoption of practices as taking away their control of their land were less likely to adopt (Sautter et al 2011). Similarly, producers who desire more control over their farm were less likely to adopt conservation tillage in a 2011 study by Sheeder & Lynne.

3. Perceived Practice Characteristics

As producers weigh their options regarding practice adoption, they carefully consider the characteristics of a practice – or at least how they perceive those characteristics to be. They appraise the perceived benefits of and barriers to adoption, they consider the economic implications, they weigh the risk of adopting (and of not adopting), and consider how observable, compatible, and trial-able the practice is.

Economic Considerations

Certainly the economic implications of a practice are important for producers to consider as they can help remove barriers (Carlisle 2016, DeDecker et al 2022) or be barriers themselves in the form of establishment, equipment, or labor costs (Sacket 2013, Knutson et al 2011, Perry & Davenport 2020, Plastina et al 2020). For no-till, input savings was a significant driver of adoption (Reimer et al 2012, Ranjan et al 2019). For cover crops, however, the increased costs associated with establishing a new unknown crop (Wilson et al 2019), the additional equipment/technology needs (Thompson et al 2021, Busse et al 2015), and termination costs (Sawadgo et al 2021) were significant barriers to adoption.

Perceived Benefits

The benefits producers believe adopting a practice can provide are important drivers of adoption. Producers who participated in cohorts or peer networks about conservation practices were more likely to learn about the various benefits about adoption – both economic and ecological (Bressler et al 2021). Improving soil health was an important driver for many producers (Arbuckle & Roesch-McNally 2015, DeDecker et al 2022, Fleckenstein et al 2020, Plastina et al 2020, Sackett 2013, Yoder et al 2021) including increasing organic matter, decreasing compaction, and controlling erosion. Increases to yield was another perceived benefit and driver of adoption for producers (Prokopy et al 2019). However, if benefits are uncertain, it can be a barrier to adoption (Knutson et al 2021, Wang et al 2020).

Perceived Barriers

The barriers producers perceive about practices, on the other hand, can be a constraint to adoption. As Reimer et al (2014) describes, producer decisions are “scale dependent and influenced by issues of space, institutions, and time” – they are not “discrete, binary” adoption decisions, nor are they purely individual decisions. Weather (Perry & Davenport 2020), timing issues (Plastina et al 2020), pests (Yoder et al 2021) and labor availability (Campbell and King 2022) – along with expenses – are perceived as key barriers to adoption that are influenced by scale and time. The more barriers a producer perceives, the less likely they are to adopt (Wilson et al 2018). For example, a study in 16 corn producing states found that because conservation tillage impacts are more immediate with fewer costs, it is more palatable than practices that take longer to see the return on investment (Soule et al 2000).

Perceived Risk

The perceived risk of a practice – or the producer's level of risk they are willing to accept – is a major factor in the decision to adopt. Perceived risk of cover crops in particular is a barrier of adoption for many producers (Arbuckle & Roesch-McNally 2015, Dunn et al 2016, Ranjan et al 2019, Reimer et al 2012, Snapp et al 2005, Wilson et al 2018, Yoder et al 2021). Risks included the potential yield reduction of cash crops, as well as the cost of implementing of cover crops (seeds, equipment, chemicals) without knowing the return on investment. Producers with less land in or lower quality land, in particular, can perceive more risk of recouping investment costs and be less likely to adopt (Wang et al 2020).

Producers with higher personal risk tolerance were more likely to adopt practices (Burnett et al 2018). Producers with access to resources and educational organizations about practices (Blesh & Wolfe 2014), as well as peer cohorts or networks (Bressler et al 2021) were more likely to adopt because they helped mitigate risk through education about practice benefits. Additionally producers who viewed a practice as reducing yield risk because it had less variability between seasons were more likely to adopt (Ramsey et al 2019).

However, risk can also be a driver of adoption if the disadvantages or risks due to *not* adopting are perceived to be greater than adopting. Thompson et al (2021) demonstrated that producers who believe cover crops reduce the risk of nutrient loss in waterways were more likely to adopt. Knutson et al (2011) detailed the way practices can help reduce short term drought risk and increase long-term adaptation for drought, and thus risk was a driver for adoption. Similarly, producers who lived on highly erodible land (HEL) saw no-till and cover crops as ways to reduce risk of soil erosion and minimize flooding impacts (Morton et al 2015).

