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Research article

Crop insurance: A barrier to conservation adoption?

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ABSTRACT

Midwest corn producers face inherent risks in their daily operations and incorporate risk-management strategies to reduce uncertainty; among these, crop insurance has dominated the agricultural landscape for decades. Previous research on conservation adoption has primarily examined the impact of individual-level characteristics on adoption, yet little is known about the impact of external factors, such as crop insurance. Using a mixed-methods approach, we conducted semi-structured interviews and a multi-state survey to determine if crop insurance requirements limit cover crops and/or conservation tillage adoption for Midwest corn producers. Our findings indicate that crop insurance requirements are not a barrier to adoption. Rather, crop insurance and conservation practices serve unique - not contradictory - roles in Midwest producers' operations and are used simultaneously. Future research should continue to identify and seek solutions for external barriers to broadly increase adoption rates.

1. Introduction

1.1. Minimizing risks through resiliency and risk-management

Risks are inherent to agricultural producers' daily operations and producers use a multitude of strategies to manage uncertainty; one approach is enhancing resiliency. The concept of resiliency has its roots in ecology; however, it has increasingly been adapted to a variety of fields (Brand and Jax, 2007; Tendall et al., 2015). Resiliency in agricultural operations is defined as the ability for the operation to recover from external stressors (Brand and Jax, 2007). Producers are faced with changing circumstances, including price fluctuations and shifting market trends; a varying climate, vulnerable to more extreme precipitation or drought events, as well as temperature fluctuations; and rising concerns over both global and national agricultural policies (Bowling et al., 2018; Ullah and Shivakoti, 2014). In addition to adapting to broader societal changes, producers have the day-to-day managerial challenges that come with their occupation, and are often faced with quick operational decisions that can have a lasting impact on the current production season or multiple seasons (Tendall et al., 2015; Urruty et al., 2016). The US federal crop insurance program is a widely utilized approach to manage risk; in 2018, 87% of all corn acres were insured (American Farm Bureau Federation, 2019). Other risk-management strategies that a producer may use include crop diversification, forward contracts and hedging, and diversifying income sources (Ullah and Shivakoti, 2014; Velandia et al., 2009). Conservation practices may offer an avenue for agricultural resiliency. Cover crops and reduced tillage or no-till (hereafter, conservation tillage) are recommended for addressing soil erosion and water quality, as well as broader soil health benefits (Gardezi and Arbuckle, 2019). Conservation practices can also mitigate some of the negative impacts of climate change by managing excess field moisture and maintaining organic matter (Bowling et al., 2018; Gardezi and Arbuckle, 2019).

1.2. Existing conservation research emphasizes the individual's role in adoption

Existing research on conservation adoption has primarily emphasized the role that individuals play in behavior change, with less examination on external factors that either promote or hinder adoption (Ajzen, 1991; Prokopy et al., 2019; Ranjan et al., 2019; Roesch-McNally et al., 2018). Conservation adoption research has been conducted for

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over 35 years and several reviews of this literature exist (Baumgart-Getz et al., 2012; Knowler and Bradshaw, 2007; Prokopy et al., 2008). Most recently, Prokopy et al. (2019) examined the conservation adoption literature from 1982 to 2017 and found few consistent predictors of adoption across 93 studies. Researchers in the field of conservation adoption have acknowledged the need to examine external factors that impact adoption (Prokopy et al., 2019; Roesch-McNally et al., 2018). Often, conservation adoption research uses theoretical models such as the Theory of Planned Behavior, Value-Belief-Norm, or the Reasoned Action Approach. These models primarily center around the individual and how individual factors (e.g., social indicators including attitudes, awareness, and knowledge) lead to (non-)adoption (Ajzen, 1991; Fishbein and Ajzen, 2011; Prokopy et al., 2019; Stern et al., 1999). According to Stern (2000), there are four types of causal variables for environmental behavior: attitudinal factors, contextual forces, personal capabilities, and habit or routine. Most adoption research addresses some combination of attitudinal factors and personal capabilities, with less emphasis on contextual forces or habit and routines. Shove (2010) calls for a greater emphasis on the institutions that influence (or impede) behavior change, rather than leaving environmentally responsible behavior solely in the hands of the individual.

