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The influence of the seasons: how the agricultural calendar impacts farmer perceptions of cover crops

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Abstract

Across the Midwest, substantial funding and personnel time have been allocated to encourage farmers to adopt a wide range of conservation practices but adoption rates for many of these practices remain low. Prior research focuses largely on the influence of individual-level factors (e.g., beliefs, attitudes) on conservation practice adoption rather than on contextual factors (e.g., seasons) that might also play a role. In the present study, we considered seasonal variation and its potential influence on farmer cover crop decision-making. We first established how farmer temporal and financial resources fluctuate across the year and then compared the annual agricultural decision and cover crop decision calendars. We also considered farmer cover crop perceptions and likely behaviors. To study this, we surveyed the same Midwestern farmers in the spring, summer and winter within a 12-month period. Results indicated that farmers were generally the least busy and the most financially comfortable in the winter months. Moreover, farmers perceived the benefits of cover crops differently throughout the year. These results indicate that seasonality can be a confounding factor which should be considered when designing and conducting research and farmer engagement. As researchers, it is our responsibility to understand the specific calendar experienced by our sample and how that may influence responses so we can examine theory-supported factors of interest rather than seasonality as a driver of farmer responses. As practitioners, it is important to use research findings to engage with farmers about conservation in a way that prioritizes communicating about the most salient aspects of the practice at the time of year when farmers will be most receptive.

Introduction

On-farm conservation practices are one strategy to increase resilience on farms in the face of climate change by reducing runoff that contributes to harmful algal blooms in places like Lake Erie, and in certain cases, increasing yield through improved soil health (King *et al.*, 2015; Williams *et al.*, 2016). Conservation practices are undertaken by farmers on their operations to alleviate the negative environmental impacts of farming. Recent years have seen substantial investments in conservation practices, including $59.7 billion earmarked by Congress for such activities over the next 10 years (Agricultural Improvement Act of 2018, 2018). However, despite these investments and the potential benefits, current adoption levels for many conservation practices are largely stagnant (Beetstra *et al.*, 2018). A large body of academic literature describes the factors influencing on-farm conservation decision-making (e.g., Arbuckle and Roesch-McNally, 2015; Roesch-McNally *et al.*, 2017; Burnett *et al.*, 2018; Lee *et al.*, 2018). However, this literature largely emphasizes the influence of individual-level factors (i.e., the micro scale) but provides limited understanding of how socio-economic, political and biophysical settings structure how farmers make decisions (i.e., the macro scale; Liu *et al.*, 2018).

The present research offers an alternative perspective by applying the lens of seasonality to conservation decisions among farmers growing corn in six Midwestern states: Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin. To our knowledge, farmer conservation decision-making in the United States has not been considered within this perspective of seasonal variation or resource fluctuations. We seek to understand the calendar for on-farm decisions, uncover the temporal and financial fluctuations that farmers experience throughout the year, and consider the influence of these variations on perceptions that may influence conservation practice adoption. Specifically, we examine how perceived cover crop barriers, benefits and intentions as well as general on-farm concerns shift throughout the year.

Literature review

Even in cases of high expressed motivation to use conservation practices, there is still a gap between intentions and actual behavior (Wilson *et al.*, 2014, 2018; Sheeran and Webb, 2016). In response, there have been calls for additional research into the context surrounding

farmer decision-making, such as broader social, economic and political factors (Knowler, 2014; Reimer *et al.*, 2014). Recent meta-analyses of the adoption literature indicate inconsistent trends in predictors of adoption, perhaps revealing that the relevance of commonly measured predictors varies by contextual factors yet unstudied (e.g., Prokopy *et al.*, 2008; Baumgart-Getz *et al.*, 2012; Prokopy *et al.*, 2019; Ranjan *et al.*, 2019).

One potentially significant constraint in the conservation decision process is the mismatch between where costs and benefits accrue. For some practices, such as buffer strips, the benefits are purely societal, with the farmer incurring the cost to install the strips but experiencing limited to no personal benefits (Wauters and Mathijs, 2013). For other practices, like winter cover crops, there are co-benefits to the farm and society (Arbuckle and Roesch-McNally, 2015). Federally supported conservation programs, such as the Environmental Quality Incentives Program, are designed to help address this mismatch by offsetting the near-term cost (Bergtold *et al.*, 2017). Participation in such programs increases adoption by addressing financial constraints that act as barriers for many farmers (Reimer and Prokopy, 2014). That said, participation in federal conservation programs is time-intensive, and time constraints have been found to limit participation despite the potential financial benefits (Reimer and Prokopy, 2014). Indeed, prior research reports that the extra time and money required to implement the cover crops are barriers to use (Reimer *et al.*, 2012; SARE-CTIC, 2020).

Cover crops tend to have one of the lowest adoption rates among recommended conservation practices (Swinton *et al.*, 2015; Thompson *et al.*, 2015), perhaps due to challenges and risks associated with the practice such as potential interference with spring planting (Roesch-McNally *et al.*, 2017) and the need for trial-and-error to get the practice properly tailored to one's farm operation (Arbuckle and Roesch-McNally, 2015). While increasing the feasibility of using cover crops and emphasizing (or increasing) their benefits may increase adoption rates (Roesch-McNally *et al.*, 2017; Burnett *et al.*, 2018), the relevance of different costs and benefits may vary across the year. Understanding changes in perceptions and resources throughout the year could provide insights into how best to time efforts such as farmer engagement and data collection.

