Navigating the Information Landscape: Public and Private Information Source Access by Midwest Farmers

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Abstract

Timely and accurate information is vital to the success of row crop farmers in the United States. Information access is also critical to conservation efforts due to its influence on best management practice adoption. Public information sources like extension educators have been declining in importance for farmers, raising concerns around what information farmers receive on conservation practices and the accessibility of agronomic information. In this study we investigate farmers' changing information source consultation by broadly considering the agricultural information landscape, exploring whether farmers have displayed clear trends in access between public and private sources and whether certain farmer or operational characteristics predict public or private source access. We utilize data from a 2018 survey of farmers in four Corn Belt states to examine farmers' information seeking behaviors and predict the number of total, public, and private sources accessed using structural equation modeling with latent variables. Our findings elaborate on the public-to-private source shift and reveal that farmers continue to seek information from both private and public sources, though the frequency, mode of contact, and types of farmers contacting these sources differ. Results suggest public information sources are still influential, but they are accessed less frequently, tend to appeal to farmers with stronger environmental concerns, and have less appeal to older farmers compared to private information sources. Our findings indicate the potential for extension and other public sources to diversify modes of communication to further their reach.

Keywords

information sources; agriculture; decision-making; structural equation modeling; corn belt

Abbreviations

SEMLV: Structural equation modeling with latent variables

USDA: United States Department of Agriculture

SWCD: Soil and water conservation district

CFA: Confirmatory Factor Analysis

IFI: Incremental Fit Index

TLI: Tucker-Lewis Index

CFI: Comparative Fit Index

RMSEA: Root Mean Square Error of Approximation

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Introduction

Timely and accurate information is critical for the success and survival of row crop farmers in the United States, as the agricultural market is competitive and production is plagued by tight margins. Farmers require up-to-date and relevant market and agronomic information to guide their daily farm management decisions to remain profitable and meet production demands for food and fuel. In addition, the urgent pursuit of sustainable agriculture (Smith et al. 2014; Prokopy et al. 2020) requires farmers to have accurate and applicable information on resource conservation, including information pertinent to the reduction of chemical inputs, minimization of soil and water degradation, and realization of potential environmental benefits of agriculture. Environmentally positive behavior can be brought about through encouraging voluntary change, incentivizing management, or regulating behavior. Agri-environmental schemes based on voluntarily-entered contracts between farmers and government have been used in Europe, the United States, and Australia to promote conservation practices (Kuhfuss et al. 2015). In the United States, voluntary (rather than legally mandated) adoption of conservation practices is the dominant approach. As such, information is vital to conservation within the United States, since farmers need to be informed of the steps to implement conservation practices and convinced of their utility for the common good and for their farm (Wojcik et al. 2014; Epanchin-Niell et al. 2022).

Public and private actors alike produce and provide agricultural information. Private sources are those operating on a for-profit basis, including independent crop consultants and input suppliers such as chemical and seed dealers. These sources are generally more attendant to the speedy provision of market and agronomic information (Wolf 2006; Luloff et al. 2012). In contrast, public sources are those that operate using state and federal funding and include extension educators, soil and water conservation districts, and United States Department of Agriculture (USDA) agencies. These sources provide a range of essential agronomic, economic, and conservation information and are responsive to farmers' needs (Luloff et al. 2012; Wojcik et al. 2014). University extension is a key resource, providing stakeholders with education on agricultural and rural issues from land grant-universities, with extension educators spread throughout states at either the regional or county level. Despite their importance, public sources have also been identified as providing information that is outdated, irrelevant, or too general (Luloff et al. 2012; Stuart et al. 2018). Outside of public and private sources, information can also be provided interpersonally by farmers' peers or generated through group learning (Sutherland and Marchand 2021). Different types of sources have distinct motivations and methods for producing information, which generates diverse content and impacts farmers' choice of sources. Simultaneously, farmers' selection of sources may be based on their own attitudes (via a tendency to seek information which reinforces existing attitudes through selective exposure), operational needs, traits, or evaluations of each source (Diekmann et al. 2009; Jenkins et al. 2011).