Observability, Trialability, & Compatibility

Producers are more likely to adopt and maintain practices if they have opportunities to test a practice out or trial it (trialability), if they can see the benefits for themselves on their own or others' fields (observability), and if they deem the practice to fit into their current farming system and land type (compatibility). Trialability is a common driver for practices including cover crops, livestock integration, and conservation tillage practices (Dunn et al 2016, Campbell and King 2022, Ramsey et al 2019). Sautter et al (2011) found that producers who try conservation tillage are more likely to stay with it over time. Compatibility is also an important factor. Producers might have the desire to adopt but if they are unsure if it fits in with their current farming system such as equipment (Atwell et al 2009) land type, or tenant situation (Sawadgo et al 2021) they might not deem it feasible. A practice's perceived compatibility with other adopted practices on the farm can be a driver of adoption (Reimer et al 2012). Observability (or lack thereof) can also be an important factor in adoption. If a practice does not have benefits that are easily viewable or observable, it can make producers less likely to adopt (Fleckenstein et al 2020); while seeing the benefits of a practice makes producers more likely to continue (Perry & Davenport 2020, Ramsey et al 2019) or intensify the practice (Thompson et al 2021).

4. Social Factors

A variety of social factors play an important role in influencing adoption of soil health practices. The types of groups and individuals a producer interacts with can be very important. Also important is the

types of communication, outreach, and engagement are taking place within those interactions. Social norms and trust are also important influencing factors.

Influencing Groups

Many different groups have influential roles on producers' decision to adopt soil health practices including social networks, private industry/crop advisors, and conservation agency/extension staff.

Formal or informal social networks such as farmer networks or peer cohorts are an important driver of adoption. Bressler et al (2021) found that producers who participated in a social network or peer cohort helped generate innovative ideas, had reduced feelings of isolation associated with adoption, and were more likely to promote practices to their peers. Many other studies found that producers who are involved in social networks are more likely to adopt (Prokopy et al 2008, Baumgart-Getz et al 2012, Lee et al 2018). Blesh and Wolfe (2014) shared this increase in adoption of those who are involved in social networks is because they have additional access to resources for learning. The strength of ties to a social network also matter. According to work by Manson et al (2016), the more strong ties that exist in a social network, the more adoption is likely to take place. Che et al (2022) showed that peer networks have as great of an effect on adoption as subsidies do regarding rotational grazing practices. Social networks are important for practice maintenance/continuance as well: producers who engage more in farmer networks in Iowa were shown to be more successful after adoption (Roesch-McNally et al 2018). Interestingly, DeDecker et al (2022) found that producers who are *less* engaged in farmer networks are more likely to adopt because if they are more visible in their network, it increases the risk associated with innovating or adopting because more peers will see if it "fails". Increasing farmer networks and peer learning opportunities is recommended to decrease perceived barriers and increase efficacy (Wilson et al 2018), strengthen social ties and resource flow (Manson et al 2016), and improve the stability and viability of new markets (Mattie et al 2016).

Beyond social networks, Cutforth et al (2001) found it depended on the group producers interact with whether they were positively influenced towards adoption or negatively influenced. Commodity groups, crop consultants, retailers, and even family were seen as negative influences on expanding farm diversity beyond corn & soy, while local extension and non-family landlords were positive influences (Cutforth). In Michigan, producers who use a crop advisor were more willing to try a new practice and more likely to have already adopted cover crops and conservation tillage (Eanes et al 2017). Eanes' work did show crop advisors have a greater effect on conservation practices that are associated with products or services (such as cover crop seeds), compared to tillage. While Atwell et al (2009) found that producers in Iowa listen more to agribusiness staff than conservation agency staff, several studies showed more frequent interactions with private agribusiness and retailers had a negative effect on adoption (Lee et al 2018, Morton et al 2015, Prokup et al 2017).

Recent work in Minnesota found that local conservation agencies, family, and neighbors are the most influential groups on producer decision making related to conservation practices (Pradhananga & Davenport 2022). Interactions with public conservation staff were positively associated with adoption in Iowa (Lee et al 2018) and in Indiana (Kalcic et al 2014). Similarly, producers in Ohio who get more information from public agencies – or who work with a nutrient management consultant – are more likely to adopt cover crops (Prokup et al 2017). In Iowa, producers who visited USDA service centers more often were more likely to adopt cover crops, no-till, and turn cropland to perennials (Morris & Arbuckle 2021).