1.3. RMA's evolving crop insurance guidelines and its impact on adoption

While federal crop insurance's cover crop termination guidelines continue to evolve, these guidelines may be a barrier to producers adopting cover crops. Governed by the Risk Management Agency (RMA), federal crop insurance has specific termination guidelines for cover crops that must be followed to maintain insurance coverage (Barbre, 2019). Developed in collaboration with the Natural Resources Conservation Service (NRCS), the RMA has released multiple iterations of these guidelines (Barbre, 2019). Most recently updated in the 2018 Farm Bill, the RMA officially designated cover crops planted in the 2020 crop season or later as a Good Farming Practice, consistent with other management decisions such as fertilizer application (Barbre, 2019). Prior to this, any divergence from the guidelines had to be pre-approved, or risk losing coverage (National Sustainable Agriculture Coalition, 2019). Indeed, prior to these changes, Roesch-McNally et al. (2018) commented that greater flexibility in crop insurance requirements may reduce barriers to cover crop adoption. Beginning in the 2020 season, insurance automatically attaches at the time of planting the insured crop (Barbre, 2019).

Although the RMA's termination guidelines specifically apply to cover crops, it is possible that crop insurance stipulations may hinder adoption of conservation tillage, as well. Crop insurance may exacerbate existing concerns or uncertainties regarding conservation adoption, in relation to both cover crops and conservation tillage. These concerns include any potential complications or challenges that may arise when maintaining both the cash crop and conservation practice(s), including concerns about yield reductions or farm suitability (Arbuckle and Roesch-McNally, 2015; Roesch-McNally et al., 2018). Reimer et al. (2012b) found that perceived risk was a key barrier to conservation tillage adoption. Additionally, cover crops must be planted and harvested in a timing window that coincides with other key management activities, which may take away time from higher-priority tasks (Roesch-McNally et al., 2018). When a producer has crop insurance, these additional considerations are especially important to keep in mind, as it can impact a producer's coverage. Indemnity payments (i.e., financial compensation) are granted to a producer on the premise that the loss is not in any way caused by negligence or error on the part of the producer (Coppess and Schnitkey, 2017). For example, if the adoption of a conservation practice negatively impacts the insured crop's yield, the producer may be at risk of losing coverage. Producers must ensure that any practices used do not interfere with the insured crop's ability to reach maturity (Coppess and Schnitkey, 2017).

In recent years, agricultural media publications have highlighted the notion that cover crops may be risky or impractical for some producers when using crop insurance (e.g., Clayton, 2013, 2016; Looker, 2017). Agricultural media articles on crop insurance and cover crops often position these behaviors as mutually exclusive, highlighting narratives from farmers who experienced difficulty maintaining crop insurance requirements while using cover crops, and ultimately chose to stop using crop insurance (Elsbernd, 2018; Ohlson, 2016). While the decision to stop enrolling in crop insurance is ultimately the producer's decision, it is a rarity among Midwest row-crop producers; for example, close to 94% of Iowa's corn and soybean acres were insured with crop insurance in 2018 (Wright, 2020). Habits and routines have underlying influences on behavior (Shove, 2010). Indeed, individuals are more comfortable continuing familiar behaviors than implementing new ones, and additional challenges make it even more difficult when starting a new behavior (Chai et al., 2015; Whitmarsh et al., 2011). Arbuckle and Roesch-McNally (2015) found that producers do not adopt cover crops if the risks outweigh the benefits, even for those with positive views of cover crops. This is in line with what is termed the "value-action" gap, in which individual behavior does not always line up with one's values due to external factors (Shove, 2010; Whitmarsh et al., 2011). Rather, even if a producer wants to adopt cover crops, crop insurance requirements may act as an external barrier to adoption. Furthermore, given that narratives in agricultural media publications imply that producers may have to choose between crop insurance and conservation practices, producers' interest in adopting conservation practices may further diminish. Media sources have the potential to amplify or moderate perceptions of risk, and narratives are a compelling way to share information (Church et al., 2017; Kasperson et al., 1988; Hinyard and Kreuter, 2007). It is important to understand if the narratives in these publications are true and experienced by the broader population; otherwise, these narratives may be spreading false information and perhaps increasing producer concern unnecessarily.