Prior studies suggest farmers are moving away from university researchers and extension agents due to the shifting availability and content of these sources (Prokopy et al. 2015; Edge et al. 2017). Farmers who do not seek out public sources, lack access to them, or are unaware of them may be filling the resulting information gap with advice from private sources. Such a trend could have profound implications for farmers' access to information and the provision of conservation information (Houser et al. 2018). However, existing research leaves many dimensions of the agricultural information landscape understudied, meaning that the complexities of the shift from public to private sources are largely unexplored. More specifically, differences between which sources are in communication with farmers, the frequency of contact with those sources, changing modes of communication between source types, and factors that affect information access are rarely studied empirically.

This study aims to fill these gaps by examining the access, frequency, mode of contact, and determinants of different types of information sources. We focus on understanding which sources farmers actively consult when seeking information relating to on-farm management. As used here, information access refers to communications initiated by farmers seeking information. We aim to advance knowledge of the agricultural information landscape, with attention to how the implementation of information in changing management practices can motivate future work. To address these unexplored areas, we use survey data from corn and soybean farmers to examine the information source access of row crop farmers in four eastern Corn Belt states: Illinois, Indiana, Michigan, and Ohio. The U.S. Corn Belt is a major site for row crop agriculture and produces a large percentage of the nation's total corn. Structural equation modeling with latent variables (SEMLV) is used to address which attitudinal, operational, and demographic characteristics affect farmers' access of public or private information sources, as well as which farmers utilize certain modes to communicate with different source types.

Background

The decline of public information source use has been noted for decades as extension offices and government provisioners have cut staffing and funding (Luloff et al. 2012; Prokopy et al. 2015; Edge et al. 2017). Consultation of extension has dropped dramatically compared to private sources and peers for information on precision agriculture practices (Edge et al. 2017). Such a shift from public to private sources has implications for farmers and other stakeholders. The privatization and specialization of information transforms it from a public good to a commodity. As a result, farmers may lose access to or find themselves paying for previously free information on management practices and markets, and less educated and less affluent farmers may be disproportionately impacted (Evans 1992; Wolf 2006). As education is crucial to the financial success of farmers, loss of access to information could affect the viability of some farming operations (Diekmann et al. 2009).

A second concern with the shift from public to private agricultural information sources is its impact on conservation information dissemination. In recent decades, public sources like extension programs and the USDA Natural Resource Conservation Service have instructed farmers on how to minimize the negative environmental effects of agriculture. A decline in this public service may have profound implications for the availability of conservation information and the accountability for resource conservation (Wolf 2006; Luloff et al. 2012). General information seeking has been linked to farmers' adoption of conservation practices (Baumgart-Getz et al. 2012; Liu et al. 2018; Prokopy et al. 2019), and while research on how public compared to private information affects conservation practices is limited, some studies suggest these sources differ in their strength and ability to influence conservation behaviors (McBride and Daberkow 2003; Baumgart-Getz et al. 2012). One study found that farmers who contacted public information sources were *more* likely to adopt conservation agriculture practices, while those who relied on private sources were *less* likely to adopt conservation agriculture (Chalak et al. 2017). Additionally, private sources may prioritize their own profits over supporting land managers and, in the process, undermine farmers' capacity to implement practices effectively (Duncan et al. 2021). A shift in the provision of information from public to private sources therefore impacts the uptake of beneficial conservation practices.

Despite the claims of such a shift, there are several understudied dimensions of information source access. In addition to *whom* farmers turn for information, there are also questions around *how often* sources are consulted with, *how* the sources are contacted, and *which farmers* are more likely to access which information sources. Many of these elements of the agricultural information landscape have been studied individually, while fewer have been studied in tandem or in relation to the public-private shift. In the following, we elaborate on these dimensions and their importance for understanding farmers' access to information sources.