Objectives

Our objectives included understanding (1) how farmer temporal and financial resources may fluctuate across the calendar year, (2) how the annual agricultural decision and cover crop decision calendars compare, and (3) how farmers' cover crop perceptions, intentions, or general on-farm concern levels may vary across the year. We anticipated that farmers would be the least busy in the winter months, busiest near planting and harvest, and moderately busy in the summer months. In addition to fluctuations in available time, we also investigated fluctuations in financial resources. We expected that farmers would feel the most financially stressed right before harvest and most financially satisfied right after harvest and that they would spend more right after harvest because they would have more income at that point of the year. Overlaying the temporal and financial calendars, we also identified the typical timing of on-farm and cover crop decisions. If temporal and financial resource fluctuations match the hypothesized patterns, we expected that most on-farm and cover crop decisions would take place during the winter because farmers would have the most abundant resources at this time of the year. Due to expected fluctuations in resources, we anticipated that perceived cover crop barriers would be lowest in the winter while perceived benefits would be highest in the winter when resources are most abundant. Likewise, we expected intentions to use cover crops would be highest in the winter and that general levels of concern about potential on-farm challenges would be highest in the spring near planting.

Methodology

Sampling and survey administration

We used a panel survey to capture data from the same farmers at three different points in time within a 12-month period. We purchased contact information from Farm Market ID for corn farmers across six states: Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin. We chose these states because they are within the Midwest and border at least one Great Lake. Water quality in the Great Lakes is increasingly an issue of interest, particularly because of the annual recurrence of algal blooms in Lake Erie (e.g., Reutter 2019) and recent appearance of cyanobacterial blooms in Lake Superior (Reinl *et al.*, 2020). The sample included an approximately equal number of corn-growing farmers with operations of different sizes: 10–249 acres (4–101 hectares), 250–499 acres (101–202 hectares), 500–999 acres (202–404 hectares) and 1000+ acres (405+ hectares). In addition, we requested the sample to include a mixture of operations with and without livestock because an operation producing manure or in need of feed is sometimes a catalyst for using cover crops. Purchasing a sample with these specifications increased the likelihood that some farmers in the study used cover crops, something that was important given the relatively low adoption rate of the practice in many areas (e.g., Beetstra *et al.*, 2018).

Farmers completed the same survey three times over a 12-month period: in April/May 2019 (spring, T1), in August 2019 (summer, T2) and in January/February 2020 (winter, T3). We anticipated that the April/May timing coincided with spring planting for the farmers in our sample, representing a time of the year when farmers tend to work long hours on their farming operation. We expected that August would be less busy than April because it is not within the planting or harvesting window for most farmers, but farmers must still actively manage their growing crops at this time. Finally, we predicted that January/February (coinciding with the typical time researchers collect data from farmers) would align with the time of year when farmers tend to be the least busy as it is post-harvest but pre-planting.

Data collection followed a modified version of the Tailored Design Method (Dillman, 2011), including an initial letter in the mail with a link to complete the survey online plus four email reminders for the spring recruitment. A similar format was followed for the August and January/February data collection efforts, with no letter by mail but emails sent to all those who completed the survey in the previous data collection period. We recruited 1580 farmers and received usable responses from 101, for an initial response rate of 6.4%. We re-contacted the 101 farmers via email for the second wave and received 71 responses for a 70.3% response rate and ended with a final 48 usable responses and a 67.6% response rate in the third wave. The initial response rate was low but not unexpected given the time of year when contacting the farmers and the general decrease in survey response rates over time as reported in the literature (Sax *et al.*, 2003; Stedman *et al.*, 2019). We were unable to locate typical response

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rates for farmer surveys that were conducted entirely online,[1] but farmers overwhelmingly prefer mailed surveys over online ones (e.g., Avemegah *et al.*, 2020) and response rates to online surveys tend to be lower even for the general population (16.8% online *vs* 45.5% mailed; Guo *et al.*, 2016). Regardless, our response rate was adequate given the starting sample size (Bartlett *et al.*, 2001).

Measurement

In the first survey (spring, T1), a series of questions explored the farmer's past use of cover crops, including the years the practice was used (if at all), the percentage of total planted acres where the practice was used, and intentions to use the practice in the next 5 years, regardless of if they had used the practice previously. T1 also included several questions meant to establish the timing of cover crop and agricultural decision-making broadly during the year as well as questions about the farmer's demographic and farm characteristics. All questions in the T1 survey that asked about timing during the year used a bimonthly scale (e.g., January/February, March/ April, etc.). There were also a series of questions repeated across all three data collection points (T1, T2 and T3). These included time and financial constraints, cover crop intentions at the time of survey completion, perceived barriers and benefits associated with cover crops, and other general on-farm concerns (e.g., soil retention, field access, weed management). The on-farm concerns reflected potential problems on an operation that cover crops might help solve. We provide the specific wording of items presented in this analysis in Table 1.

Analyses

The present analysis includes descriptive statistics and one-way repeated-measures ANOVA tests to compare results across all three survey time points. We also ran the analyses using the non-parametric Friedman test and achieved similar results. We used the Student-Newman-Keuls post hoc test for multiple comparisons to control for Type I and Type II errors. Using this statistical test allowed for simultaneous testing of any differences in means for all three time points. Unless otherwise noted, results presented here reflect responses from the 48 respondents who completed all three surveys.