1.4. Crop insurance as a potential barrier to conservation adoption

Few researchers have explored the connections between crop insurance and conservation adoption, and existing literature is sparse with mixed findings. In the rare instances that crop insurance is mentioned or studied in the context of conservation adoption, the dynamic between these variables isn't directly studied; rather, it is often nuanced in a broader exploration of motivations and barriers to conservation adoption (Arbuckle and Roesch-McNally, 2015; Prokopy et al., 2019). In Prokopy et al.'s (2019) 35-year review of conservation adoption literature, only six studies included crop insurance as a variable. Ultimately, the results concluded that crop insurance was not a barrier for conservation adoption; however, these studies only tangentially included crop insurance (Prokopy et al., 2019). In a cross-national comparison of farmers' climate change beliefs, Prokopy et al. (2015) speculated that crop insurance, by disincentivizing adaptation, may explain why Midwestern US producers were the least concerned about climate change. Arbuckle and Roesch-McNally (2015) tested producers' level of agreement to the statement "Cover crops can complicate crop insurance" and found that 25.1% of producers agree or strongly agree with the statement, while 61.7% of producers were uncertain. Clearly, further research is needed in understanding the relationship between conservation adoption and crop insurance, and producers' perceptions of this dynamic.

Given the current lack of consistent research on the connection between crop insurance and conservation adoption, our study seeks to understand Midwest corn producers' involvement with both crop insurance and conservation to address whether crop insurance requirements are barriers to cover crop and/or conservation tillage adoption. Our hypothesis is that crop insurance requirements limit conservation adoption.

2. Materials and methods

2.1. Data collection

Illinois, Indiana, and Iowa were some of the top corn producing states in 2018 (United States Department of Agriculture Economic Research Service, 2019). Our study explores Midwest corn producers in these states through a mixed-methods approach, combining qualitative interviews and a mail survey. Using a mixed-methods approach allows us to explore the topic in-depth through qualitative interviews, while obtaining data from a broader audience of producers through the mail survey (Almalki, 2016; Church et al., 2019). An interview guide was developed in collaboration with colleagues from the Departments of Agricultural Economics and Agricultural and Biological Engineering at Purdue University. Content included identifying producers' main risks and risk-management strategies, use of conservation and crop insurance, as well as their perspectives and attitudes towards crop insurance. Individual interviews were conducted in spring 2018 with 14 conventional corn producers in Indiana and Iowa through purposive snowball sampling (Goodman, 1961). Interviewees were initially recommended by USDA-NRCS, Indiana Association of Soil and Water Conservation Districts (IASWCD), and The Nature Conservancy and contacted by phone and/or email. After each interview, interviewees were asked for recommendations of other producers to contact. Interviewees representing a diverse range of behavior and perspectives regarding crop insurance and conservation were requested, and the interviewer did not know whether a producer was involved in either behavior prior to each interview. The average length of each interview was around 1 h. Interviews were voice-recorded with prior consent and transcribed using a transcription software. The codebook was developed using an iterative coding process with two coders (Church et al., 2019; Hak and Bernts, 1996; Saldaña, 2015). Each coder read through multiple interviews and identified potential codes using inductive reasoning; then, the researchers met together to discuss the coding scheme and reach conclusions on any discrepancies. This process was repeated until all coding was complete. Thematic analyses presented in the results pertain to interviewees' perceptions of the main benefits received from participating in either crop insurance or conservation practices. NVivo (Version 12) was used for thematic coding.

