

How do different types of social norms relate to farmers' adoption of conservation practices?

Landon Yoder¹ , Matt Houser² , Kurt Waldman³  and Nathaniel Geiger⁴ 

¹Indiana University Bloomington, USA; ²The Nature Conservancy, USA; ³Cornell University, USA and ⁴University of Michigan, USA

Research Paper

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Corresponding author:

Landon Yoder;
Email: yoderl@iu.edu

Abstract

Society faces an urgent need to move agriculture toward more environmentally sustainable practices to reduce greenhouse gas emissions, biodiversity loss, and water pollution. Mandatory policy tools, such as regulations, are unpopular with farmers, notoriously difficult to enforce, and politically challenging in the United States. Instead, social norms—descriptive, dynamic, and injunctive—may be critical levers for scaling up conservation practices. In this study, we analyze the predictive power of social norms on three practices, two of which benefit conservation (no-till and cover crops) and one that is likely harmful to conservation (fall nitrogen fertilizer application). Farmers ($N = 585$) in four U.S. states (Illinois, Indiana, Maryland, and Pennsylvania) completed a survey indicating perceived social norms and adoption of each practice. Logit models of practice adoption demonstrate that different types of social norms predict each of the three practices. We find that social norms are correlated with practices that are both helpful and harmful to conservation outcomes. Descriptive norms are associated with no-till adoption, while dynamic norms are associated with the use of cover crops. Both descriptive and injunctive norms are associated with fall nitrogen fertilizer application. In line with previous work, we also find that self-efficacy, response efficacy, farm size, and farm income are statistically significant predictors of the adoption of each practice. Future research would benefit from examining the role of different types of social norms in more contextually specific areas of farm management and at different junctures in the prevalence of management practices within a farming community, whether emerging, well-established, or declining in use.

Introduction

A long-standing yet increasingly urgent challenge for policymakers is how to move agriculture toward more environmentally sustainable practices to reduce greenhouse gas emissions (IPCC, 2022), biodiversity loss (IPBES, 2019), and water pollution (Breitburg et al., 2018). While compulsory regulations are often seen as the central policy tool for dealing with environmental harms, enacting regulations in agriculture is often politically challenging. Existing regulations do not convince farmers of the existence of a problem (Morton, 2008; Sang and Birnie, 2008), result in mixed responses for compliance (Barnes, Willock and Toma, 2009), and can entail costly monitoring and enforcement (Shortle and Horan, 2013; Drevno, 2016). Moreover, the expansion of environmental concerns over the past 50 years, such as habitat protection and climate change, has led to the development of and need for a wider range of policy approaches (Fiorino and Ahluwalia, 2020). Among this broader range of options, scholars have increasingly recognized the important role that social norms may play in environmental behavior (Nyborg et al., 2016). Despite the importance of social norms in pro-environmental behavior (cf. Cialdini, Reno and Kallgren, 1990; Schultz et al., 2007; Goldstein, Cialdini and Griskevicius, 2008; Nyborg et al., 2016; Rhodes, Shulman and McClaran, 2020; Perry et al., 2021), researchers have studied social norms in a relatively narrow fashion in agriculture.

Social norms are shared understandings and expectations that guide people's behavior in specific situations (Nyborg, 2018; Qiu, Zhong and Huang, 2021). Social norm researchers commonly differentiate between descriptive and injunctive (or prescriptive) norms, where the former represents *common* behaviors while the latter represents *expected* behaviors (e.g., Cialdini, Reno and Kallgren, 1990; Schultz et al., 2007; Rhodes, Shulman and McClaran, 2020; Sparkman, Howe and Walton, 2021). More recently, scholars have begun exploring dynamic norms, reflecting changes in norms over time (Bicchieri, 2017; Sparkman and Walton, 2017). When people perceive changes over time, they may also perceive that the change will persist into the future (Lee et al., *in prep*) and thus conform to what they perceive people will do in the future. In this sense, dynamic norms can motivate people to adopt new behaviors anticipated to be common in the future, even when such behaviors are currently uncommon (Sparkman, Howe and Walton, 2021).

Research on farmer decision-making has looked at social norms primarily through the theory of planned behavior (TPB; Ajzen, 1991) by focusing on subjective norms. Conceptually,

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descriptive, injunctive, or dynamic norms could be subjective norms, which refer to an individual's perception of what others around them think about a behavior or practice—whether it is approved or opposed (Ham, Jeger and Ivković, 2015; Jost et al., 2015). While often unspecified, TPB studies often define subjective norms in line with injunctive norms, based on perceptions of what other referents believe is expected behavior. Within TPB studies, the influence of subjective norms is inconsistent, being sometimes a very important factor (Huttel et al., 2020), a marginal factor (Artikov et al., 2006), or a non-factor (van Dijk et al., 2015). Also interesting is that Wauters et al. (2010) found subjective norms to be statistically significant predictors of *non-adoption* for several conservation practices. The measurement of only one norm construct is a potential limitation for developing a better theoretical understanding of whether different types of social norms play different roles in conservation practice adoption. For example, Ham, Jeger and Ivković (2015) find that including both descriptive and injunctive norms increases variance in intention to purchase environmentally sustainable food. One argument in TPB research broadly, but not concerning farming, is that the specification of a referent group is critical to whether norms are found to be statistically significant (Terry and Hogg, 1996; Fielding et al., 2008).

In this study, we test whether different types of social norms have consistent effects on conservation practice adoption and whether this can contribute to better theorization around the role of social norms in farming. By conservation practices, we refer broadly to different types of farm management that promote greater environmental sustainability while still supporting agricultural productivity. We ask two research questions regarding the effects of three social norms: (1) Are perceptions of past or current levels of conservation practices (i.e., perceived dynamic or descriptive norms) correlated with adoption or non-adoption of those practices? (2) Do perceptions of support or opposition to conservation practices among key messengers (i.e., perceived injunctive norms) correlate with the adoption or non-adoption of those practices? To answer these questions, we asked farmers about three different conservation-relevant practices, one of which is environmentally problematic: no-till (or zero tillage), cover crops, and applying fall nitrogen fertilizer following harvest. In this last practice, we abbreviate as Fall N for fall nitrogen fertilizer. We selected these different practices to examine whether social norms have similar or different effects across practices that may be helpful or unhelpful to promoting conservation, particularly on water quality outcomes. Both no-till and cover crops improve water quality by reducing the loss of nitrate from fertilizer (Busari et al., 2015; Hanrahan et al., 2018). The application of Fall N has been discouraged by conservation advisors because much of the Fall N application is lost to runoff (Wilcox, 2022). Application of fertilizer during winter and particularly on frozen ground is prohibited in numerous states. The inclusion of Fall N use enables our study to assess whether social norms also work against conservation outcomes in farming.

The effect of social norms on conservation practice adoption

In farm management, one theoretically crucial aspect is the observability of the farm management practices that farmers adopt. Burton's (2004) 'good farmer identity' theory argues that farmers experience peer pressure to maintain practices that look a certain way—straight crop rows, well-maintained field edges, and healthy crop appearance—because of the importance those practices have as indicators of good farming. Other studies also report that peer pressure can matter to conservation practices, whether supportive

or oppositional. Peer pressure potential stems from the long-term opportunities for observation and judgment of farmers' fields by neighbors, which can lead to a type of 'commonsense agriculture' for what practices are seen as acceptable or unacceptable (Siebert, Toogood and Knierim, 2006, p. 330). Yoder et al. (2021) also found evidence that visible failures, such as replanting a cash crop, linked to conservation practices, can serve as cautionary tales that get repeated by other farmers. This potential peer pressure, such as hearing criticism about other farmers, can serve to enforce injunctive norms about what types of farm management practices demonstrate good or bad farming. Support or opposition to a given practice may influence whether a farmer will risk criticism or conform to other farmers' expectations.