Results

Descriptive characteristics

Farmers from each of the six states of interest completed the survey and on average owned 600 acres (243 hectares) and rented an additional 740 acres (299 hectares). All our participants grew corn and 92% grew soybeans, while 38% received some income from livestock in 2018. Exactly 50% of farmers planted cover crops. The average respondent was 52 years old and had farmed for 25 years. Eighty-five percent of the sample continued their education beyond high school, with 48% completing a bachelor's or graduate degree. The median gross income was in the $250,000–$500,000 range. In addition, 60% of the sample reported that they or their spouse received off-farm income (Table 2). Aside from farmed acreage (which was high due to our sampling strategy), the other farmer and farm characteristics were comparable to values from the 2017 Agricultural Census (USDA-NASS 2019). We also compared all farmer and farm characteristics of the respondents in each of the survey rounds and did not identify any significant changes in these characteristics over time.

Exploring annual fluctuations in available time and financial resources

Participants overwhelmingly noted they felt the busiest around planting (May/June) and harvest (September/October), while the winter (January/February) was the least busy (Fig. 1). On the financial side, most of the spending and income generation occurred post-harvest (Fig. 2). Even with higher spending rates in the winter, most farmers indicated feeling the most financially satisfied during those months (Fig. 3). Financial stress peaked in the late summer right before harvest but was relatively consistent throughout the rest of the year.

Establishing the agricultural decision calendar

Results indicate that farmers make many of their on-farm decisions for the growing season during the winter months when they are less likely to be in the fields; one exception was decisions about on-farm labor hiring that occurred mostly near planting (Fig. 4). However, most cover crop decisions were made in July and August, although approximately a quarter of respondents who used cover crops in the past 5 years ($N = 24$) also indicated that they still make decisions regarding cover crops during harvest (Fig. 5). The one exception to this was the timing of termination of the cover crop in the spring, a decision made largely right before spring planting. Like the general farm decisions presented above, few decisions were made in May and June. However, unlike the general farm decision calendar, few decisions regarding cover crops were made in the winter as the cover crop is in the ground at that time.

Comparing beliefs, concerns and resources over time

In general, respondents had higher levels of concern about their operation in spring (T1 M = 3.57) than in summer (T2 M = 3.34, $P = 0.03$) or winter (T3 M = 3.36, $P = 0.04$). More specifically, farmers were more worried about reducing soil compaction in spring than in summer (T1 M = 3.75, T2 M = 3.42, $P = 0.03$) or in winter (T3 M = 3.40, $P = 0.05$). We also found that participants perceived cover crop benefits differently across the year; they viewed cover crops as providing greater benefits in winter (T3 M = 4.00) than in spring (T1 M = 3.70, $P = 0.04$) or summer (T2 M = 3.77, $P = 0.05$). In addition, farmers were significantly more likely to indicate a belief in a cover crop's ability to retain soil during a heavy rain event in winter surveys than in spring surveys (T3 M = 4.36, T1 M = 4.09, $P = 0.03$).

As expected, farmers reported being significantly less busy in winter (T3 M = 2.97) than in spring (T1 M = 3.34, $P = 0.00$) or summer (T2 M = 3.20, $P = 0.02$). The lack of a significant difference between spring and summer was a bit surprising because we expected the time right before fall harvest to be a slower period for farmers. We also found that farmers felt more financially stressed in spring (T1 M = 3.04) than in summer (T2 M = 2.79, $P = 0.04$) or winter (T3 M = 2.63, $P = 0.00$). Additionally, farmers reported feeling that money was tighter in the spring

[1]The authors have participated in other online farmer surveys with low response rates, although that research is not yet published or is in review. In particular, one study entirely online with Midwestern farmers had a 2.5% response rate, while another that was online but also had a paper option had a response rate of 13.7%.

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Table 1. Survey questions and associated response options for the primary variables of interest