Which sources farmers access for agricultural information implicitly relates to the level of trust farmers place in them. Some farmers distrust nutrient dealers because they recommend nutrient rates that are too high to maximize their own sales; conversely, university extension is sometimes viewed as recommending nutrient application rates that are too low due to their conservation focus (Stuart et al. 2018). Trust has been shown to differ across farmer information sources (Blackstock 2007; Mase et al. 2015; Stuart et al. 2018). Trustworthiness is partially a characteristic of the information source, but the information seeker's level of trust in a source also varies by experience, familiarity with the source, and the content of information provided. For example, Mase et al. (2015) found that farmers placed the most trust in university extension and soil and water conservation districts for information on soil and water quality information, with a strong correlation between trust and familiarity with the source.

Closely related to which sources farmers turn to is the question of *how often* they seek out each source. A study in Ohio measured farmers' frequency of use of a variety of sources and found that other farmers, friends and neighbors, farm magazines, agricultural newspapers, and extension publications were most utilized (Diekmann et al. 2009). Another study found that over half of farmers reported using fertilizer consultants and fertilizer suppliers frequently or very frequently for their nitrogen management decisions, while relatively few farmers accessed other farmers or extension frequently (though most farmers reported contacting both sources) (Stuart et al. 2018). Although underexplored, how often sources are contacted likely relates to evaluative elements like trust and perceived usefulness. Private and public sources may differ in terms of whether farmers contact them and their frequency of contact. Exploring contact frequency could therefore reveal nuance in the public-private shift.

A third dimension of farmer information seeking is mode of access or *how* sources are contacted. Information is communicated through channels including in-person conversations, technical demonstrations, written publications, websites, and phone calls. Mode of communication matters for farmer access, since not all farmers may be able or want to access information through certain modes. Complex topics, like sustainable agriculture, may require a variety of modes of communication. Farm magazines, radio, television, on-farm tours, field demonstrations, and interpersonal meetings are major channels of agricultural information dissemination (Tucker and Napier 2002; Diekmann et al. 2009; Stuart et al. 2018). A recent review found that print media, like farm magazines and newspapers, is a key information channel for farmers, yet for some situations both traditional and digital communication modes are preferred (Witzling et al. 2021). Like frequency of contact, mode of communication has implications for farmers' preference of sources and evaluation of the information accessed (Blackstock 2007; Bates and Arbuckle 2017; Rust et al. 2021). Understanding the changing access of public and private sources requires examination of differing modes of communication between source types, as these may have shifted over time (Rust et al. 2022).

A final dimension of interest is *which farmers* access information sources and choose to use certain modes of communication to do so. Research has identified several farmer characteristics, such as farm stewardship attitudes, education, farming experience, tenure, and age, as factors associated with the number of information sources accessed (Diekmann et al. 2009; Edge et al. 2017; Houser et al. 2019). Attitudes may impact the evaluation of information sources through the importance individuals assign to them or via the type of information sought through selective exposure as individuals seek affirmation of their existing attitudes and beliefs (Case 2007; Houser et al. 2019). Contact with information sources and modes of access have also been found to depend on farm structure variables like farm size, product type, and debt-to-asset ratio (Tucker and Napier 2002; Diekmann et al. 2009; Houser et al. 2019). Like other aspects of the information landscape, some evidence suggests that which farmers seek out information sources varies by source type—for example, extension users differ significantly from non-extension users in age, education, income, and farm size (Edge et al. 2017). However, farmer and farm factors influencing information source access, and especially along the public-private divide, are largely unexplored (Witzling et al. 2021).

Given these unknowns within the changing information landscape, there is a need for updated study of farmer information source access. Although prior work notes a shift from public to private information sources, knowledge about the dynamics of this shift is incomplete. In this paper we seek to fill this gap by comprehensively examining the agricultural information landscape through exploration of two key questions. First, have farmers in the eastern Corn Belt shown a clear preference for private over public sources, and have they shown a clear preference in mode of contact for each of these source types? Second, do farmers with certain attitudes, knowledge, characteristics, or who operate farms with certain traits use more public or private sources, and do they access these sources via certain modes? Empirical examination of these areas contributes to research on the evolving agricultural information landscape.