Conversely, the opportunity to observe peers is a theoretically important part of the diffusion of innovations theory, where farmers see whether peers are able to successfully adopt new practices and consider trying them out themselves (Rogers, 2003). Diffusion of innovations depicts a sigmoidal (S-shaped) adoption curve, whereby early adopters lead to the diffusion of the practice encourages an increasing number of farmers to also adopt until it reaches a potential equilibrium. Different types of social norms may be relevant to different points along this adoption curve. For relatively new practices, dynamic norms—reflecting perceptions about whether others are increasingly adopting a particular practice—might be particularly influential. In contrast, for longer-serving practices, descriptive norms, which reflect what other farmers are doing currently, may serve as an indicator of what other farmers have found to be an effective practice.

One of the reasons that descriptive or dynamic norms may influence farmers is the tacit knowledge gained by learning through observation or learning through interacting (e.g., Butler et al., 2006). Reimer et al. (2021) found that farmers often do not talk to one another about conservation practices, which may limit how effectively knowledge transfer happens but could also increase the importance of descriptive or dynamic norms on what practices farmers consider. If a conservation practice is uncommon, then farmers may not consider it. If a practice emerges, farmers may try it out but without sufficient knowledge of effective implementation, increasing the potential for perceived failure and dis-adoption.

We selected three conservation-relevant practices for the potentially different roles that social norms may play in adoption or non-adoption. We selected no-till because the practice is now the most common form of tillage nationally (used by a plurality of 38% of farms), though it varies widely within counties (USDA, 2024). Tillage decisions occur on a gradient of soil disturbance, with conventional tillage (i.e., plowing) causing the most disturbance for soil ecology (used by 33% of farms), with conservation tillage (e.g., forms of reduced tillage) causing limited disturbances (used by 29% of farms), and no-till causing the least amount of soil disturbance (ibid.). Because no-till is an established practice and overall rates have not changed quickly, we hypothesize that it is likely to be perceived as more static than cover crops or Fall N and that descriptive norm perceptions are more likely to be positively correlated with it than the other two practices. That is, farmers who perceive no-till as uncommon would be less likely to adopt no-till and vice versa. If descriptive norms do not correlate with the adoption of no-till, it would indicate that farmers are likely adopting it for other reasons, such as for cost savings (Creech, 2017; Coughenour, 2003). In contrast to the more static presence of no-till, cover crop adoption has increased relatively quickly over the past 10 years in the United States, though not uniformly at more local levels. We include cover crops to explore the role of dynamic

norms in particular. Our sampling strategy selected counties based on the changes in cover crop use from the USDA data. We hypothesize that dynamic norms will be correlated with cover crop adoption. Because cover cropping is a relatively recent practice, we do not necessarily know if other farmers will adopt it simply because it is more common or vice versa. If anything, we would expect that descriptive norms may lean toward non-adoption, given their generally low use (6%) nationally (USDA, 2024). Lastly, we included Fall N application because it could show that social norms may work against conservation adoption, but also because the use of Fall N has been increasingly discouraged in recent years by conservation advisors (Wilcox, 2022). Fall N is also a visible practice because farmers can see farmers using fertilizer equipment in their fields. While information on the prevalence of Fall N is not collected, there have been several high-publicity events over the past 10 years that generated widespread media attention on the risks of harmful algal blooms due to fertilizer losses, notably the closure of Toledo, Ohio's drinking water supply for two days in 2014 (Henry, 2014). We hypothesize that dynamic norms would matter for non-adoption, given that Fall N use may be becoming less common. It is also possible that descriptive or injunctive norms may matter, as perceptions of commonness or support or opposition to Fall N use would influence ongoing adoption of the practice.

The effects of control variables on conservation practice adoption

While research has only just begun to consider the effects of social norms in conservation practice adoption literature (Yoder et al., 2021), there has been a large variety of factors that have been investigated, which Prokopy et al. (2019) analyze in-depth. In their meta-analysis, they demonstrate that many variables are inconsistently correlated with adoption. Nonetheless, some variables remain theoretically important to consider. For example, large farm sizes clearly matter to adoption decisions, both because they can be associated with higher incomes from economies of scale that make conservation practices more affordable to try out (Houser, 2022; Houser et al., 2022), but also because the large size can also make it difficult to adopt the practices for the entire farm, such as for cover crops (Thompson et al., 2021). Farmers' self-perceptions of their ability to adopt a practice have also increased the likelihood of adoption (Yoder et al., 2025), as do farmers' perceptions that a practice is effective in accomplishing a particular outcome or goal (Pannell, 2017). Financial assistance, often through government programs, is likely to encourage greater use of practices, at least temporarily (Reimer et al., 2021). Farmer demographics are also frequently analyzed, particularly age, where younger farmers are often hypothesized in the literature to be more receptive to adopting new practices (Prokopy et al., 2019).

Methods

Data collection and study area

For this study, we collected data from a random sample of 8,000 grain crop farmers across four states: Illinois, Indiana, Maryland, and Pennsylvania. We selected these states for their likely differences in Fall N application, which we expected to be higher in Illinois and Indiana and lower in Maryland and Pennsylvania. Within each state, we selected eight counties, divided into the four largest increases and four largest decreases in the use of cover crops from the 2012 to 2017 U.S. Department of Agriculture's Census of

Agriculture, which is undertaken every 5 years (USDA, 2019; Fig. 1). An equal number of surveys was distributed to each county during February and March of 2022. We worked with DataForce, a private company, to conduct the random selection of farmer addresses for the survey. Farmers were mailed a postcard inviting them to take the survey online, followed by two subsequent mailings of a paper copy of the survey, which also provided farmers with an option to take the survey online. We closed the survey at the end of May 2022, receiving 585 returned surveys for a response rate of 7.3%. The study received institutional review board approval from Indiana University (#10067). While farmer response rates have continued to decline in recent decades (Glas et al., 2019), we recognize that the low response rates limit the potential generalizability of our sample.

Measures

Table 1 provides an overview of how dependent and explanatory variables were operationalized. Our dependent variables were a series of questions about whether farmers currently used no-till, cover crops, and fall N application. These were operationalized as binary variables for whether or not the practice was adopted. In the case of the Fall N use, we asked if farmers currently apply fall nitrogen fertilizer on their farm. We assessed social norms subjectively, asking farmers about their perceptions of 1) descriptive, 2) dynamic, and 3) injunctive norms. For descriptive norms, farmers estimated how many farmers in their county currently used each of the three practices, on a five-point scale ranging from 'almost none' to 'nearly all'. For dynamic norms, farmers estimated how much more or less common each practice had become over the past 5 years on a five-point scale ranging from much less common to much more common. For injunctive norms, farmers estimated how supportive or opposed important actors in farmers' social networks (family, neighbors, landlords, agronomists, and extension agents) would be to each practice on a five-point scale ranging from 0 to 4. Cronbach's alpha scores on these responses justified a single composite injunctive norm variable for each model: 0.89 for no-till, 0.89 for cover crops, and 0.95 for Fall N. We also include in the [Supplementary Material](#) a table on the correlations between the three norm constructs for each of the three conservation practice adoption models. Correlations ranged from 0.3 to 0.5 across the models.

We also asked a series of questions regarding farmer beliefs about management practices, farmer demographics, and farm characteristics to control for other important predictors of farmer practice adoption (Roesch-McNally et al., 2018; Prokopy et al., 2019). For self-efficacy, we asked farmers how confident they are in implementing each of the three management practices on a five-point scale from low to high. For response efficacy, we created an index based on farmers' perceptions of how effective each practice was in addressing soil erosion, weed pressure, soil health, nitrate loss, and profitability. Likert ratings were then summed and divided by the total possible score to create a continuous variable of response efficacy. We operationalized program assistance as a binary variable to capture if farmers had used any federal or state agricultural program assistance to implement cover crops. Our sampling strategy focused on identifying counties with high and low cover crop changes; thus, we focused only on financial assistance for this practice.