Question	Scales and associated statements
Cover crop intentions: How likely are you to use cover crops in the next five years?	Will definitely not use cover crops (1), Am unlikely to use cover crops (2), Am unsure if I will or will not use cover crops (3), Am likely to use cover crops (4), Will definitely use cover crops (5)
Farm-related concern: Please indicate the extent to which you worry about the following issues on your farm. I tend to worry about…	Not at all (1), A little (2), Somewhat (3), Frequently (4), All the time (5)
	Retaining soil during heavy rain events; Reducing compaction in soils; Retaining nutrients during heavy rain events; Finding cost effective strategies to manage pests; Accessing fields sooner after wet weather; Increasing my soil's water holding capacity during times of drought; Managing yield-robbing weeds
Cover crop benefits: In your opinion, to what extent do (or could) cover crops do the following on your farm?	Definitely not (1), Probably not (2), Possibly (3), Probably (4), Definitely (5)
	Provide benefits to your farm; Retain soil during heavy rain events; Reduce compaction in soils; Retain nutrients during heavy rain events; Cost-effectively manage pests; Allow for sooner access to fields after wet weather; Increase soil's water holding capacity during times of drought; Manage yield-robbing weeds; Save you money (through reduced inputs, time savings, etc.); Increase your yield
Cover crop barriers: Below [to the right] is a list of barriers that can make using cover crops difficult. Please indicate to what extent you agree or disagree with each statement. If a statement does not apply to you, please indicate N/A (e.g., if you do not have a landlord)	Strongly disagree (1), Disagree (2), Neither agree nor disagree (3), Agree (4), Strongly agree (5), N/A (6)
	Cash crop seasons do not leave enough time for cover crops; I don't want to invest in cover crops on rented land; My landlord does not want me to use cover crops; Having access to technical assistance that is specific to my farm is hard to find; The 'trial-and-error' nature of cover crops is unappealing; Establishing winter cover crops is too difficult due to weather uncertainty; The risks of winter cover crops interfering with spring planting are too great; The benefits of cover crop use are too uncertain; I am too old to implement a new practice like cover crops; Cover crop seed costs are too high; Managing cover crops is too time intensive; Incentive programs that off-set the costs associated with; adopting cover crops do not last long enough; There is a lack of information available about cover crop benefits; Cover crops require too many operational changes; The restrictions associated with incentive-based programs are too great; The economic returns from cover crops do not come fast enough; Being unable to harvest and sell cover crops makes them unappealing; My co-manager(s) of my farm does not want me to use cover crops
Busy level: The next set of questions will address how busy you feel in general this time of the year in comparison to how you feel at other times of the year. Currently…	Strongly disagree (1), Disagree (2), Neither agree nor disagree (3), Agree (4), Strongly agree (5)
	I have to do things which I don't really have the time for; There are too many demands on my time; I need more hours in the day to do all the things which are expected of me; I can't ever seem to get caught up; I don't ever seem to have any time for myself; There are times when I cannot meet everyone's expectations; Sometimes I feel as if there are not enough hours in the day; Many times I have to cancel commitments; I have to overextend myself in order to be able to finish everything I have to do; I feel I have to do things less carefully in order to get everything done
Financial stress: What do you feel is the general level of your financial stress during this time of the year?	No stress at all (1), A little stress (2), A moderate amount of stress (3), A lot of stress (4), Overwhelming stress (5)
Financial satisfaction: How satisfied are you with your financial situation during this time of the year?	Completely dissatisfied (1), Somewhat dissatisfied (2), Neither satisfied nor dissatisfied (3), Somewhat satisfied (4), Completely satisfied (5)
Financial tightness: Money is tighter right now than it is at other times of the year.	Strongly agree (1), Agree (2), Neither agree nor disagree (3), Disagree (4), Strongly disagree (5)
Farm-related spending and income: My household is spending more money right now than we are earning.	Strongly agree (1), Agree (2), Neither agree nor disagree (3), Disagree (4), Strongly disagree (5)

Table 2. Descriptive results for farmer and farm characteristics ($n = 48$)

Variable	Mean	S.D.	Median	Min	Max
Acres owned (hectares)	604.3 (244.6)	875.9 (354.5)	400 (161.9)	0 (0)	5200 (2104.4)
Acres rented (hectares)	741.3 (300.0)	783.8 (317.2)	525 (212.5)	0 (0)	2975 (1203.9)
Total acres (hectares)	1345.6 (544.5)	1299.7 (526.0)	1012.5 (409.7)	40 (16.2)	7900 (3197.0)
Proportion of acres in corn	0.48	0.19	0.50	0	1
Proportion of acres in beans	0.39	0.18	0.45	0	0.80
Livestock (y/n)	0.31	0.47	0	0	1
Years farming	30.3	13.7	30	4	64
Age (years)	52.4	12.5	54	21	80

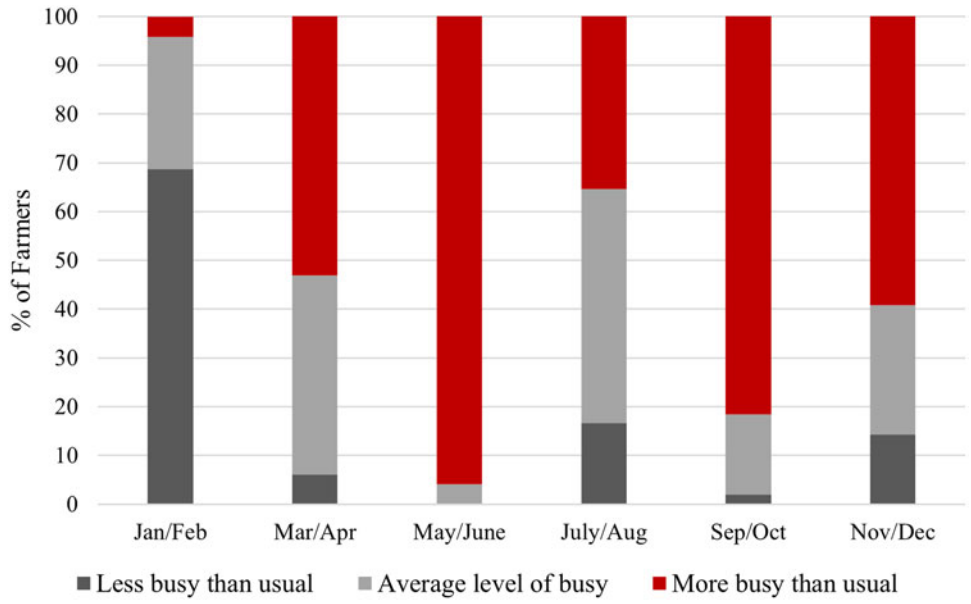

Fig. 1. Farmers' expressed level of busy-ness reported in bimonthly intervals ($n = 48$). Note that all figures reflect data that was only collected at T1 and that the scale of this figure differs from the figures below.