Social Norms

Social norms – the pressures or expectations about how others will behave or expect you to behave – are an important influencing factor of adoption. The societal pressures within a community often drive producers to adopt if others that are important to them are adopting – or if they believe that others want them to adopt. Producers are influenced by others' opinions of a particular practice (DeDecker et al 2022, Liu et al 2018), whether they are peers they know personally or others in their community or geography that they consider important or leaders. Che et al (2022) found the more people a producer knows who have adopted, or as adoption rates increase in their local geography, the more likely a producer is to adopt. Producers who perceived themselves as central or important to their social group were more likely to adopt cover crops (Gardezi & Arbuckle 2019).

Social norms can also act as a constraint to adoption. Grover and Gruver (2017) found the pressure to do what large-scale conventional farmers are doing to be a major barrier for diversification of cropping systems, including perennials. The perception – whether true or not - that a crop is not successful or carries risks can be spread through a community and become a barrier to adoption (Yoder et al 2021). In Wisconsin, a main barrier to silvopasture adoption was the existing social norm that you do not talk about the practice with natural resource professionals or other producers for fear it could be construed as woodland grazing – a discouraged practice (Mayerfeld et al 2016).

Trust

Trust is a lesser studied, but important factor affecting adoption. Producers need to deem information about practices as credible and trustworthy – and when they do, it is a consistent driver of adoption (Liu et al 2018). Research in Minnesota showed that when trust and communication were consciously built within a network of producers, resources, and agency staff, that knowledge exchanged flowed more freely which encouraged adoption (Nerbonne & Lentz 2003). In Michigan, producers had high levels of trust for their crop advisors and in turn, those who used crop advisors were more likely to adopt (Eanes et al 2017). On the other hand, when trust does not exist, it can be a barrier to adoption. In Indiana, producers with low trust of government and its programs (including conservation programs) were less likely to adopt (Kalcic et al 2014).

Outreach, Engagement, & Communication

The types outreach, engagement, and communication that take place within social contexts are also very important determinants of adoption.

Terms like awareness or knowledge need to be used cautiously to describe their impact on adoption. Awareness or knowledge needs to be accompanied by specifics of what they refer to – rather than broad "awareness". Several studies show awareness or knowledge of specific conservation programs available is positively associated with adoption (Baumgart-Getz et al 2012, Prokopy et al 2019, Sackett 2013) while not having enough information about practices was a barrier to adoption for others (Singer et al 2007). Additionally, knowledge or awareness of specific practice impacts was also associated with higher adoption (Baumgart-Getz et al 2012). In an evaluation of conservation tillage studies, Knowler & Bradshaw (2007) found one of the only factors affecting adoption that was significant across studies was the awareness of environmental threats. Other studies found awareness or knowledge of the cause and consequences of environmental problems was not a driver of adoption (Baumgart-Getz et al 2012).

Outreach and engagement programs and their direct impact on adoption is also lesser studied. In Indiana, even when adoption did not change over time after focused outreach efforts, producers self-

reported a change in behavior as a result of attending an outreach event (Busse et al 2015). Support and outreach by conservation staff *during* the time when producers are trialing or transitioning practices should be a key focus.

Outreach also needs to be tailored and targeted to the local context because the factors that affect adoption are also local and contextual (Knowler & Bradshaw 2007). In a 2002 Midwest study, the most used source of information about conservation differed between states and locally, so broad-based outreach approaches are likely less effective. Instead, agencies should target outreach in "smaller, specific segments of the farm population" (Tucker & Napier). Carlisle (2016) echoed that outreach should be targeted locally and be different depending on the audience (adopters, non-adopters, potential adopters, etc.). Targeted outreach should also be appropriate for the audience, as often resources are seen as too "academic" (Grover & Gruver 2017). Even though soil and water modeling has improved, producers will not change practices due to better models – but instead want to know impacts on a "field by field basis" through tailored plans (Zimnicki et al 2020).

Another key component to successful engagement around adoption is the use of feedback and feedback loops. Sharing back with producers the difference they are making in the community or in the environment and the benefits they are receiving on their farm – and bringing together farmer networks to learn together – are key concepts of feedback loops that help empower self-efficacy to continue a practice (Perry & Davenport 2020).

Outreach and communication with absentee landowners, non-operating landlords (NOLs), and renters is particularly tricky. Over financial constraints, absentee landowners flagged a lack of communication with local conservation agencies and relying on their renters for information as the top barriers to adoption (Petrzelka et al 2009).

5. Structural Factors

The broader systems (governmental, economic) outside of an individual producer and their farm also impacts adoption of soil health practices through factors such as funding incentives and subsidies, markets, crop insurance, policies, regulations, and program structures.