Farm size is a continuous variable representing the number of acres farmed. We use the natural log of farm size to deal with the non-normal distribution of acres in our sample, which range from

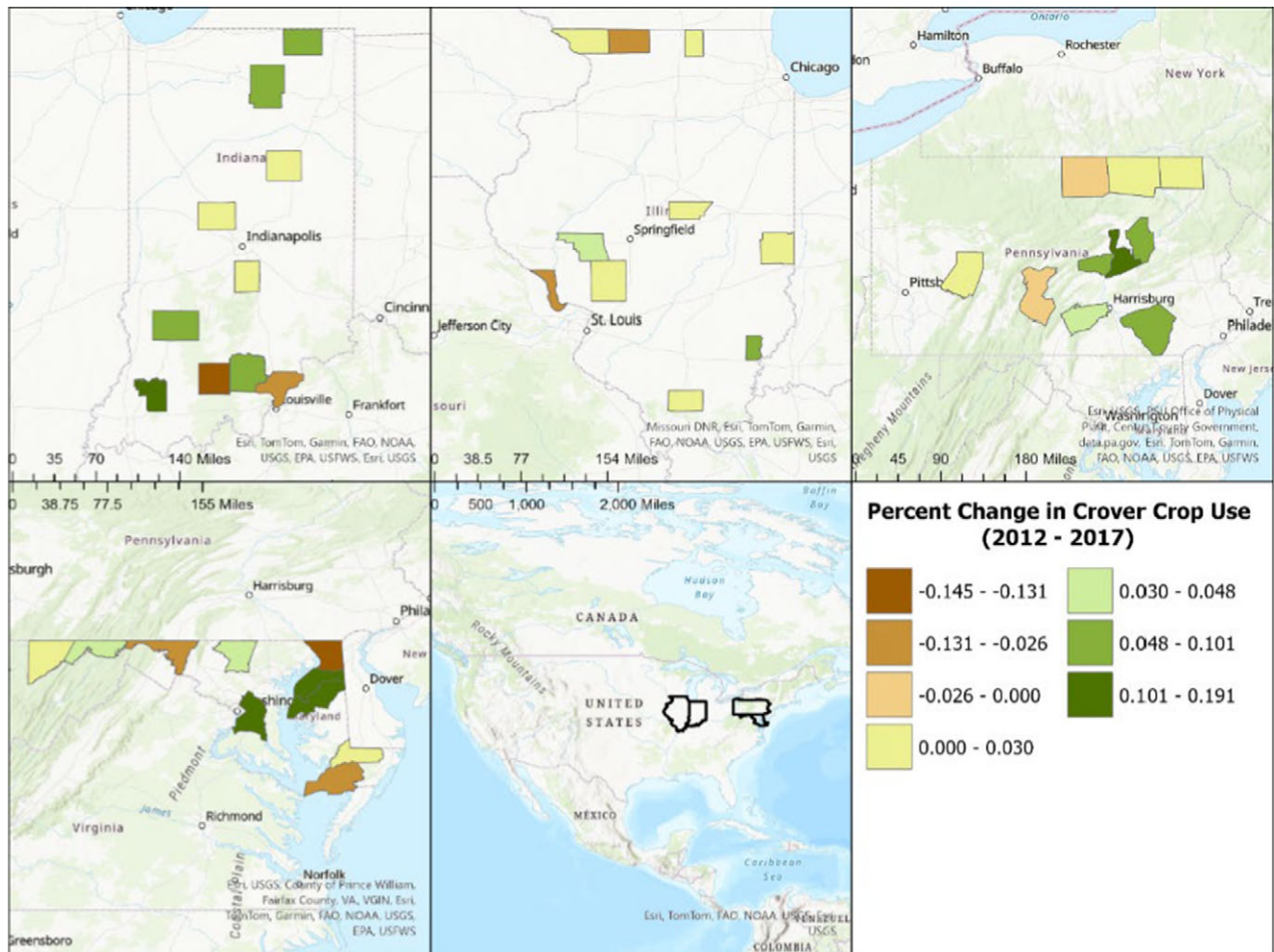


Figure 1. Study area of the counties we sampled, which represent the largest increases or decreases in county-level cover crop use in each of the four states in the survey.

Table 1. Dependent and explanatory variables used in the logit regression models, along with the hypothesized effects on the dependent variables

Dependent variables		Operationalized
No-till adoption		Binary response on whether farmers currently use the practice or not
Cover crop adoption		Binary response on whether farmers currently use the practice or not
Fall N fertilizer use		Binary response on whether farmers currently use the practice or not
Explanatory variables	Operationalized	Hypotheses
Descriptive norm	Likert scale of farmers' perceptions of how common the conservation practices are in the county where they farm, ranging from 'almost none' to 'nearly all'	Positively correlated with no-till
Dynamic norm	Likert scale of farmers' perceptions of recent trends in conservation practices in the county where they farm, ranging from 'much less common' to 'much more common'	Positively correlated with cover crops and Fall N
Injunctive norm	Likert scale of farmers' perceptions of support or opposition to conservation practices from family, neighbors, landlords, agronomists, and extension agents	Current research does not offer enough guidance for a hypothesis

fewer than 100 acres to several thousand acres. Percent owned is a continuous variable representing the percentage of the farmland that farmers own. Farm income is an ordinal variable representing five levels of gross farm income, from less than \$50,000 to greater

than \$1,000,000. Age is operationalized as a continuous variable. Gender was operationalized as a binary variable of male or non-male. Education is operationalized as an ordinal variable representing five levels from some high school to postgraduate. State is

included as a categorical variable with Illinois serving as the reference group.

Statistical analysis and hypotheses

We ran three logit regression models with state fixed effects to predict the adoption of no-till, cover crops, and Fall N. We ran the models in Stata, using the *how_many_imputation* package (von Hippel, 2018, Statistical Software Components S458452) to impute missing values. We made 20 imputations in each of the models. With the imputed values, the number of observations in models was 512 for no-till, 515 for cover crops, and 512 for Fall N. In the results, we report the odds ratios, standard errors, and *p*-values. Additional statistics associated with the validity of models are included in the [Supplementary Material](#). In [Table 1](#), we show our hypothesized relationships for each of the explanatory variables' effects on the different conservation practices. We expect descriptive norms to be positively correlated with the adoption of cover crops and no-till and negatively correlated with the adoption of Fall N. Given the theoretical importance of a practice's visibility to descriptive norms, we expect that descriptive norms would be more relevant for no-till and cover crops, which are more visible than Fall N. We hypothesize that dynamic norms will also predict cover crop adoption, given the recent increase in this practice, but not be correlated with no-till adoption, given that no-till and conservation tillage have been known for decades. We are unsure what its relationship with Fall N application is because there are no publicly available data on fertilizer rates. For injunctive norms, there is insufficient research currently on which to base hypotheses for any of the practices. For the farm management variables, we expect self-efficacy and response efficacy to have a positive relationship with the pro-environmental management practices and a negative relationship with applying Fall N. For Fall N, we anticipate a negative relationship because greater skill in applying fall fertilizer also implies greater confidence in precision application during the growing seasons, which would reduce the value or need for fall application. For response efficacy of each practice for soil benefits, we hypothesize that no-till and cover crops will be positively correlated, but do not expect to see a relationship for Fall N due to the lower relevance of fall fertilizer for soil benefits.

Results

Descriptive statistics

Our sample of farmers was split roughly evenly across the four states: Pennsylvania (29%), Indiana (27%), Illinois (25%), and

Maryland (19%). Responses from counties that had an increased number of cover crops represented 51% of the sample, while responses from counties that had a decreased number of cover crops planted represented 49% of the sample. The vast majority of farmers use no-till currently (78%), while cover crop adoption was also above the general population's use at 59% of the sample. A small portion (17%) applies nitrogen fertilizer in the fall, while the vast majority do not (76%). We also ran correlations among our three dependent variables to see the level of co-occurrence between the practices. Zero-order correlations revealed that those who adopted no-till were also moderately more likely to adopt cover crops ($r = 0.37$), while those who adopted Fall N were only slightly more likely to adopt no-till ($r = 0.12$) or cover crops ($r = 0.13$).