(T1 M = 2.52) and summer (T2 M = 2.48) than winter (T3 M = 3.00, $P = 0.01$ for both comparisons).

Respondents did not indicate any differences in their intentions to use cover crops across time (Table 3). In addition, farmers did not perceive barriers to using cover crops differently across the year, looking both at specific barriers and the average scale of barriers. Perceptions of financial satisfaction and farm-related spending and income did not significantly differ across the year, both of which were surprising considering the descriptive results above.

Discussion

These preliminary results indicate that farmer temporal and financial resources fluctuated throughout the year, that the annual on-farm decision-making calendar did not match that of the cover crop decision-making calendar, and that the perceived benefits of cover crops and other on-farm concerns varied across time. We further consider these findings and relevant implications in the subsequent sections.

Do temporal or financial resources fluctuate?

Farmers experienced different temporal constraints across the year aligning with critical points of the agricultural decision-making calendar. Farmers were substantially less busy in the winter months and the busiest near planting and harvest. On the financial side, the largest group of farmers felt financial satisfaction in the winter right after harvest. This was expected given the income generated from harvested crops. The largest group of farmers expressed feeling financial stress in the months preceding fall harvest. This finding supports other work suggesting that many farmers may consistently experience financial challenges (Sommer *et al.*, 1998). In addition, these results indicate that even with the substantial annual investments toward farmer subsidies and incentives (EWG, 2019; USDA-ERS, 2020), they do not eliminate seasonal financial fluctuations.

The timing of financial fluctuations differed from temporal fluctuations. Most current conservation adoption research with farmers takes place in the winter months, the time of year when farmers are the least busy and potentially the most financially comfortable. For most farmers, the time and financial

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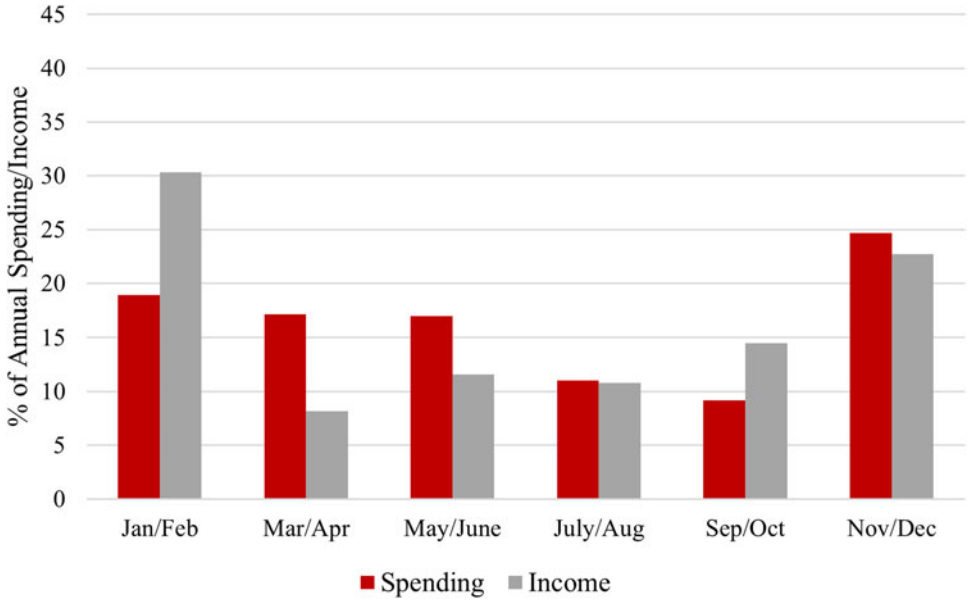

Fig. 2. The mean percentage of farmer spending and income throughout the year (n = 48).