The target audience for the crop insurance survey were producers in Indiana, Illinois, and Iowa with over 50 corn acres. Farm Market iD, a commercial source for agribusiness data, was used to obtain a random sample of mailing addresses. The questionnaire was designed to accompany the primary themes of the qualitative interviews: risk-management, crop insurance, and conservation. Several questions were sourced from previous work (Arbuckle et al., 2013; Prokopy et al., 2009, 2017). Many questions used a 5-point Likert scale from one to five to indicate a respondent's level of agreement with a particular statement, where one indicates strongly disagree, two indicates disagree, three indicates neither agree nor disagree, four indicates agree, and five indicates strongly agree. The questionnaire was distributed in summer 2018 following the Dillman 5-wave method, which included an advance letter, first survey mailing, second survey mailing, a post-card reminder, and third survey mailing (Dillman et al., 2014). When receiving the first round of the mail survey, participants received a $2 bill as a monetary incentive, which has been shown to significantly increase response rates (Glas et al., 2019). The potential participants were provided the opportunity to complete the questionnaire online (Qualtrics) or use a hardcopy questionnaire. Prior to distribution, a unique identifier (ID) was assigned to each addressee. Participants who completed the questionnaire online were asked to provide their unique ID at the beginning of the questionnaire. All hardcopy questionnaire responses, once received, were entered into Qualtrics and a quality control process was performed to ensure data entry was correct. All questionnaires were checked to confirm that the response type, date received, and unique ID were 100% accurate as written on the questionnaires. Then, 10% of the entries were checked to ensure no data field exceeded a 2% error rate. If the 2% error was exceeded, additional review occurred on that data field to ensure accuracy. After the quality control process was finalized, the hardcopy and online data were combined into one datafile to clean the data. Only one entry per unique ID was permitted; therefore, any questionnaires with identical unique IDs (i.e., duplicates) were resolved by selecting either the questionnaire that was more complete or if equally complete the questionnaire that arrived first. Consistency in data type was confirmed for each data field. Additionally, personal identifiable information was removed to ensure confidentiality (see Hemler et al., 2020 for the public dataset). A total of 2000 questionnaires were distributed, and 1871 respondents were deemed eligible to respond (omitting bad addresses and producers who were no longer farming). There were 719 completed questionnaires for a final response rate of 38.4%.

Statistical analyses were conducted in R (Version 3.4.3). We performed a two-sample binomial proportion test (one-tailed) to examine whether crop insurance enrollment limits the adoption of conservation practices with large independent samples. The null hypothesis was that the percentage of respondents adopting conservation practices for those who have *enrolled* in crop insurance is equal to or higher than those who have *not enrolled* in crop insurance, which would indicate that crop insurance is not a limiting factor for conservation practice adoption. The alternative hypothesis is that the percentage of respondents adopting conservation practices for those who have enrolled in crop insurance is lower than those who have *not enrolled* in crop insurance, which would indicate that crop insurance is a limiting factor for conservation practice adoption. We also performed a logistic regression model to include other factors as control variables to investigate whether crop insurance enrollment will influence the adoption of conservation practices (see supplementary material Table S1). The dependent variable is the adoption of a conservation practice and the independent variables include gender, age, education, farm size, farming experience, land tenure, and crop insurance enrollment. For the above two analyses, we tested two conservation practices, cover crops and conservation tillage, which continue to have low adoption rates in the Midwest despite availability of both financial and technical assistance programs (Zulauf and Brown, 2019).

3. Results

3.1. Demographics

All interviewees were male. Many were farming a combination of family-owned and rented land. A few had full or part-time jobs outside of farming, such as a government job, selling seed, or selling crop insurance. A few interviewees had livestock. All interviewees were enrolled in crop insurance. All but one interviewee was currently using either cover crops or conservation tillage and most interviewees were using both conservation practices.

Nearly all (96.4%; n = 699) survey respondents were male. Survey respondents ranged in age from 19 to 96 years old, with a mean of 62.6 years old (SD = 12.5) and a median of 63 years old. Over one-third (39.1%; n = 688) of respondents' highest level of education was the completion of their high school diploma or GED. Over one-fourth of respondents' highest level of education was the completion of a four-year college or higher (27.3%) and over one-third completed a 2-year college or some college (33.6%). Surveyed producers had mean acreages of 388.6 corn acres (n = 656; SD = 633.6) and 329.0 soybean acres (n = 656; SD = 539.0). Additionally, surveyed producers had mean acreages of 419.9 owned acres (n = 627; SD = 818.4) and 518.1 acres rented from others (n = 554; SD = 739.0) (Table 1). According to the United States Department of Agriculture, the average farm sizes for Indiana, Illinois, and Iowa ranged from 264 to 372 acres (United States Department of Agriculture National Agricultural Statistics Service, 2017). It should be noted that these state statistics are lower than the

Table 1
Farmer survey demographics.