Farmers were 95% male and 5% female with an average age of 66 years. Median farm size was 300 acres (mean = 600 acres; range = 20–10,000 acres). A majority of farmers had some college or a bachelor's degree (50%), while the next largest group had at least some high school or a high school degree (38%), and a smaller group had a graduate degree (11%). In [Table 2](#), we provide a state-level comparison of key variables from our sample against publicly available data from the USDA's 2022 *Census of Agriculture*. In comparing our sample to USDA data, our sample includes farms that are larger on average in each state, skew more toward male operators, are slightly older than the average, and are more likely to use the conservation practices we are interested in studying, including low use of Fall N. In combination with our response rate, we interpret our findings cautiously to be more indicative of adopters of no-till and cover crops than the general population of farmers.

When looking at perceptions of how much more or less common the different practices had become over the past 5 years, most respondents perceived that no-till and cover crops were becoming more or much more common (55% and 63%, respectively), while very few saw declines in the practices (5% and 4%, respectively). We also ran correlations between these perceptions and the actual adoption rates for cover crops at the county level and found that descriptive norm perceptions were modestly correlated ($r = 0.54$). For dynamic norms, the correlation was low ($r = 0.15$) between perceptions of changes with reported levels of cover crops from 2012 to 2017. In contrast, Fall N application was mostly perceived as staying about the same (48%), while the next largest group saw the practice declining (38%).

When looking at farmers' perceptions of support or opposition to each practice, the most notable element was the far higher percentage of neutral scores for Fall N (49%) compared with no-till (28%) and cover crops (27%). For no-till and cover crops, a large majority of respondents reported that the five groups of people were either supportive or very supportive (68% and 71%, respectively).

Table 2. Comparison of state-level averages of key variables between our survey sample and the U.S. Department of Agriculture's 2022 Census of Agriculture

Variable	Illinois		Indiana		Maryland		Pennsylvania	
	Sample	USDA	Sample	USDA	Sample	USDA	Sample	USDA
No-till adoption	79%	35%	79%	33%	82%	37%	74%	28%
Cover crop adoption	32%	10%	45%	13%	76%	25%	69%	24%
Fall N application	41%	–	6%	–	9%	–	16%	–
Farm size (mean acres)	826	355	868	281	561	146	351	107
Age (mean years)	65.8	58.6	66.3	56.0	66.3	57.8	65.2	55.4
Female operators	7%	<1%	5%	<1%	7%	<1%	<1%	35%

For farm sizes, we considered farms and acres listed under cropland, which is more relevant to our sample of grain farmers.

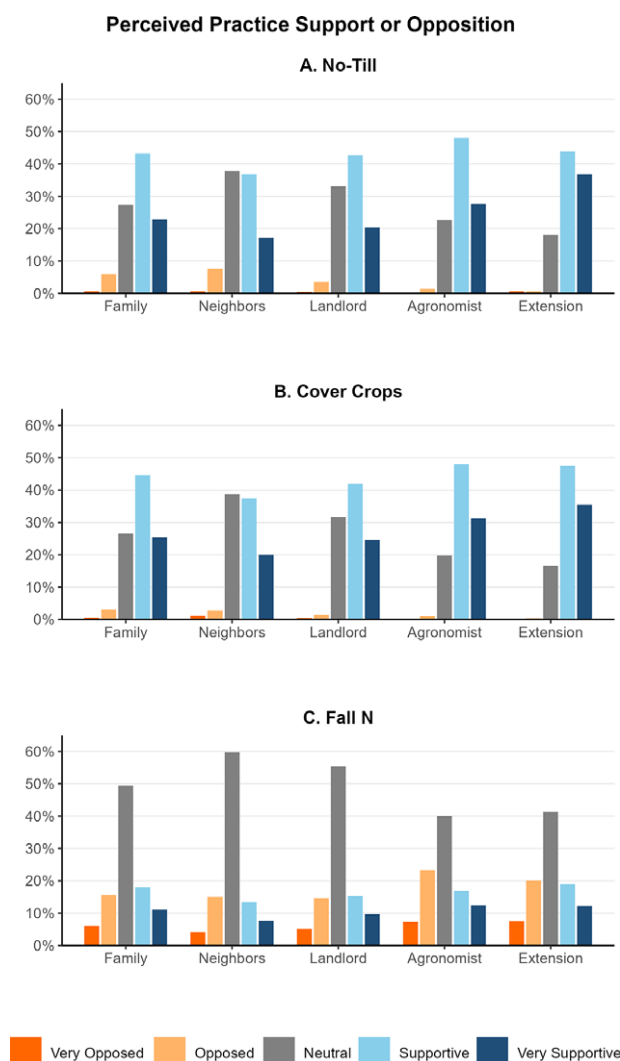


Figure 2. Injunctive norm perceptions by group for Fall N fertilizer application.

Neighbors were given the largest neutral scores for both no-till and cover crops, as well as the largest scores for opposed or very opposed (8% for no-till and 4% for cover crops). Farmers perceived nearly 25% of the five groups as being opposed or very opposed to applying Fall N (Fig. 2). Overall, our descriptive statistical findings indicate that most respondents approach these three practices in ways that provide conservation benefits by adopting no-till and cover crops and not applying Fall N.

Norm relationships with conservation practice use

Our three logit models with state fixed effects predicting the adoption of no-till, cover crops, and Fall N application revealed that different types of social norms predicted each practice (see Table 3 for details). For no-till, only descriptive norms had a statistically significant, though modest, effect. Consistent with hypotheses, for every one-unit increase in how common farmers perceived no-till was in their county, the odds that a farmer used no-till increased by 31%. Only dynamic norms predicted cover crop adoption: The odds that a farmer adopted cover crops increased by 68% with a one-unit increase in perceptions that cover crops had become more common. Both descriptive and injunctive norms predicted Fall N application. In this model, the perception that Fall N was common (i.e., the descriptive norm) had a very large effect on adoption, with

a one-unit increase in perceived commonness predicting farmers being 126% more likely to apply Fall N. Injunctive norms perceptions also increased the odds by 70% that farmers would apply Fall N as support increased.

Non-norm variables were also important predictors of adoption. Self-efficacy predicted greater adoption of all three practices, with the odds of farmers adopting cover crops nearly doubling as self-confidence increases. Consistent with hypotheses for each practice, perceptions that a practice was effective for a set of conservation priorities (response efficacy) predicted greater adoption of no-till and cover crops (77% and 56%, respectively), but not of applying Fall N. Program assistance, which represents whether farmers had received federal or state support for cover crops, had the largest effect of any variable on any practice across our models, with farmers being 260% more likely to adopt cover crops than farmers who did not receive any program assistance. Program assistance was also strongly correlated with no-till adoption (113% more likely), which is unsurprising since cover crops and no-till are seen as complementary conservation practices. Surprisingly, program assistance was also associated with greater Fall N: Farmers were over twice as likely (216%) to apply Fall N if they received program assistance for cover crops.

In its natural log form, farm size had expected results for no-till and cover crops, where there was no effect on adopting no-till and cover crop adoption decreases as farm size increases. Farm size was statistically significant for Fall N, where larger farms were more likely to use Fall N. Surprisingly, neither the percentage of farmland owned nor farmer demographics (age, gender, and education) were statistically significant predictors of any of the practices.

The state variables were statistically significant in the cover crops and Fall N models but were not statistically significant in the no-till model. With Illinois as the reference state, farmers in Pennsylvania were more than twice as likely to plant cover crops, while there was no statistically significant difference between farmers in Illinois, Indiana, and Maryland. This finding is surprising since Maryland farmers in our sample adopt cover crops at a similar rate as Pennsylvania farmers. Indiana and Maryland farmers in our sample were 71% less likely to apply Fall N compared with farmers in Illinois, while there was no statistically significant difference for Illinois and Pennsylvania farmer application of Fall N.