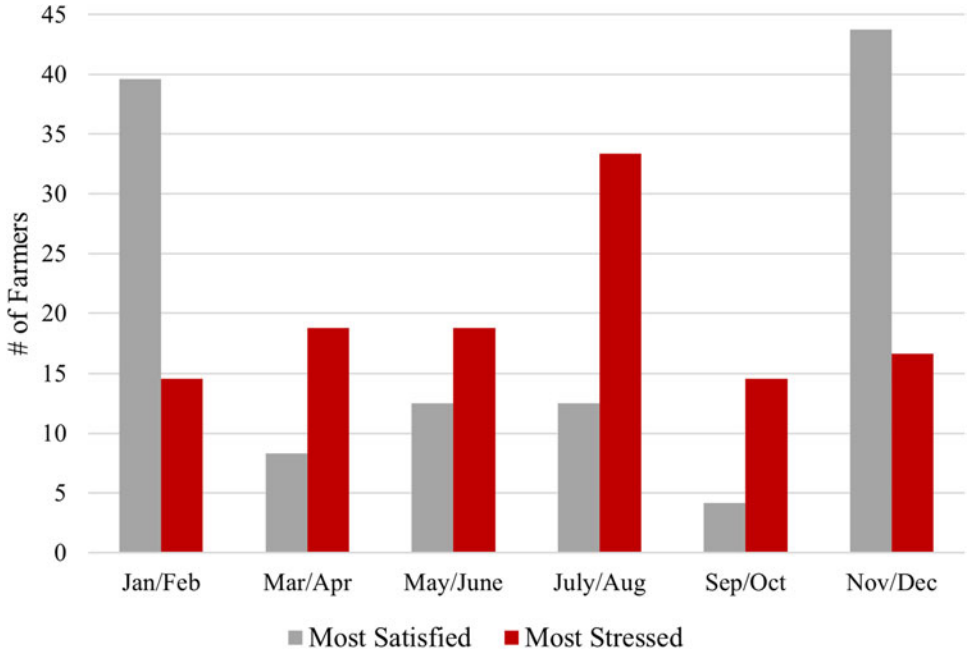

Fig. 3. The count of farmers expressing feeling financially satisfied or stressed throughout the year (n = 48). Farmers could select more than one period of the year when they felt financially satisfied or stressed, so the percentages exceed 100%. In addition, 13% of the sample indicated that they never felt financially satisfied, while 17% never felt financially stressed.

conditions in the winter do not match the rest of the year. As a result, if farmers have a more positive outlook in the winter because of abundant time and money, then they may rely on common heuristics that bias their viewpoint relative to other times of the year. For example, the projection bias (e.g., Loewenstein *et al.*, 2003) could lead them to assume that they will experience their current positive outlook toward cover crops later in the year when resources are tighter. Alternatively, the positive affect (e.g., Pyone and Isen, 2011; Lempert and Phelps, 2016) felt in the winter could lead them to think about cover crops, and other conservation practices, more positively. If these occur, then farmers may respond more positively to questions about cover crop use at certain times of the year, biasing data collection efforts.

When are on-farm and cover crop decisions made?

In general, farmers made most of their on-farm decisions between harvest and planting when there was the least amount of on-farm

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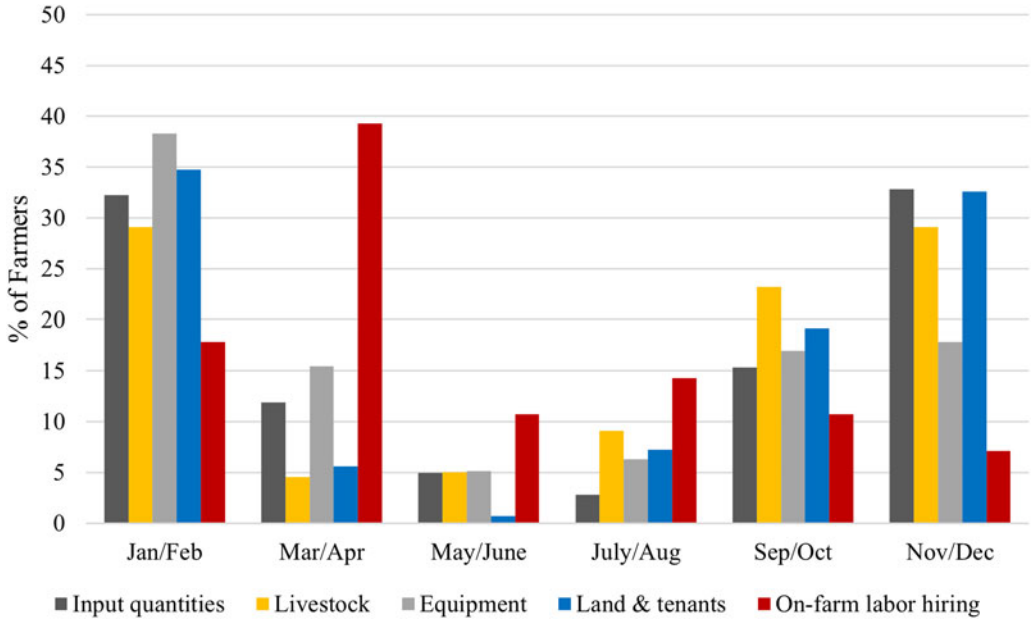

Fig. 4. The percentage of farmers making common on-farm decisions at different times of the year (n = 48).