Data and methods

In 2018, we conducted a survey of commercial corn and soy producers in Illinois, Indiana, Michigan, and Ohio to gather information regarding their crop management and stewardship practices (Marquart-Pyatt 2022). We selected these four states from the Eastern Corn Belt in the U.S. Midwest (Arbuckle et al. 2014; Kellner et al. 2016; Green et al. 2018), representing the range of physical, demographic, and socioeconomic conditions of this geographic region. Most row crop farms in this region rotate between growing corn and soy on a yearly basis. Combined, these four states contain more than 55 million acres of cropland, about 14% of the total cropland in the U.S. More than four out of five of those acres were planted to corn or soy in 2017 (USDA National Agricultural Statistics Service 2019).

Given our population of interest of row crop farmers, the sample frame consisted of corn and soy producers with more than 100 acres of cropland, living in counties with at least 15% of total land planted to corn or soybeans. We excluded counties in the four sampled states where corn and soybean were not widely grown, resulting in 96 counties in Illinois, 81 counties in Indiana, 31 counties in Michigan, and 56 counties in Ohio. We stratified our sample into farms operating 100 to 499 acres and 500 or more acres, with large farms being oversampled. Our sample was purchased from a private vendor.

We followed a multi-wave mailing process using a modified Tailored Design Method that included a pre-notice postcard-survey-postcard protocol (Dillman et al. 2014). Farmers in our sampling frame were mailed a survey questionnaire in spring of 2018 along with a prepaid return envelope, followed by a reminder postcard approximately seven to ten days later, up to three times over the ten-week data collection period. Our response rate of 42% approximates recent surveys using similar designs (Arbuckle et al. 2013; Denny et al. 2019; Houser et al. 2019). The survey questionnaire covered topics including crop and nutrient management, information seeking behavior, views of farming, and practice adoption.

Outcome variables: information source access according to type, frequency, and mode

We measured information access with sets of questions asking farmers about their frequency of consulting information sources and how they communicated with them. Our first outcome variable summarizes the number of information sources from which survey respondents reported seeking information about new agronomic practices and land stewardship issues. Respondents were asked how often they consulted nine different sources: county or regional extension educators, university campus-based extension faculty, chemical dealers, seed dealers, independent crop consultants, other farmers, soil and water conservation districts (SWCDs), USDA agencies, and growers associations. Response options for consultation frequency included "never," "once a year," "once a month," "once a week," and "once a day." We collapsed these into binary measures where values of one indicate at least monthly access and created an additive scale of total sources that ranges from zero to nine. Higher values indicate that respondents consulted a greater number of information sources.

We also constructed measures of public and private information source access given prior work (Mase et al. 2015). Public information source access is measured using a summative scale that combines binary responses for consulting county or regional extension educators, university campus-based extension faculty, soil and water conservation districts, and USDA agencies. This measure ranges from zero to four, with higher values indicating more public information sources accessed. Our measure of private information source access combines responses for consulting chemical dealers, seed dealers, and independent crop consultants. This measure ranges from zero to three. Note that contact with other farmers and with growers associations are included in our scale of total information source access but are not classified as either public or private.

Our survey instrument also included questions about modes of communication with different sources. For each of the nine information sources, respondents were asked how they access the source and instructed to check all that apply. Possible responses were "in person, on farm," "in person, off farm," and "by phone or online." We applied the same steps as above using the binary measures for each source by mode of access, creating measures that sum the total number of sources consulted by each mode, as well as measures differentiating within modes by consultation of public and private information sources. For each mode of access, therefore, a respondent could have responded that they consulted up to nine sources in total, up to four public sources, and up to three private sources.