Discussion

Our findings provide correlational evidence that different types of social norms may matter to different on-farm conservation practices or at different junctures in the process of community-level adoption. Our findings both confirm our hypotheses for descriptive and dynamic norms for no-till and cover crops, respectively, while also challenging our hypothesis for descriptive norms for Fall N. While we did not have a hypothesis about how injunctive norms would predict adoption of farm practices, our findings suggest that injunctive norms matter, consistent with existing theory for pro-environmental behavior more generally (e.g., Nyborg et al., 2016). While our skewed sample limits the generalizability of our findings largely to farmers who use no-till and cover crops in our study area, there are a number of valuable insights that can be taken from our three models to inform conservation outreach.

Descriptive norm implications

Our findings support our hypothesis that no-till would be positively correlated with perceptions that it is common, consistent with USDA *Census of Agriculture* data that a plurality of farmers use

Table 3. Results from the three logit models examining the adoption of no-till, cover crops, and applying fall nitrogen fertilizer

Logit models	No-till adoption (<i>n</i> = 512)		Cover crop adoption (<i>n</i> = 515)		Fall N fertilizer application (<i>n</i> = 512)	
	Odds ratio (SE)	<i>P</i> -value	Odds ratio (SE)	<i>P</i> -value	Odds ratio (SE)	<i>P</i> -value
Descriptive norm	1.31 (0.20)	0.073*	1.03 (0.15)	0.804	2.26 (0.42)	<0.001***
Dynamic norm	1.15 (0.24)	0.491	1.67 (0.32)	0.007***	1.37 (0.34)	0.200
Injunctive norm	1.00 (0.24)	0.995	1.20 (0.28)	0.421	1.70 (0.40)	0.056*
Self-efficacy	1.66 (0.20)	<0.001***	1.80 (0.22)	<0.001***	1.72 (0.25)	<0.001***
Response efficacy	1.77 (0.30)	<0.001***	1.55 (0.29)	0.018**	1.31 (0.24)	0.214
Program assistance	2.13 (0.78)	0.040**	3.60 (1.11)	<0.001***	3.16 (0.82)	0.014**
Farm size (log)	1.14 (0.20)	0.460	0.76 (0.12)	0.087*	1.54 (0.34)	0.028**
Farm income	1.44 (0.23)	0.025**	1.97 (0.32)	<0.001***	0.97 (0.18)	0.860
Percent owned	0.99 (0.01)	0.227	1.00 (0.01)	0.650	0.99 (0.01)	0.268
Age	1.01 (0.01)	0.378	0.99 (0.01)	0.413	1.01 (0.02)	0.289
Gender	0.89 (0.64)	0.875	0.84 (0.55)	0.794	1.00 (0.62)	0.998
Education	0.82 (0.24)	0.486	1.17 (0.31)	0.563	1.13 (0.40)	0.760
State fixed effects (Illinois is the reference group)						
Indiana	1.07 (0.39)	0.854	0.61 (0.20)	0.136	0.29 (0.15)	0.015**
Maryland	0.66 (0.31)	0.368	1.15 (0.54)	0.766	0.29 (0.17)	0.038**
Pennsylvania	0.75 (0.30)	0.472	2.05 (0.80)	0.067*	1.25 (0.64)	0.667
Goodness-of-fit statistics						
Model	LL (null)		LL (model)		AIC	BIC
No-till	−267.6858		−202.1383		436.2766	504.0898
Cover crops	−348.1583		−237.0853		506.1706	574.0772
Fall N	−231.7572		−129.7442		291.4883	359.3015

Note: Asterisks indicate statistical significance at the *0.1, **0.05, and ***0.01 levels. Because the models were imputed 20 times, we present the mean scores for the goodness-of-fit statistics for log-likelihood (LL), Akaike information criterion (AIC), and Bayesian information criterion (BIC). The statistics for each imputed model are available in the [Supplementary Material](#).

no-till nationally. Yet, in contrast to our hypothesis for Fall N, farmers in our study also see applying Fall N fertilizer as a common practice. These results are surprising since our sample is skewed toward farmers who use both no-till and cover crops and do not use Fall N (~25% adoption in our sample). There are a couple of possible explanations. First, even though a majority of farmers in our sample do not personally use Fall N, they may believe, correctly, that it is a common practice. Since we do not have national statistics on applying Fall N, we do not have a basis for evaluating how common the practice is. Second, the theoretical importance of visibility of a practice may also matter (e.g., Burton, 2004). No-till and cover crops are highly visible from the roadside, and so it may be easier for farmers to accurately discern the popularity of those practices. Fall N is less visible by comparison since a farmer would need to actually see other farmers applying the fertilizer, whereas no-till and cover crops are visible for a longer time frame after farmers finish tilling or planting.

While Fall N could be declining in commonality as conservation advisors increasingly advise against its use, the limited role of visibility could also mean that farmers presume the practice is still widely maintained in the absence of any credible data to the contrary. This could then represent a case of ‘pluralistic ignorance’ (Bicchieri, 2017), whereby people do not know each other’s true beliefs and maintain a perception that an uncommon or unpopular practice remains widely used. One possible recommendation for conservation advisors would be to have county-level data that can

be shared with farmers to help provide accurate information about the prevalence of Fall N (or any practice of interest). To avoid boomerang effects—whereby non-adopters of Fall N might start to use the practice more if it is more common than they believe—other research has demonstrated that information about actual behaviors needs to be combined with messages about the benefits of dis-adopting Fall N (or for adopting other conservation practices; e.g., Schultz et al., 2007).

Dynamic norm implications

Our hypotheses for dynamic norms were confirmed with only cover crops being perceived as increasing. This is consistent with theoretical expectations that people will act in a counter-normative way—toward a future norm—when they anticipate that norms are changing (Sparkman and Walton, 2017). However, similar to our findings for descriptive norms, it is possible that the over-representation of cover crop adopters may be influencing our findings and limiting the generalizability that dynamic norm perceptions are changing. For adopters, our finding indicates that the perception that the practice is increasing is an important factor in using the practice. This is notable considering that other studies have demonstrated serious challenges for scaling up cover crops from widespread dis-adoption occurring throughout the United States (Plastina, Sawadgo and Okonkwo, 2024). Theoretically, dynamic norms may also derive their importance from visibility

for farming, much like descriptive norms. A more generalizable sample could potentially offer a different indication given the widely ranging variability of cover crop adoption at the county level.

Much conservation adoption research is theoretically based on Rogers' (2003 [1962]) diffusion of innovations framework, where farmers are largely categorized based on when they adopt an innovation relative to other farmers in their network. From this perspective, many extension programs work to catalyze new innovations by identifying a respected and well-known farmer to adopt the innovation first and increase interest and support for the practice to lead to greater adoption. Dynamic norms would appear to fit well into these existing efforts in the United States—with the caveat that getting a larger group of farmers, and ideally ones that are connected to a variety of social networks, is potentially crucial to tapping into the dynamic norm perceptions. A potential challenge is that farmers may not spend much time talking about conservation practices, as Reimer et al. (2021) found. Thus, the lower visibility of any practice, such as Fall N, could also mean that there is a greater need for efforts that promote knowledge transfer to shape perceptions on the popularity and usefulness of individual practices, such as on-farm demonstration events, outreach by conservation advisors, or initiatives focused on farmer peer-to-peer learning.