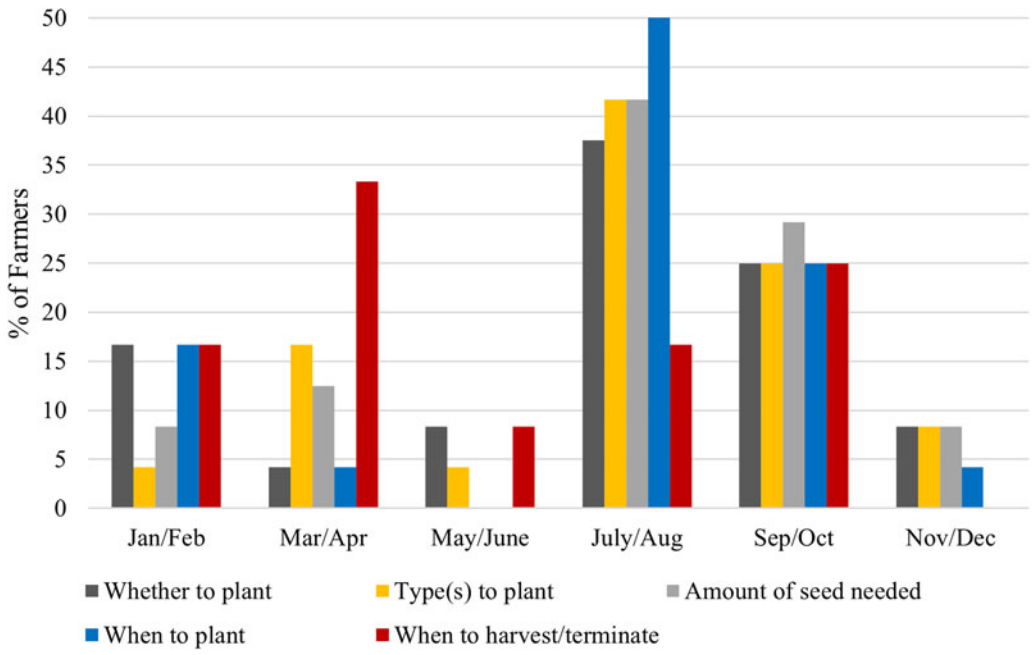

Fig. 5. The percentage of farmers making cover crop-related decisions at different times of the year. Note that only farmers who used cover crops are included here (n = 24).

work. There were a few notable exceptions to this, including hiring which occurred closer to when farmers needed that labor. Also, even though the majority followed a similar annual pattern, not all farmers made the same decisions at the same times. Future work with a larger sample could help to clarify if specific groups of farmers have their own annual decision-making calendars. This would help researchers target their questions to the appropriate times of the year based on the decision and the type of operation being studied.

Likewise, when considering cover crops, many farmers followed a similar annual decision-making calendar. Most cover crop decisions were made in the late summer and during harvest, right before most planted cover crops. Termination was the notable exception to this pattern as it was decided in the spring. All of the cover crop decisions were influenced by weather to some extent, particularly the timing of termination. Unlike other on-farm decisions, cover crop decisions did not take place in the post-harvest winter months.

Do responses to questions about conservation fluctuate?

Cover crop perceived benefits varied significantly throughout the year, with the benefits highest in the winter. However, perception

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Table 3. Summary of changes across the year in farmer survey responses ($n = 48$)

	Spring	Summer	Winter
Cover crop intentions	No differences		
Farm-related concerns	↑	No differences	
Cover crop benefits	No differences		↑
Cover crop barriers	No differences		
Busy level	No differences		↓
Financial stress	↑	No differences	
Financial satisfaction	No differences		
Financial tightness	No differences		↓
Farm-related spending and income	No differences		

An arrow indicates that responses at that time of the year were significantly ($P < 0.05$) higher or lower than at the other times. Farm-related concern, cover crop benefits and cover crop barriers are composite variables of all the specific items assessing farm-related concerns, cover crop benefits and cover crop barriers, respectively.

of barriers and intentions to use cover crops in the future were consistent across the year, while levels of concern about issues that cover crops can address peaked in the spring. The lack of significant variation of perceived barriers suggests that barriers are not the inverse of benefits and that it may be easier for farmers to identify negative aspects of a conservation practice than positive ones. The inconsistency of perceived cover crop benefits may also reflect differences in both a farmer's feelings of positive affect as described above and cover crop-specific considerations. In the winter, cover crops are in the ground, and farmers who use cover crops may feel hopeful about potential benefits as they see it greening otherwise bare land. Additionally, at this point in the year, achieving benefits from cover crops is out of a farmer's control. As shown by the cover crop decision-making calendar, farmers make almost no active decisions about the practice in the winter. The visual cue of plant growth in the winter, a lack of responsibility to actively make practice-related decisions, more free time and comfortable finances may create an atmosphere conducive to a more positive perception of the practice compared to other times of the year when these factors are not simultaneously present.

So why do responses to the same questions differ significantly across the calendar year? The current data collection effort does not answer this question by itself. However, it is worth considering the potential effect of fluctuating levels of time required for on-farm work on farmer perceptions of practices like cover crops. As mentioned previously, farmers were significantly less busy in the winter than at other times of the year. This difference was by far the most pronounced of any explored. When an individual is especially busy, it may be necessary to rely on heuristics to make decisions quickly (e.g., Hilbig *et al.*, 2012). A change in decision-making related to the lack of a resource, here time, is reflected in the concept of scarcity. Scarcity originates in the behavioral economics literature and relates to the limited resources an individual has available to them at a given moment (Mullainathan and Shafir, 2013). When an individual experiences scarcity, changes in decision-making may occur, often resulting in decisions which are less ideal in the long-run than those made under regular circumstances (Shah *et al.*, 2012). Scarcity appears to merit additional consideration in future studies, particularly because adopting a conservation practice like cover crops is often viewed as a long-term investment rather than a quick fix (Bergtold *et al.*, 2017).