Funding Incentives for New Practices

The availability of funding or incentives for soil health practices is often a point of focus for those trying to encourage adoption. The availability of funding is important and can help remove any economic barriers of adoption such as early costs of equipment or seed (Che et al 2022, Wilson et al 2019). Producers with more negative perceptions of practices or with greater perception of risk are less likely to self-fund adoption, so these incentives can be imperative (Dunn et al 2016). Availability of funding or financial incentives (Lee et al 2018, Plastina et al 2020, Liu et al 2018) or tax incentives (Mattia et al 2016, Sawadgo et al 2021) can be drivers of adoption. However, these incentives are rarely the *top* driver of adoption (Carlisle 2016, Ryan et al 2003). In fact, a study on rotational grazing found the effects of producers participating in peer networks to have an equal affect on adoption as providing incentives (Che et al 2022). Producers often have mixed perceptions on incentives – it usually depends on the type of practice and how much of a transition from current cropping systems it would require (Kalcic et al 2014), as well as the situational context (Ranjan et al 2019). It is important that incentive and cost-share

programs are communicated about clearly and broadly. Dunn et al (2016) found that over half of producers in their study believed they were not eligible for cost-share programs.

Conventional Crop Subsidies & Markets

One of the biggest barriers to adoption for producers is the current agricultural system market and its subsidies for conventional crops. Producers feel constrained by this system and unable to make changes, even when they desire to (Atwell et al 2009, Carlisle 2016, Knutson et al 2021, Grover & Gruver 2017, Perry & Davenport 2020). These subsidies also act as a risk management strategy so producers may be less likely to relinquish them by changing cropping systems (Gardezi & Arbuckle 2019). Additionally new crops are perceived to have lower prices than commodity crops, disincentivizing adoption (Grover & Gruver 2017). Federal crop insurance can also act as a barrier to adoption (Perry & Davenport 2020, Gardezi & Arbuckle 2019).

Even when funding incentives or cost-share is available, it sometimes is not substantial enough to warrant adoption and overcome the barriers of keeping conventional cropping systems. Stuart and Gillon (2013) found that subsidies and markets for commodity crops can be so strong that they overcome any producer desire to maintain conservation – and can even cause producers to revert land in conservation. They believe voluntary approaches have too small of incentives and instead recommend incentives be closer tied to crop values to discourage reversion or abandonment. Roesch-McNally et al (2018) echoed that resolving field-level barriers (costs of seeding) does not solve the broader agricultural system structural barrier that constrains producers. Developing markets for non-commodity crops would be on step towards encouraging adoption (Mattie et al 2016).

Contrary to other studies finding commodity markets to be a barrier, one study in the upper Midwest found that an increase in number of total corn markets in an area was positively correlated with an increase in planting of highly erodible soils (HEL) and land in cover crops (Morton et al 2015)

Policies, Regulations, & Program Structures

The program structures, regulations, and policies in place – from the local level to the federal level – also play a role in adoption, typically as a barrier. Perceptions of federal programs matter when it comes to adoption of soil health practices (Ranjan et al 2019). A study in Indiana showed producers are constrained by current state and federal regulations because they tend to favor large, non-diverse operators (Grover & Gruver 2017). Producers desire programs around soil health practices that are straightforward, flexible, targeted, and consistent over time, rather than changing every few years (Atwell et al 2009). For other producers, however, participation in federal programs around conservation lowered their perceived yield-risk impacts and thus drove them to continue the adoption of their practice (Ramsey et al 2019). Recommendations to encourage adoption include better incentivizing large-scale transition through federal policy change, such as improving the Farm Bill (Zimnicki et al 2020).

Literature Gaps/Needs

Through this summary – as well as the literature reviews compiled by other scholars over the years – a variety of literature gaps have emerged. These needs for further research are summarized below, in no particular order.