Injunctive norm implications

While we did not have a hypothesis regarding injunctive norms for our three practices, it is notable that support for Fall N, often depicted as an anti-conservation practice, was statistically significant in favor of adoption. It is important to interpret this finding cautiously because the modal response for Fall N across all five important influences was 'neutral', rather than supportive or oppositional. What it indicates is that if a farmer in our sample has support for using Fall N, they are much more likely to use this practice, while overall our sample is comprised of mostly non-users of Fall N whose influences do not support or oppose its use. One potential explanation for this dynamic could be that Fall N adopters may plant winter wheat as a cash crop or cover crop and apply fertilizer alongside it. When wheat is planted as a cash crop—which is planted in the fall, goes dormant during winter, and then resumes its growth in the spring—it is standard for farmers to apply nitrogen fertilizer to wheat. Support for fall fertilizer may be associated with planting winter wheat but not necessarily supported beyond this specific application; thus, a majority of farmers may see Fall N as a management tool that is acceptable when needed. Alternatively, injunctive norms may only matter for a minority of farmers; if farmers are aware that conservation advisors have begun to discourage the practice of Fall N, peer support may take on greater importance than for practices that are more common or increasing in use.

One implication here is that injunctive norms may operate differently than descriptive or dynamic norms, where dynamic norms may create more room for trialing new practices while injunctive norms provide a greater basis for maintaining the status quo. This matters for intervention strategies. For example, a demonstration from a 'lead farmer' in a county may be useful for trying something new, such as cover crops, but may be a poor fit for promoting dis-adoption of Fall N. If support is critical to maintaining the status quo, then creating widely acceptable reasons for changing practices becomes critical to overcoming group-level perceptions. Conversely, situations that require changing popular injunctive norms represent a collective action challenge because

individuals must work together to support new reasoning that undergirds the change in behavior (Bicchieri, 2017). For example, McGuire et al. (2015) found that getting farmers to address water quality impairment required new narratives around improved efficiency in fertilizer application to make the case that better management was the salient justification for making a change, rather than improved water quality.

Non-norm implications

Lastly, alongside our main finding that different social norms matter in different ways, we also find that several standard variables for conservation adoption continue to be important. Consistent with our hypotheses, self-efficacy, response efficacy, beliefs about the practice, and program support were statistically significant and positively correlated with adoption (excluding the response efficacy of Fall N, which we hypothesized to not matter for soil health—as the survey question asked). What our approach is unable to disentangle is the potential interaction between these more rational factors and normative ones. For example, it is intuitive that farmers would be reluctant to adopt a practice for which they do not feel capable of implementing or believe is ineffective for their management priorities. At the same time, a farmer's willingness to try something new could reflect whether there is a social norm in favor of experimentation, whereby potential failures are seen as a valuable learning opportunity, or norms that encourage conformity, whereby failures are seen as evidence that a farmer is not skilled at farming.

Given the importance of the non-norm variables, traditional technical assistance (e.g., for response and self-efficacy beliefs) and financial support remain the most important aspects of adopting conservation practices based on our findings. However, we understand relatively little about how the delivery of technical assistance interacts with social norms. For example, Burton and Paragahawewa (2011) argue that U.K. farmers dislike prescriptive regulations because that approach not only reduces farmers' autonomy, but it also takes away their opportunity to demonstrate their skill as a farmer and to experience the satisfaction and reputational benefits that they could experience. This may be especially valuable considering evidence that many farmers are reluctant to participate in government programs for a variety of reasons (Houser et al., 2024). One implication could be that non-government actors or programs could further strengthen technical assistance if their involvement increases the number of farmers who are receptive to learning about conservation practices. Additionally, if injunctive norms maintain the status quo, then a diversified pool of trusted messengers may be especially critical to increasing receptivity to new ideas and changing long-held perceptions.

The results for the state variables do not reveal obvious patterns or tradeoffs at the state level. The Fall N results indicate that Indiana and Maryland farmers are less likely to use the practice. For Maryland, which restricts winter fertilizer application, lower Fall N application could reflect a spillover effect of this policy. While Indiana does not prohibit Fall or winter application, the results could reflect that both states may be more effective in advocating against the use of Fall N as part of their conservation strategies, compared with Illinois and Pennsylvania. It seems inconsistent that Pennsylvania, which has smaller farms like Maryland, is dissimilar on this measure, while also being more likely to adopt cover crops compared to Illinois farmers. One possible explanation is that farmers see cover crops and Fall N as management tools that can

be used together, rather than representing a tension within a conservation paradigm.

Limitations and future directions

Our study considers farmers in a specific region of the world (the lower Midwest and mid-Atlantic United States); future work is needed to consider how findings might generalize to other contexts and cultures. For example, state-level policies in Maryland provide above-average levels of subsidies for cover crop adoption and also prohibit winter fertilizer application. These types of policy variations could obscure or override the effects of social norms. Additionally, we are limited by the low survey response rate, which could suggest that farmers who are more likely to adopt conservation practices might have been more likely to respond to our survey. Our sample is skewed toward management that benefits conservation outcomes, with high levels of adoption for no-till and cover crops and low use of Fall N. The study demonstrates the relevance of social norms for this particular segment of farmers. Because social norms operate within social networks, our findings show that researchers of farm decision-making should work to include more nuanced understandings of social norms, such as whether different referent groups are more influential with regard to specific practices or when a practice is uncommon, increasing in use, or has been widely established over a long period of time.

Additionally, the correlational nature of our study does not demonstrate causality; it is possible that people's own adoption of these behaviors might influence the extent to which they perceive the behaviors are common, increasing, or socially acceptable (e.g., the false consensus effect; Marks and Miller, 1987). Future work could consider experimentally manipulating farmers' perceptions of norms to examine causal effects, though using informational messages to highlight what other community members are doing or approve of may be ineffective because such messages may not be trusted or believable. Finally, future work should consider the extent to which the perceived social norms are accurate representations of what other farmers are actually doing and feeling, as previous work suggests that people often systematically underestimate other people's pro-environmental opinions and behaviors (Sparkman, Geiger and Weber, 2022; Wyss, Berger and Knoch, 2023) and these underestimations can limit individuals' own behaviors (Geiger and Swim, 2016; Wyss, Berger and Knoch, 2023).

Conclusion

This study examines how descriptive, dynamic, and injunctive norms could be influencing current conservation practices in the United States. We find that different types of social norms are important to adoption decisions and can work for or against conservation. Our findings support the clear need for researchers to look at different types of social norms with respect to different practices and situations in agriculture, as descriptive, dynamic, and injunctive norms represent different and important aspects of influence on management decisions. Arguably, the most prevalent approach in farmer decision-making and adoption research currently is the use of subjective norms based on the theory of planned behavior. Our study shows that social norms may be important to explain relationships with long-standing variables in farmers' adoption research, such as self-efficacy, farm income, and response efficacy.

Future research should more specifically look at how the influence of social norms shapes knowledge transfer of practices over time and how this shapes perceived and actual changes in costs and

benefits of individual practices. In our study, we see evidence that cover crops may have benefited from dynamic norms, but it is unclear whether this will be sustained given ongoing disagreements about the practice's financial viability, in contrast to no-till. Similarly, multiple studies have pointed to farmers using fertilizer practices that are not financially advantageous, since crops can only uptake a limited amount of fertilizer during the growing season—meaning farmers are willing to overapply, costing them money (Pannell, 2017; Houser, 2022). Our study offers a strong indication that future research is needed to provide additional evidence and theory for how social norms influence farmers' adoption practices. Deeper examination of these critical social forces can provide us with insights on how to better promote and scale up pro-environmental management in agriculture as a lever of behavior change (Nyborg et al., 2016).