Gender (n=699)	
Male	96.4%
Female	3.6%
Age (years; n = 674)	
Mean *(SD)*	62.6 *(12.5)*
Median	63
Range	19–96
Education (n = 688)	
High school diploma/GED	39.1%
2-year college or some college	33.6%
Four-year college or higher	27.3%
Farm size	
Mean *(SD)* corn acres (n = 656)	388.6 *(633.6)*
Mean *(SD)* soy acres (n = 656)	329.0 *(539.0)*
Mean *(SD)* owned acres (n = 627)	419.9 *(818.4)*
Mean *(SD)* acres rented from others (n = 554)	518.1 *(739.0)*
Crop insurance	
Enrolled in crop insurance (n = 686)	89.7%
Crop insurance type: revenue (n = 576)	76.2%
Coverage level at or above 75% (n = 597)	87.9%
Conservation adoption	
Cover crop adoption (n = 684)	24.7%
Conservation tillage adoption (n = 681)	60.4%

Notes. This table represents demographic data from survey respondents across Indiana, Illinois, and Iowa.

mean acreages in our sample, as these statistics include data for all farm operations, including farms smaller than 50 acres, which skews the distribution.

Among surveyed producers, 89.7% (n = 686) enrolled in crop insurance between 2013 and 2017. The majority chose revenue insurance (76.2%; n = 576) and 87.9% (n = 597) of surveyed producers chose a coverage level at or above 75%. This is consistent with national trends of crop insurance use among corn producers. In 2018, 87% of all corn acres were insured, with up to 94% of acres enrolled in the top corn-producing states, and most corn producers choosing revenue insurance (Newton, 2019). More than half (60.4%; n = 681) of surveyed producers were currently using conservation tillage, while 24.7% (n = 684) were using cover crops (Table 1). It should be noted that our survey reflects a higher percentage of cover crop adopters than national trends, as national trends for cover crop use are typically presented as a percentage of total cropland acres, whereas our survey reflects the percentage of producers using cover crops on any acres (Zulauf and Brown, 2019).

3.2. Effects of crop insurance on adoption rates of conservation practices

Nearly all (89.7%, n = 686) respondents had enrolled in crop insurance between 2013 and 2017 (Table 1). Over half (61.6%, n = 593) of those enrolled were currently using conservation tillage and around a quarter (25.4%, n = 594) of those enrolled were currently using cover crops.

Here, we used a two-sample binomial proportion test (one-tailed) to compare adoption rates of conservation practices between respondents who have *enrolled* in crop insurance and those who have *not enrolled* in crop insurance. By comparing crop insurance enrollment status, there was no strong evidence that the conservation adoption rate for those who *have enrolled* in crop insurance is lower than those who have *not enrolled* in crop insurance for either cover crops (p-value = 0.840; Table 2) or conservation tillage (p-value = 0.814; Table 2). Conversely, the adoption rate of conservation practices for those who have *enrolled* in crop insurance is higher than those who have *not enrolled* in crop insurance (Table 2), although no statistically significant difference was found. The logistic regression model showed that the adoption of both cover crops (p-value = 0.961) and conservation tillage (p-value = 0.673) are not significantly associated with crop insurance enrollment (see supplementary material Table S1).

While the result of our two-sample binomial proportion test (one-tailed) indicates that crop insurance was not a limiting factor for adoption of either conservation practice, it is important to note that these tests are underpowered, indicating a high probability of a type II error.[1] Therefore, extreme caution should be used when interpreting the results from this test. However, this is just one component of our multifaceted analysis examining the impact of crop insurance on conservation adoption. Other aspects of our analysis shed light on this relationship and are discussed below.

Table 2
Difference in adoption rates by crop insurance enrollment status using a two-sample binomial proportion test.

Conservation Practice	Adoption Status	Enrolled in crop insurance		Not enrolled in crop insurance		p-value
		(%)	(n)	(%)	(n)	
Cover crops	**Adopter**	25.4	594	20.3	69	0.840
	Non-adopter	74.6		79.7		
Conservation tillage	**Adopter**	61.6	593	55.9	68	0.814
	Non-adopter	38.4		44.1		

3.3. Crop insurance requirements are not limiting conservation adoption

Questionnaire responses indicate that crop insurance was not limiting conservation adoption. When given a list of potential limiting factors for conservation adoption, including cost and time/labor required (see Table 3 for complete list), crop insurance was perceived as the least limiting, in comparison to all other factors, for both conservation tillage and cover crops (Table 3). Rather, cost and the time/labor required were tied for the highest limiting factor for cover crops. More respondents selected "Don't know" about crop insurance as a limiting factor than any other potential limiting factor, with 34.7% of producers choosing "Don't know" in relation to cover crops and 18.4% of producers for conservation tillage.