1. First, a very understudied aspect of adoption behavior is the concept of discontinuing or abandoning a practice. Studies have typically focused on motivations for adoption or intentions to adopt – but few have studied producers who have discontinued their soil health practices. Additionally, understanding the barriers to maintaining these practices might shed some light on reasons for abandonment.
2. While there have been a few studies focused on non-operating landowner and renter adoption behavior, over half of cropland in the US is rented and eighty percent of rented cropland is owned by non-operating landowners (Bigelow et al 2016). That makes this group of particular importance to understand the motivations behind adoption behavior. We need more studies to understand this group of producers and landowners, especially as tenure trends continue to change.
3. One area that is continually called out as a future research need in existing literature is studies that test out specific intervention strategies (such as outreach and engagement programs [Carlson & Stockwell 2013]) and see the change in adoption behavior before and after, as well as any changes in attitudes, risk perceptions, and perceived efficacy: factors that are known to be important influences to adoption. Studies should incorporate feedback back to producers (as Perry & Davenport 2020 described as key) and evaluate program effectiveness. Evaluation of specific conservation programs, their participation, and related outcomes are also an important research need (Reimer et al 2014).
4. Several studies have shown that social norms play an important role in influencing adoption behavior. However, as Prokopy (2019) states, "…variables suggested by common social science theories do not seem to be frequently or effectively operationalized in the farmer conservation practice adoption literature; prominent among these missing variables is the role of social norms". Thus, we need additional theory-based studies to continue to flesh out the importance of this variable. In what ways and contexts do social norms present themselves and are most salient? How can program managers seek to activate these norms to encourage adoption?
5. An emerging area of study around adoption behavior has been around network analysis – understanding the diverse influences in a producers' sphere, how they connect, and what the relative strength of influence is among each player/group. More study in this field could shed additional light on how these players interact to influence producers, in what venues and contexts, and where to prioritize resources to amplify these networks.
6. One area of study that is almost non-existent is long-term longitudinal studies. Longitudinal studies could demonstrate changing adoption trends over time, if intentions to adopt lead to actual adoption, trends in abandonment, and even how adoption moves through a landscape or region. These studies could importantly show the stages of adoption in a community over time – and how they might translate to other geographies.
7. Few studies investigated adoption behavior related to the planting of perennial crops. Many of these perennial crops have been developed more recently, and thus encouraged for less time, than other practices such a conservation tillage and cover crops.

8. Last but not least, few scholars have studied the culturally specific barriers to adoption by producers that are non-traditional, but growing, in the Midwest (first generation producers, female producers, producers of color, and immigrant producers). Just as the drivers of and barriers to adoption for the "typical" white, male producer are diverse and varied – so likely are those for non-typical producers. Studies should focus on understanding the culturally specific and place-based factors influencing adoption behavior for these newer groups of producers to make sure outreach and programs can be appropriately targeted.

Citations

Arbuckle, J. G., & Roesch-McNally, G. (2015). Cover crop adoption in Iowa: The role of perceived practice characteristics. Journal of Soil and Water Conservation, 70(6), 418-429.

Atwell, R. C., Schulte, L. A., & Westphal, L. M. (2009). Linking resilience theory and diffusion of innovations theory to understand the potential for perennials in the US Corn Belt. Ecology and Society, 14(1).

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes 50(2):179–211.

Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior 1. Journal of applied social psychology, 32(4), 665-683.

Baradi, N. K. (2009). Factors affecting the adoption of tillage systems in Kansas. PhD dissertation, Kansas State University.

Baumgart-Getz, A., Prokopy, L. S., & Floress, K. (2012). Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. Journal of environmental management, 96(1), 17-25.

Beetstra, M. A., Wilson, R. S., & Doidge, M. (2022). Conservation behavior over time: Examining a Midwestern farmer sample. Land Use Policy, 115, 106002.

Blesh, J., & Wolf, S. A. (2014). Transitions to agroecological farming systems in the Mississippi River Basin: toward an integrated socioecological analysis. Agriculture and Human Values, 31(4), 621-635.

Bigelow, D., Borchers, A., & Hubbs, T. (2016). U.S. Farmland Ownership, Tenure, and Transfer, EIB-161, U.S. Department of Agriculture, Economic Research Service.

Bressler, A., Plumhoff, M., Hoey, L., & Blesh, J. (2021). Cover crop champions: linking strategic communication approaches with farmer networks to support cover crop adoption. Society & Natural Resources, 34(12), 1602-1619.

Burnett, E., Wilson, R. S., Heeren, A., & Martin, J. (2018). Farmer adoption of cover crops in the western Lake Erie basin. Journal of Soil and Water Conservation, 73(2), 143-155.

Busse, R., Ulrich-Schad, J. D., Crighton, L., Peel, S., Genskow, K., & Prokopy, L. S. (2015). Using social indicators to evaluate the effectiveness of outreach in two Indiana watersheds. Journal of Contemporary Water Research & Education, 156(1), 5-20.