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References

- Ajzen, I. (1991) 'The theory of planned behavior', *Organizational Behavior and Human Decision Processes*, **50**, pp. 179–211.
- Artikov, I., Hoffman, S.J., Lynne, G.D., Pytlík, L.M., Zillig, Q.H., Tomkins, A. J., Hubbard, K.G., Hayes, M.J. and Waltman, W. (2006) 'Understanding the influence of climate forecasts on farmer decisions as planned behavior', *Journal of Applied Meteorology and Climatology*, **45**(September), pp. 1202–1214.
- Barnes, A.P., Willock, J. and Toma, L. (2009) 'Farmer perspectives and practices regarding water pollution control programmes in Scotland', *Agricultural Water Management*, **96**, pp. 1715–1722.
- Bicchieri, C. (2017) *Norms in the wild: how to diagnose, measure, and change social norms*. Oxford, United Kingdom: Oxford University Press.
- Breitburg, D., Levin, L.A., Oschlies, A., Grégoire, M., Chavez, F.P., Conley, D. J., Garçon, V., Gilbert, D., Gutiérrez, D., Isensee, K., Jacinto, G.S., Limburg, K.E., Ivonne Montes, S.W.A.N., Pitcher, G.C., Rabalais, N.N., Roman, M.R., Rose, K.A., Seibel, B.A., Telszewski, M., Yasuhara, M. and Zhang, J. (2018) 'Declining oxygen in the global ocean and coastal waters', *Science*, **359**(6371), p. eaam7240. <http://doi.org/10.1126/science.aam7240>.
- Burton, R.J.F. (2004) 'Seeing through the 'good farmer's' eyes: towards developing an understanding of the social symbolic value of 'productivist' behaviour', *Sociologia Ruralis*, **44**(2), pp. 195–215.
- Burton, R.J.F. and Paragahawewa, U.H. (2011) 'Creating culturally sustainable agri-environmental schemes', *Journal of Rural Studies*, **27**, pp. 95–104.
- Busari, M.A., Kukal, S.S., Kaur, A., Bhatt, R. and Dulazi, A.A. (2015) 'Conservation tillage impacts on soil, crop and the environment', *International Soil and Water Conservation Research*, **3**(2), pp. 119–129. <http://doi.org/10.1016/j.iswcr.2015.05.002>.
- Butler, A., Le Grice, P. and Reed, M. (2006) 'Delimiting knowledge transfer from training' edited by H. Matlay, *Education + Training*, **48**(8/9), pp. 627–641.

- Cialdini, R.B., Reno, R.R. and Kallgren, C.A. (1990) 'A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places', *Journal of Personality and Social Psychology*, 58(6), pp. 1015–1026.
- Coughenour, C.M. (2003) 'Innovating conservation agriculture: the case of no-till cropping', *Rural Sociology*, 68(2), pp. 278–304.
- Creech, E. (2017) 'Saving money, time and soil: the economics of no-till farming'. Natural Resources Conservation Service Blog. 30 November. Available at: <https://www.usda.gov/about-usda/news/blog/saving-money-time-and-soil-economics-no-till-farming> (Accessed: 9 February 2025).
- Drevno, A. (2016) 'Policy tools for agricultural nonpoint source water pollution control in the U.S. and E.U.', *Management of Environmental Quality: An International Journal*, 27(2), pp. 106–123. <http://doi.org/10.1108/MEQ-12-2014-0177>.
- Fielding, K.S., Terry, D.J., Masser, B.M. and Hogg, M.A. (2008) 'Integrating social identity theory and the theory of planned behaviour to explain decisions to engage in sustainable agricultural practices', *British Journal of Social Psychology*, 47(1), pp. 23–48. <http://doi.org/10.1348/014466607X206792>.
- Fiorino, D.J. and Ahluwalia, M. (2020) 'Regulating by performance, not prescription: the use of performance standards in environmental policy' in *Handbook of U.S. environmental policy*. Northampton, MA: Edward Elgar Publishing Limited, pp. 217–230.
- Geiger, N. and Swim, J.K. (2016) 'Climate of silence: pluralistic ignorance as a barrier to climate change discussion', *Journal of Environmental Psychology*, 47, pp. 79–90.
- Glas, Z.E., Getson, J.M., Gao, Y., Singh, A.S., Eanes, F.R., Esman, L.A., Bulla, B.R. and Prokopy, L.S. (2019) 'Effect of monetary incentives on mail survey response rates for midwestern farmers', *Society & Natural Resources*, 32(2), pp. 229–237. <http://doi.org/10.1080/08941920.2018.1530815>.
- Goldstein, N.J., Cialdini, R.B. and Griskevicius, V. (2008) 'A room with a viewpoint: using social norms to motivate environmental conservation in hotels', *Journal of Consumer Research*, 35(3), pp. 472–482. <http://doi.org/10.1086/586910>.
- Ham, M., Jeger, M. and Ivković, A.F. (2015) 'The role of subjective norms in forming the intention to purchase green food', *Economic Research—Ekonomska Istraživanja*, 28(1), pp. 738–748. <http://doi.org/10.1080/1331677X.2015.1083875>.
- Hanrahan, B.R., Tank, J.L., Christopher, S.F., Mahl, U.H., Trentman, M.T. and Royer, T.V. (2018) 'Winter cover crops reduce nitrate loss in an agricultural watershed in the central U.S.', *Agriculture, Ecosystems and Environment*, 265, pp. 513–523.
- Henry, T. (2014) 'Water crisis grips hundreds of thousands in Toledo area, state of emergency declared'. *Toledo Blade*, 3 August.
- Houser, M. (2022) 'Farmer motivations for excess nitrogen use in the U.S. corn belt', *Case Studies in the Environment*, 6(1), p. 1688823. <https://doi.org/10.1525/cse.2022.1688823>.
- Houser, M., Campbell, B., Jacobs, A., Fanok, S. and Johnson, S.E. (2024) 'Farmers' participation in incentivized conservation programs: exploring barriers and opportunities for innovative designs', *Journal of Soil and Water Conservation*, 79(1), pp. 20–30. <http://doi.org/10.2489/jswc.2024.00122>.
- Houser, M., Gazley, B., Reynolds, H., Browning, E.G., Sandweiss, E. and Shanahan, J. (2022) 'Public support for local adaptation policy: the role of social-psychological factors, perceived climatic stimuli, and social structural characteristics', *Global Environmental Change*, 72, p. 102424. <https://doi.org/10.1016/j.gloenvcha.2021.102424>.
- Hüttel, S., Leuchten, M.-T. and Leyer, M. (2020) 'The importance of social norm on adopting sustainable digital fertilisation methods', *Organization & Environment*, 35(1), pp. 79–102. <https://doi.org/10.1177/1086026620929074>.
- Intergovernmental Panel on Climate Change (IPCC). (2022) *Climate change 2022 – impacts, adaptation and vulnerability: working group II contribution to the sixth assessment report of the intergovernmental panel on climate change*. 1st edn. Cambridge, United Kingdom: Cambridge University Press.
- Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). (2019) *Global assessment report on biodiversity and ecosystem services of the intergovernmental science-policy platform on biodiversity and ecosystem services*. Zenodo. <http://doi.org/10.5281/ZENODO.3831673>.
- Jost, J.T., Sterling, J.L. and Langer, M. (2015) 'From 'is' to 'ought' and sometimes 'not': compliance with and resistance to social norms from a system justification perspective', *Journal of Cross-Cultural Psychology*, 46(10), pp. 1287–1291. <http://doi.org/10.1177/0022022115600268>.
- Lee, J., Geiger, N., Sparkman, G. and Constantino, S.M. (in prep.) 'Time for a change? Examining Americans' perceptions of linear and nonlinear social norm change'.
- Marks, G. and Miller, N. (1987) 'Ten years of research on the false-consensus effect: an empirical and theoretical review', *Psychological bulletin*, 102(1), 72.
- McGuire, J.M., Morton, L.W., Gordon Arbuckle, J. and Cast, A.D. (2015) 'Farmer identities and responses to the social-biophysical environment', *Journal of Rural Studies*, 39, pp. 145–155. <https://doi.org/10.1016/j.jrurstud.2015.03.011>.
- Morton, L.W. (2008) 'The role of civic structure in achieving performance-based watershed management', *Society & Natural Resources*, 21(9), pp. 751–766. <http://doi.org/10.1080/08941920701648846>.
- Nyborg, K. (2018) 'Social norms and the environment', *Annual Review of Resource Economics*, 10(1), pp. 405–423. <http://doi.org/10.1146/annurev-resource-100517-023232>.
- Nyborg, K., Anderies, J.M., Dannenberg, A., Lindahl, T., Schill, C., Maja Schlüter, W.N.A., Arrow, K.J., Barrett, S., Stephen Carpenter, F.S.C., Crépin, A.-S., Daily, G., Ehrlich, P., Folke, C., Jager, W., Kautsky, N., Levin, S.A., Madsen, O.J., Polasky, S., Scheffer, M., Walker, B., Weber, E.U., Wilen, J., Xepapadeas, A. and de Zeeuw, A. (2016) 'Social norms as solutions', *Science*, 354(6308), pp. 42–43. <http://doi.org/10.1126/science.aaf8317>.
- Pannell, D.J. (2017) 'Economic perspectives on nitrogen in farming systems: managing trade-offs between production, risk and the environment', *Soil Research*, 55(6), p. 473. <http://doi.org/10.1071/SR16284>.
- Perry, G.L.W., Richardson, S.J., Harre, N., Hodges, D., Lyver, P.O.'B., Fleur, J.F.M., Taylor, R., Todd, J.H., Tylianakis, J.M., Yletyinen, J. and Brower, A. (2021) 'Evaluating the role of social norms in fostering pro-environmental behaviors', *Frontiers in Environmental Science*, 9, p. 620125. <http://doi.org/10.3389/fenvs.2021.620125>.
- Plastina, A., Sawadgo, W. and Okonkwo, E. (2024) 'Pervasive disadoption substantially offsets new adoption of cover crops and no-till', *Choices*, 39(2), pp. 1–14.
- Prokopy, L.S., Floress, K., Arbuckle, J.G., Church, S.P., Eanes, F.R., Gao, Y., Gramig, B.M., Ranjan, P. and 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), pp. 520–534. <https://doi.org/10.2489/jswc.74.5.520>.
- Qiu, W., Zhong, Z. and Huang, Y. (2021) 'Impact of perceived social norms on farmers' behavior of cultivated land protection: an empirical analysis based on mediating effect model', *International Journal of Low-Carbon Technologies*, 16(1), pp. 114–124. <http://doi.org/10.1093/ijlct/ctaa043>.
- Reimer, A., Doll, J.E., Boring, T.J. and Zimnicki, T. (2021) 'Scaling up conservation agriculture: an exploration of challenges and opportunities through a stakeholder engagement process', *Journal of Environmental Quality*, 52(3), pp. 465–475. <http://doi.org/10.1002/jeq2.20317>.
- Rhodes, N., Shulman, H.C. and McClaran, N. (2020) 'Changing norms: a meta-analytic integration of research on social norms appeals', *Human Communication Research*, 46(2–3), pp. 161–191. <http://doi.org/10.1093/hcr/hqz023>.
- Roesch-McNally, G.E., Basche, A.D., Arbuckle, J.G., Tyndall, J.C., Miguez, F.E., Bowman, T. and Clay, R. (2018) 'The trouble with cover crops: farmers' experiences with overcoming barriers to adoption', *Renewable Agriculture and Food Systems*, 33(4), pp. 322–333. <https://doi.org/10.1017/S1742170517000096>.
- Rogers, E.M. (2003) *Diffusion of innovations*. New York: The Free Press, A Division of Simon & Schuster, Inc.
- Sang, N. and Birnie, R. (2008) 'Spatial sampling and public opinion in environmental management: a case study of the Ythan catchment', *Land Use Policy*, 25(1), pp. 30–42. <https://doi.org/10.1016/j.landusepol.2007.02.005>.
- Schultz, P.W., Nolan, J.M., Cialdini, R.B., Goldstein, N.J. and Griskevicius, V. (2007) 'The constructive, destructive, and reconstructive power of social norms', *Psychological Science*, 18(5), pp. 429–434.
- Shortle, J. and Horan, R.D. (2013) 'Policy instruments for water quality protection', *Annual Review of Resource Economics*, 5(1), pp. 111–138. <http://doi.org/10.1146/annurev-resource-091912-151903>.
- Siebert, R., Toogood, M. and Knierim, A. (2006) 'Factors affecting European farmers' participation in biodiversity policies', *Sociologia Ruralis*, 46(4), pp. 318–340.