When directly asked if crop insurance requirements limit their ability to implement either conservation practice, most respondents reported that crop insurance requirements are "Not limiting" or chose "Don't know" (Table 4). Specifically, 64.7% of corn producers indicated "Not limiting" in relation to conservation tillage, whereas 39.1% responded "Not limiting" in relation to cover crops. Additionally, 52.5% of respondents (n = 621) disagreed or strongly disagreed with the statement "Crop insurance requirements limit my ability to adopt conservation practices", while 41.6% of respondents chose that they neither agree nor disagree (Table 5).

All interviewees were enrolled in crop insurance and all but one was currently using cover crops or conservation tillage. Most interviewees were using a combination of conservation tillage, cover crops, and crop insurance. Interviewees provided no indication that crop insurance was limiting their conservation adoption. One producer commented:

[1] For a one-tailed test, power is 0.17 and 0.21 for the cover crop and conservation tillage tests, respectively. The low power of these tests are linked to two primary factors. First, the relatively small effect sizes reduce the power of these tests. It was difficult to hypothesize a priori the effect of crop insurance on conservation practice adoption given the dearth of research in this area. The results of our survey indicate that these differences are relatively small, making it very difficult to detect these differences statistically. Secondly, the sample size also contributes to the low power. Mainly, the low proportion of the population that does not enroll in crop insurance makes it difficult to collect a sample size large enough to give us a high-powered test that will detect small effect sizes. For example, given that only 10% of the population does not enroll in crop insurance, we would need a sample size of 6674 to achieve power of 0.80 for the given effect size. At an assumed response rate of 20%, that would mean mailing 33,355 surveys, which was infeasible with the budget of the current study.

Table 3
Impact of potential limiting factors on conservation adoption.

How much do the following factors limit your ability to implement …?	n	Mean *(SD)*	Don't know (%)
Cover crops			
Cost	576	2.7 *(0.95)*	12.6
Time/labor required	592	2.7 *(0.98)*	10.2
Lack of proven benefits	545	2.4 *(1.07)*	15.9
Number of years needed to see benefits	515	2.4 *(1.04)*	21.3
Lack of equipment/technology	600	2.3 *(1.05)*	8.8
Desire to continue current farming practices/ methods	569	2.2 *(1.01)*	12.9
Physical features of my property make it difficult (e.g. soil types, drainage, and/or topography)	574	2.0 *(1.03)*	12.8
Crop insurance requirements	416	1.7 *(0.95)*	34.7
No-till/reduced tillage			
Desire to continue current farming practices/ methods	593	1.8 *(0.99)*	6.9
Lack of equipment/technology	600	1.8 *(1.04)*	6.3
Lack of proven benefits	577	1.8 *(0.96)*	9.7
Number of years needed to see benefits	566	1.8 *(0.98)*	11.7
Cost	599	1.7 *(0.96)*	7.3
Physical features of my property make it difficult (e.g. soil types, drainage, and/or topography)	581	1.7 *(0.97)*	8.6
Time/labor required	582	1.6 *(0.90)*	8.9
Crop insurance requirements	520	1.3 *(0.72)*	18.4

Notes. Survey questions was "How much do the following factors limit your ability to implement …?" Value based on a 1–4 scale where 1 = not limiting, 2 = slightly limiting, 3 = moderately limiting, and 4 = significantly limiting.

Table 4
Perception among Midwest corn producers that crop insurance requirements limit conservation adoption.

Conservation practice	Not limiting (%)	Slightly limiting (%)	Moderately limiting (%)	Severely limiting (%)	Don't know (%)
Cover crops (n = 637)	39.1	8.8	14.8	2.7	34.7
Conservation tillage (n = 637)	64.7	8	7.5	1.4	18.4

Notes. Survey questions was "How much does crop insurance limit your ability to implement…?"