Campbell, A., & King, A. E. (2022). Choosing Sustainability: Decision Making and Sustainable Practice Adoption with Examples from US Great Plains Cattle Grazing Systems. Animals, 12(3), 286.

Carlisle, L. (2016). Factors influencing farmer adoption of soil health practices in the United States: A narrative review. Agroecology and Sustainable Food Systems, 40(6), 583-613.

Carlson, S., & Stockwell, R. (2013). Research priorities for advancing adoption of cover crops in agriculture-intensive regions. Journal of Agriculture, Food Systems, and Community Development, 3(4), 125-129.

Che, Y., Feng, H., & Hennessy, D. A. (2022). Assessing peer effects and subsidy impacts in conservation technology adoption: Application to grazing management choices. Journal of the Agricultural and Applied Economics Association.

Cutforth, L. B., Francis, C. A., Lynne, G. D., Mortensen, D. A., & Eskridge, K. M. (2001). Factors affecting farmers' crop diversity decisions: An integrated approach. American Journal of Alternative Agriculture, 16(4), 168-176.

DeDecker, J., Malone, T., Snapp, S., Thelen, M., Anderson, E., Tollini, C., & Davis, A. (2022). The relationship between farmer demographics, social identity and tillage behavior: Evidence from Michigan soybean producers. Journal of Rural Studies, 89, 378-386.

Dunn, M., Ulrich-Schad, J. D., Prokopy, L. S., Myers, R. L., Watts, C. R., & Scanlon, K. (2016). Perceptions and use of cover crops among early adopters: Findings from a national survey. Journal of Soil and Water Conservation, 71(1), 29-40.

Eanes, F. R., Singh, A. S., Bulla, B. R., Ranjan, P., Prokopy, L. S., Fales, M., ... & Doran, P. J. (2017). Midwestern US farmers perceive crop advisers as conduits of information on agricultural conservation practices. Environmental Management, 60(5), 974-988.

Fishbein, M., and I. Ajzen. (2011). Predicting and changing behavior: The reasoned action approach. New York, NY: Psychology Press.

Fleckenstein, M., Lythgoe, A., Lu, J., Thompson, N., Doering, O., Harden, S., ... & Prokopy, L. (2020). Crop insurance: A barrier to conservation adoption?. Journal of Environmental Management, 276, 111223.

Floress, K., de Jalón, S. G., Church, S. P., Babin, N., Ulrich-Schad, J. D., & Prokopy, L. S. (2017). Toward a theory of farmer conservation attitudes: Dual interests and willingness to take action to protect water quality. Journal of Environmental Psychology, 53, 73-80.

Gardezi, M., & Arbuckle, J. G. (2019). The influence of objective and perceived adaptive capacity on Midwestern farmers' use of cover crops. Weather, Climate, and Society, 11(3), 665-679.

Grover, S., & Gruver, J. (2017). 'Slow to change': Farmers' perceptions of place-based barriers to sustainable agriculture. Renewable Agriculture and Food Systems, 32(6), 511-523.

Kalcic, M., Prokopy, L., Frankenberger, J., & Chaubey, I. (2014). An in-depth examination of farmers' perceptions of targeting conservation practices. Environmental Management, 54(4), 795-813.

Kara, E., Ribaudo, M., & Johansson, R. C. (2008). On how environmental stringency influences adoption of best management practices in agriculture. Journal of environmental management, 88(4), 1530-1537.

Knowler, D., & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. Food policy, 32(1), 25-48.

Knutson, C. L., Haigh, T., Hayes, M. J., Widhalm, M., Nothwehr, J., Kleinschmidt, M., & Graf, L. (2011). Farmer perceptions of sustainable agriculture practices and drought risk reduction in Nebraska, USA. Renewable Agriculture and Food Systems, 26(3), 255-266.

Lee, D., Arbuckle, J. G., Zhu, Z., & Nowatzke, L. (2018). Conditional causal mediation analysis of factors associated with cover crop adoption in Iowa, USA. Water Resources Research, 54(11), 9566-9584.

Liu, T., Bruins, R. J., & Heberling, M. T. (2018). Factors influencing farmers' adoption of best management practices: A review and synthesis. Sustainability, 10(2), 432.

Manson, S. M., N. R. Jordan, K. C. Nelson, and R. F. Brummel. (2016) "Modeling the Effect of Social Networks on Adoption of Multifunctional Agriculture." Environmental Modelling & Software 75388–401.