- Sparkman, G., Geiger, N. and Weber, E.U.** (2022) 'Americans experience a false social reality by underestimating popular climate policy support by nearly half', *Nature Communications*, **13**, p. 4779.
- Sparkman, G., Howe, L. and Walton, G.** (2021) 'How social norms are often a barrier to addressing climate change but can be part of the solution', *Behavioural Public Policy*, **5**(4), pp. 528–555. <http://doi.org/10.1017/bpp.2020.42>.
- Sparkman, G. and Walton, G.M.** (2017) 'Dynamic norms promote sustainable behavior, even if it is counternormative', *Psychological Science*, **28**(11), pp. 1663–1674. <http://doi.org/10.1177/0956797617719950>.
- Terry, D.J. and Hogg, M.A.** (1996) 'Group norms and the attitude-behavior relationship: a role for group identification', *Personality and Social Psychology Bulletin*, **22**(8), pp. 776–793. <https://doi.org/10.1177/0146167296228002>.
- Thompson, N.M., Reeling, C.J., Fleckenstein, M.R., Prokopy, L.S. and Armstrong, S.D.** (2021) 'Examining intensity of conservation practice adoption: evidence from cover crop use on U.S. Midwest farms', *Food Policy*, **101**, p. 102054. <https://doi.org/10.1016/j.foodpol.2021.102054>.
- U.S. Department of Agriculture.** (2019) *2017 Census of Agriculture*. Washington, DC: U.S. Department of Agriculture National Agricultural Statistics Service.
- U.S. Department of Agriculture.** (2024) *2022 U.S. Census of Agriculture*. AC-22-A-51. Washington, DC: U.S. Department of Agriculture National Agricultural Statistics Service.
- van Dijk, W.F.A., Lokhorst, A.M., Berendse, F. and de Snoo, G.R.** (2015) 'Collective agri-environment schemes: how can regional environmental cooperatives enhance farmers' intentions for agri-environment schemes?' *Land Use Policy*, **42**, pp. 759–766.
- von Hippel, P.T.** (2018) 'How_many_imputations: stata module to determine required number of imputations'. Statistical software components. S458452, Boston College Department of Economics.
- Wauters, E., Bielders, C., Poesen, J., Govers, G. and Mathijs, E.** (2010) 'Adoption of soil conservation practices in Belgium: an examination of the theory of planned behaviour in the agri-environmental domain', *Land Use Policy*, **27**(1), pp. 86–94. <http://doi.org/10.1016/j.landusepol.2009.02.009>.
- Wilcox, M.** (2022) 'Fall fertilizer application: best practices to save time, money and nature'. *Cool Green Science: Stories of The Nature Conservancy*. September 19. Available at: <https://blog.nature.org/2022/09/19/fall-fertilizer-application-best-practices-to-save-time-money-and-nature/> (Accessed: 5 February 2025).
- Wyss, A.M., Berger, S. and Knoch, D.** (2023) 'Pro-environmental behavior in a common-resource dilemma: the role of beliefs', *Journal of Environmental Psychology*, **92**, p. 102160.
- Yoder, L., Houser, M., Bruce, A., Sullivan, A. and Farmer, J.** (2021) 'Are climate risks encouraging cover crop adoption among farmers in the lower Wabash River basin?' *Land Use Policy*, **102**, p. 105268. <https://doi.org/10.1016/j.landusepol.2020.105268>.
- Yoder, L., Wardropper, C., Irvine, R. and Harden, S.** (2025) 'Cover crops as climate insurance: exploring the role of crop insurance discounts to promote climate adaptation and mitigate risk', *Journal of Environmental Management*, **373**, p. 123506. <http://doi.org/10.1016/j.jenvman.2024.123506>.