"There's always chatter about…crop insurance tying our hands too much. I guess I don't feel like it ties my hands too much."

3.4. Crop insurance and conservation provide unique risk-management roles

Both crop insurance and conservation practices were considered valued risk-management strategies. Over half (67.8%; n = 689) of producers reported that they were using crop insurance as a long-term risk-management strategy. Slightly more than half (51.1%; n = 683) reported using on-farm conservation practices as a long-term risk-management strategy. Producers were also asked to determine which strategy they valued the most for risk-management among various options, including crop insurance, cover crops, conservation tillage, and additional drainage. When asked which strategy they valued the most, 42.9% (n = 643) of producers reported crop insurance and 25.7% (n = 643) reported either cover crops or conservation tillage.

Qualitative analysis of the interview data reveals distinct, yet complementary, benefits by participating in both crop insurance and conservation adoption simultaneously. Interviewees discussed crop insurance as a vital form of risk-management to protect against uncontrollable risks, including weather:

"And the weather is our limiting factor. It can be the most– it will make you or break you, in a sense…the risk is tremendous…."

"Well, with farming there's a lot of different variables and only so many that the farmer can keep his fingers on and stuff, so, the weather's probably the biggest one."

Additionally, producers often spoke of crop insurance as a safety net, indicating the financial security that it provides, regardless of whether a claim is filed:

"Thankfully, we have that as a kind of a safety net to help us cushion…"

"I want the insurance just to help me if I have a disaster to carry on the next year."

"It's definitely a waste of money that way, but… We want that comfort of knowing, and that's what we're paying for."

While traditional environmental outcomes (e.g., enhanced water quality and minimized soil erosion) were often expressed as the rationale for adopting conservation practices, producers also spoke of additional in-field benefits from these practices, such as improved soil health and water infiltration:

"Part of the reason why I wanted to make the switch to no-till was through improved infiltration…Not only did it save me a lot of time but it also, I think, improves the farm."

"Because if the soil is healthier, it has more natural water-holding capacity. And the cover crops themselves, upon termination, they kind of become a mulch to hold the moisture in and keep the soil cooler."

Ultimately, the in-field benefits that producers noticed through utilizing these practices offered financial gain, as well, by reducing input costs:

Table 5
Level of agreement among Midwest corn producers' as to whether crop insurance requirements limit adoption.

Statement	N	Strongly Disagree (%)	Disagree (%)	Neither (%)	Agree (%)	Strongly Agree (%)	Mean *(SD)*
Crop insurance requirements limit my ability to implement conservation practices.	621	11.4	41.1	41.6	5.6	0.3	2.4 *(0.78)*

Notes. Survey question was "Please indicate your level of disagreement or agreement with the following statements about crop insurance." Value based on a 1–5 scale where 1 = strongly disagree, 2 = disagree, 3 = neither, 4 = agree, and 5 = strongly agree.

"… hopefully the cover crop will produce a more productive soil. So, if we can get the soil back in line where maybe grandpa had it…Then we can be a lower cost producer. We don't have to supplement the soil as much as we are today."

"I mean, just looking at the money that it costs to do tillage and the return…is zero. So why bother doing tillage when you can further show up your economic balance, your economic sheet, by not spending all the money on tillage, equipment, insurance, people, hours, fuel. There's so much– it costs so much to till and if you don't need to do it and there's no economic benefit for it, why would I keep doing it?"

4. Discussion and conclusions

4.1. Crop insurance requirements are not barriers to adoption

The findings of our multifaceted analysis indicate that crop insurance requirements are not barriers to conservation adoption for Midwest producers. There was no statistically significant difference in adoption rates in either conservation practice based on whether a producer is enrolled in crop insurance or not, although these tests are underpowered. Nonetheless, in relation to other potential limiting factors, crop insurance requirements were identified as least limiting for both cover crops and conservation tillage.

Furthermore, it should be noted that producer awareness regarding the impact of crop insurance requirements on conservation adoption is limited. When comparing potential limiting factors for conservation adoption, more producers chose "Don't know" when considering crop insurance requirements to either conservation tillage or cover crops than any other factor. The perception that crop insurance requirements were limiting also varied based on conservation practice. A higher percentage of producers agreed that crop insurance does not limit conservation tillage adoption, as opposed to cover crops, and producers also chose "Don't know" less often when considering conservation tillage. These findings are consistent with Arbuckle and Roesch-McNally (2015), who found that a large percentage of producers were uncertain as to whether crop insurance complicates adoption.