Implications for researchers

Current data collection efforts with farmers tend to concentrate in the late winter and early spring. Farmers themselves prefer this timing, noting that winter tends to be the best time of the year for them to fill out a survey, while around planting and harvest tend to be the worst times (Pennings *et al.*, 2002). This data collection timing holds true across different data collection methods including surveys (e.g., Andrews *et al.*, 2013; Arbuckle *et al.*, 2013; Stuart *et al.*, 2014; Wilson *et al.*, 2014, 2018; Arbuckle and Roesch-McNally, 2015; McGuire *et al.*, 2015), focus groups (e.g., Stuart *et al.*, 2014; Roesch-McNally *et al.*, 2017) and interviews (e.g., Stuart *et al.*, 2014). A small proportion of studies in this academic realm draw on data collected at other times of the year, with some starting at the end of autumn and continuing through the winter (e.g., Reimer and Prokopy, 2014), some engaging with farmers during the summer months (e.g., McGuire *et al.*, 2013; Yoshida *et al.*, 2017), and others collecting farmer data over a longer period in a single year (e.g., May–December; Stuart *et al.*, 2018). Interestingly, some studies have collected data from different populations at different times of the year and then compared the results (Reimer *et al.*, 2012). More commonly, a study's methodology makes no mention of the specific time of year when data were collected (e.g., Thompson *et al.*, 2015; Farmer *et al.*, 2017; Floress *et al.*, 2017; Olson and Davenport, 2017; Ulrich-Schad *et al.*, 2017; Lee *et al.*, 2018).

However, as results here indicate, when designing studies, it is worth considering if the timing of data collection requires adjustment to capture conservation decision-making nearer to the time of the decision itself. For example, studies of typical agronomic decision-making may be most appropriate in winter, while studies of cover crop decisions may be more appropriate in late summer when the decision is more salient. When designing a study, the researcher should consider if analysis of *present* perceived benefits (or another factor related to decision-making) best matches the research questions or if collecting data in the present may bias the results because the decision is more relevant at another time of year. Keeping this in mind can help to improve the quality of data collected from farmers.

Comparisons of farmer responses collected at different times of the year also warrant cautious interpretation. For instance, if one study evaluates cover crop perceptions in the winter and another in the summer, even if the questions are identical,

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seasonal biases may impact the comparison of responses. Further, broad conclusions about farmer attitudes, motivations, beliefs and other psychological factors based on cross-sectional data should include an explanation of the timing of data collection and consider potential limitations given the timing and specific research questions. To help avoid these issues, researchers need to conduct more longitudinal and panel studies that evaluate results across the calendar year and over multiple years to more accurately determine if and how farmer responses change.

Implications for practitioners

Similarly, a consideration of timing is warranted for outreach and extension efforts that target specific conservation decisions. Current incentive and subsidy cover crop programs generally have deadlines for registration in the mid- to late summer months. However, other informational programming occurs throughout the year via field days, presentations, written works and other formats to encourage the adoption of the practice. Broad examples illustrate how these results might influence current efforts to increase cover crop adoption. Sharing information about cover crop demonstration plots and different seed mixes is useful information, but it will be less salient to farmers if it is shared soon after cover crops are planted for the year (Shelley, 2015). Likewise, it is important for farmers to learn about the benefits of cover crops to pollinators, but it is difficult for farmers to make decisions based upon that information if it is presented in the middle of the winter (Lee-Mader *et al*., 2020). Engaging with farmers at the right times of the year about the most salient aspects of a practice may lead to increased levels of conservation practice adoption.

Limitations

Another study of this structure is needed with a larger sample size to improve the generalizability of results. This work was exploratory in nature, but conducting a similar type of study with a much larger sample size, and through a mailed *vs* online survey, would help to confirm if the same patterns emerge. Conducting this type of study over a longer period, such as over two or more years, would also help to increase confidence in the results. There is the possibility that the 12-month period of this study was atypical. The Midwestern United States experienced substantial precipitation in spring 2019 that resulted in flooding and delayed planting, and this may have altered responses in ways that would not occur in a different year (Schnitkey and Zulauf, 2019). By conducting this type of study over a longer period, it would be easier to conclude that any fluctuations across the calendar year are legitimate differences and not a reflection of a single year aberration.

Conclusions

Farmers experienced temporal and financial fluctuations throughout the year that mirror the seasons. Although many farmers experienced the same general temporal and financial trends, there was variation between farmers as well. Additionally, we found variation in responses to some questions, such as cover crop benefits being perceived as higher in the winter, when farmers felt that they were the least busy and when finances were the least tight. Around planting, farmers generally felt the highest levels of concern about potential problems on their operation that cover crops might solve, such as soil and nutrient retention, and were the most financially stressed. As researchers, it is our responsibility to understand the specific calendar experienced by our sample and how that may influence responses so we can examine theory-supported factors of interest rather than seasonality as a driver of farmer responses. As practitioners, it is important to use research findings to engage with farmers about conservation in a way that prioritizes communicating about the most salient aspects of the practice at the time of engagement.

We are certainly aware of the challenges associated with researcher consideration of data collection timing, and similarly, for practitioners trying to engage farmers. Most obviously, targeting data collection efforts near the time of their decision-making will likely reduce the sample size of available respondents if the decision of interest is made at any point during the active growing season. Similarly, for practitioners, creating engagement materials that emphasizes different aspects of conservation practices is a substantial undertaking. However, we think it is important to systematically consider these seasonal fluctuations both when collecting data from farmers and when engaging them in conservation. Minor fluctuations in farmer responses based upon the time of year might not seem especially worrisome, but when these data inform the design and implementation of programs as well as agricultural policies, the weight of these fluctuations becomes more apparent.

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