Mattia, C. M., & Lovell, S. T. (2016). Identifying barriers and gateways for agroforestry adoption in the US corn belt. In 3rd European Agroforestry Conference Montpellier, 23-25 May 2016. EURAF.

Mayerfeld, D., Rickenbach, M., & Rissman, A. (2016). Overcoming history: attitudes of resource professionals and farmers toward silvopasture in southwest Wisconsin. Agroforestry systems, 90(5), 723-736.

Morris, C., & Arbuckle, J. G. (2021). Conservation plans and soil and water conservation practice use: Evidence from Iowa. Journal of Soil and Water Conservation, 76(5), 457-471.

Morton, L. W., Hobbs, J., Arbuckle, J. G., & Loy, A. (2015). Upper Midwest climate variations: Farmer responses to excess water risks. Journal of environmental quality, 44(3), 810-822.

Nerbonne, J. F., & Lentz, R. (2003). Rooted in grass: Challenging patterns of knowledge exchange as a means of fostering social change in a southeast Minnesota farm community. Agriculture and Human Values, 20(1), 65-78.

Parker, J. S., Moore, R., & Weaver, M. (2007). Land tenure as a variable in community based watershed projects: some lessons from the Sugar Creek Watershed, Wayne and Holmes Counties, Ohio. Society and Natural Resources, 20(9), 815-833.

Perry, V., & Davenport, M. A. (2020). An inductive framework of self-efficacy to understand and support farmers in conservation agriculture. Journal of Soil and Water Conservation, 75(2), 198-208.

Petrzelka, P., Buman, T., & Ridgely, J. (2009). Engaging absentee landowners in conservation practice decisions: A descriptive study of an understudied group. Journal of Soil and Water Conservation, 64(3), 94A-99A.

Plastina, A., Liu, F., Miguez, F., & Carlson, S. (2020). Cover crops use in Midwestern US agriculture: perceived benefits and net returns. Renewable Agriculture and Food Systems, 35(1), 38-48.

Pradhananga, A., Davenport, M., & Perry, V. (2017). The influence of beliefs and norms on landowners' civic engagement in water resource protection. Journal of Soil and Water Conservation 72(6): 639-649.

Pradhananga, A. & Davenport, M. (2019). Predicting farmer adoption of water conservation practices using a norm-based moral obligation model. Environmental Management 64(4): 483-496.

Pradhananga, A., & Davenport, M. (2022). "I Believe I Can and Should": Self-efficacy, Normative Beliefs and Conservation Behavior. Journal of Contemporary Water Research & Education, 175(1), 15-32.

Prokopy, L. S., Floress, K., Klotthor-Weinkauf, D., & Baumgart-Getz, A. (2008). Determinants of agricultural best management practice adoption: Evidence from the literature. Journal of soil and water conservation, 63(5), 300-311.

Prokopy, L. S., Floress, K., Arbuckle, J. G., Church, S. P., Eanes, F. R., Gao, Y., ... & Singh, A. S. (2019). Adoption of agricultural conservation practices in the United States: Evidence from 35 years of quantitative literature. Journal of Soil and Water Conservation, 74(5), 520-534.

Prokup, A., Wilson, R., Zubko, C., Heeren, A, and Roe, B. (2017). 4R Nutrient Stewardship in the Western Lake Erie Basin. Columbus, OH: The Ohio State University, School of Environment & Natural Resources.

Ramsey, S. M., Bergtold, J. S., Canales, E., & Williams, J. R. (2019). Effects of farmers' yield-risk perceptions on conservation practice adoption in Kansas. Journal of Agricultural and Resource Economics, 44(1835-2019-1558), 380-403.

Ranjan, P., Church, S. P., Floress, K., & Prokopy, L. S. (2019). Synthesizing conservation motivations and barriers: what have we learned from qualitative studies of farmers' behaviors in the United States?. Society & Natural Resources, 32(11), 1171-1199.

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

Reimer, A., Thompson, A., Prokopy, L. S., Arbuckle, J. G., Genskow, K., Jackson-Smith, D., ... & Nowak, P. (2014). People, place, behavior, and context: A research agenda for expanding our understanding of what motivates farmers' conservation behaviors. Journal of Soil and Water Conservation, 69(2), 57A-61A.

Roesch-McNally, G. E., Basche, A. D., Arbuckle, J. G., Tyndall, J. C., Miguez, F. E., Bowman, T., & Clay, R. (2018). The trouble with cover crops: Farmers' experiences with overcoming barriers to adoption. Renewable Agriculture and Food Systems, 33(4), 322-333.