Despite limited awareness about the impact of crop insurance requirements on adoption, producers continue to adopt these practices and use crop insurance simultaneously. Crop insurance remains an important asset to Midwest corn producers, as indicated by the high enrollment both in our sample and nationally. Our findings routinely contradict the notion perpetuated in agricultural media publications that conservation adoption is limited by crop insurance requirements, or that producers must forgo crop insurance to use conservation practices. Agricultural media articles which position conservation adoption as an "either/or" while using crop insurance has the potential to deter producers from adopting conservation, given the high importance of crop insurance. Media sources influence their audiences' perceptions of risk (Kasperson et al., 1988). Posing these two behaviors as incompatible is misleading and unrepresentative of the broader agricultural population. It may deter producers from adopting by falsely stirring up concerns about risk and negative implications from adopting. Producers already report uncertainty and concerns about risk as reasons for not adopting conservation practices (Arbuckle and Roesch-McNally, 2015; Reimer et al., 2012b; Roesch-McNally et al., 2018). Our results show that there are other limiting factors that account for non-adoption besides crop insurance requirements. Despite a growing number of financial incentives offered by the Natural Resources Conservation Service (NRCS) and other entities, cost and the time/labor required continue to be barriers for cover crop adoption, and were tied as the most limiting factor for cover crop adoption among surveyed producers. Reimer et al. (2012a) found that farmers exhibiting the "farm as business" attitude were more likely to cite costs of time and labor as conservation barriers. While our findings provide evidence that crop insurance is not a barrier to conservation adoption, we recognize that continued research is needed to identify and resolve these external barriers to adoption. For cover crops, this could be in relation to the timing window, since cover crops must be managed during a crucial timeframe that can conflict with other management priorities (Roesch-McNally et al., 2018).

4.2. Complimentary outcomes from crop insurance and conservation

Crop insurance and conservation practices serve unique and complimentary functions for the resiliency of producers' operations. Producers face inherent risks, of which concerns about prices and weather dominate (Thompson et al., 2019; Ullah and Shivakoti, 2014). Both behaviors were considered valued strategies; in fact, when choosing between several risk-management strategies, our results found that surveyed producers commonly chose crop insurance as the risk-management strategy they valued most, with conservation coming in second. Crop insurance is widely-used by Midwest corn producers, regardless of participation in conservation practices. Interviewees acknowledged that crop insurance was not necessarily always needed, but it helped provide financial security. Meanwhile, interviewed producers commonly discussed how conservation practices led to in-field benefits (i.e., enhanced soil health and water infiltration), while providing financial gains through reduced inputs. There is increasing interest on the potential for enhanced resiliency from conservation practices (Altieri and Nichols, 2012; Altieri et al., 2017; Bowling et al., 2018; Cong et al., 2014; Ding et al., 2009; Gardezi and Arbuckle, 2019). Ultimately, practices that are good for resiliency often emphasize diversity, whether it is diversity in income sources, crops, or soil microorganisms (Cong et al., 2014; Altieri et al., 2015; Lehman et al., 2015; Blanco-Canqui and Francis, 2016). Our results suggest that resiliency for Midwest operations includes both crop insurance and conservation practices. Neither behavior was found to inhibit the other. On the contrary, corn producers experienced complimentary outcomes from a combined approach that was greater than participation in either behavior by itself.

CRediT authorship contribution statement

Michelle Fleckenstein: Conceptualization, Investigation, Formal analysis, Writing - original draft. **Ashlyn Lythgoe:** Investigation, Formal analysis, Writing - review & editing. **Junyu Lu:** Formal analysis, Writing - review & editing. **Nathan Thompson:** Conceptualization, Writing - review & editing. **Otto Doering:** Conceptualization, Writing - review & editing. **Seth Harden:** Conceptualization, Writing - review & editing. **Jackie M. Getson:** Data curation, Writing - review & editing. **Linda Prokopy:** Conceptualization, Supervision, Project administration, Funding acquisition, Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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