Rogers, E. M. (2003). Diffusion of innovations. 5th ed. New York, NY: Simon and Schuster.

Ryan, R. L., D. L. Erickson, and R. de Young. (2003). Farmers' motivations for adopting conservation practices along riparian zones in a mid-western agricultural watershed. Journal of Environmental Planning and Management 46(1):19–37.

Sackett, J. L. 2013. An NCR-SARE cover crop project: Farmer-cooperator motivation and agronomic practices. Journal of the NACAA 6(2). http://purl.umn.edu/161504"

Sautter, J. A., Czap, N. V., Kruse, C., & Lynne, G. D. (2011). Farmers' decisions regarding carbon sequestration: a metaeconomic view. Society and Natural Resources, 24(2), 133-147.

Sawadgo, W. P., Zhang, W., & Plastina, A. (2021). What drives landowners' conservation decisions? Evidence from Iowa. Journal of Soil and Water Conservation, 76(3), 211-221.

Sheeder, R. J., & Lynne, G. D. (2011). Empathy-conditioned conservation:"Walking in the shoes of others" as a conservation farmer. Land Economics, 87(3), 433-452.

Singer, J. W., Nusser, S. M., & Alf, C. J. (2007). Are cover crops being used in the US corn belt?. Journal of Soil and Water Conservation, 62(5), 353-358.

Snapp, S. S., S. M. Swinton, R. Labarta, D. Mutch, J. R. Black, R. Leep, J. Nyiraneza, and K. O'Neil. (2005) "Evaluating Cover Crops for Benefits, Costs and Performance within Cropping System Niches." Agronomy Journal 97:322–332.

Soule, M. J., Tegene, A., & Wiebe, K. D. (2000). Land tenure and the adoption of conservation practices. American journal of agricultural economics, 82(4), 993-1005.

Stern, P.C. (2000). Toward a coherent theory of environmentally significant behavior. Journal of Social Issues 56(3): 407-424.

Stuart, D., & Gillon, S. (2013). Scaling up to address new challenges to conservation on US farmland. Land Use Policy, 31, 223-236.

Thompson, A. W., Reimer, A., & Prokopy, L. S. (2015). Farmers' views of the environment: the influence of competing attitude frames on landscape conservation efforts. Agriculture and human values, 32(3), 385-399.

Thompson, N. M., Reeling, C. J., Fleckenstein, M. R., Prokopy, L. S., & Armstrong, S. D. (2021). Examining intensity of conservation practice adoption: Evidence from cover crop use on US Midwest farms. Food Policy, 101, 102054.

Tucker, M., and T. L. Napier (2002), Preferred sources and channels of soil and water conservation information among farmers in three Midwestern US watersheds, Agric. Ecosyst. Environ., 92(2), 297–313.

Ulrich-Schad, J. D., Babin, N., Ma, Z., & Prokopy, L. S. (2016). Out-of-state, out of mind? Non-operating farmland owners and conservation decision making. Land Use Policy, 54, 602-613.

Wang, T., Jin, H., Kreuter, U., Feng, H., Hennessy, D. A., Teague, R., & Che, Y. (2020). Challenges for rotational grazing practice: views from non-adopters across the Great Plains, USA. Journal of Environmental Management, 256, 109941.

Wilson, R. S., Howard, G., & Burnett, E. A. (2014). Improving nutrient management practices in agriculture: The role of risk-based beliefs in understanding farmers' attitudes toward taking additional action. Water Resources Research, 50(8), 6735-6746.

Wilson, R. S., Schlea, D. A., Boles, C. M., & Redder, T. M. (2018). Using models of farmer behavior to inform eutrophication policy in the Great Lakes. Water research, 139, 38-46.

Wilson, R. S., Beetstra, M. A., Reutter, J. M., Hesse, G., Fussell, K. M. D., Johnson, L. T., ... & Winslow, C. (2019). Commentary: Achieving phosphorus reduction targets for Lake Erie. Journal of Great Lakes Research, 45(1), 4-11.

Yoder, L., Houser, M., Bruce, A., Sullivan, A., & Farmer, J. (2021). Are climate risks encouraging cover crop adoption among farmers in the southern Wabash River Basin?. Land Use Policy, 102, 105268.

Zimnicki, T., Boring, T., Evenson, G., Kalcic, M., Karlen, D. L., Wilson, R. S., ... & Blesh, J. (2020). On quantifying water quality benefits of healthy soils. BioScience, 70(4), 343-352.