Independent variables

Extant work outlines explanatory variables we incorporate in our empirical models, including measures of economic and environmental attitudes, knowledge, farming experience, farm attributes, and demographic characteristics (Baumgart-Getz et al. 2012; Reimer et al. 2012; Houser et al. 2019; Witzling et al. 2021). Given expectations from previous research (Houser et al. 2019; Witzling et al. 2021), we examine the same set of exogenous variables to predict both the number of sources accessed overall and the number of sources contacted by each mode (in person on-farm, in person off-farm, and by phone or online). Our models include three latent constructs proposed to affect information source access: economic productivity values, perceived operational vulnerability to climate change, and environmental stewardship views. A latent construct is an unobserved variable that underlies the relationship between the multiple observed variables that are being used to measure it (Bollen 1989, 2002). To evaluate their fit, we tested each of the two latent variables independently using confirmatory factor analysis (CFA) or measurement models, a technique in SEMLV. CFA results provide fit statistics[1] for each measure included in the latent variable and the overall fit or quality of the latent construct, both of which need to be examined to assess their fit and evaluate their appropriateness to use in the analysis. We provide information on these fit measures in Appendix Table A.

Economic productivity orientation is a latent construct including four variables from survey items capturing respondents' motivations when managing their operation, including income/earnings, profit maximization, building up wealth and assets, and being among the best in the industry (Denny et al. 2019; Houser et al. 2019). Fit statistics from the CFA indicate good fit of this latent construct (West et al. 2012). These empirical checks provide information regarding the validity and reliability of the individual measures (e.g. standardized factor loadings ranging from 0.55 to 0.77 and unstandardized loadings from 0.69 to 1.00, all significant). Overall model fit statistics are very good—although the chi-square value is significant, values for the

[1] The component fit of an acceptable latent variable has standardized and unstandardized factor loadings close to one another to show that the included measures are valid and reliable (the former above .4 and the latter around 1). Overall model fit statistics for an acceptable latent variable include a non-significant chi-square value (indicating that the estimated model is not significantly different from the data), values for the Incremental Fit Index (IFI), Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI) above 0.95, and a Root Mean Square Error of Approximation (RMSEA) below 0.05 (West et al. 2012).

Incremental Fit Index (IFI), Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI) are 1.00. The Root Mean Square Error of Approximation (RMSEA) is 0.00 (CI=0.00, 0.06).

Perceived operational vulnerability is a latent construct that includes five variables that ask survey respondents how concerned they are about the impacts on their farm of environmental issues related to agriculture. The five survey items include impacts of extreme weather events, droughts, warmer temperatures, climate change, and floods. Theoretically specified correlated measurement errors are included. Higher values correspond to greater concern with these issues. As with the previous latent variable, CFA results and fit statistics indicate excellent fit of this latent construct.

Our measure of *environmental stewardship values* is a latent construct that combines responses to three variables and is scaled so higher values indicate greater stewardship values. On a five-point scale, respondents were asked about how important it was for managing their operation to look after the environment, have good-looking fields, and pass on the land in good condition. CFA results indicate acceptable fit of this latent construct.

Our knowledge construct is an additive scale of four variables. These survey items measure self-reported knowledge regarding nutrient management and soil conservation, minimizing nutrient loss, nitrogen fertilizer application, and the use of crop rotation to manage weeds and insect pests. Higher values on this scale indicate greater self-assessed knowledge.

In accordance with prior studies, we include measures of farmer characteristics including education, farming experience, being a full-time farmer, and age, as well as farm traits including having custom hired work performed, location, and farm size (Houser et al. 2019; Witzling et al. 2021). Education is a dichotomous measure of whether farmers have an associate's, bachelor's and/or graduate degree. Farming experience is the number of years the respondent reported having been in farming as the primary decision-maker. Full-time farmer status captures respondents who reported working zero days off-farm in the year of the survey, and the reference category is farmers reporting having worked from one to more than 200 days off-farm. To measure age, we created four categories from recoded responses to the question "In what year were you born?": 49 years and younger, between 50 and 59 years, between 60 and 69 years of age, and 70 years or older, with the latter as the reference category and age categories reflecting the US farming population (with average age of 57.6 years old in the four states of our survey; USDA National Agricultural Statistics Service 2019). We also include a measure of custom hiring work, created from the question “Which of the following tasks did you perform on your farm or hire a technical or consultant service to do in 2017?” where respondents were instructed to check all that apply. Our measure sums affirmative responses for those who custom hired nutrient and/or pest control recommendations, nutrient and/or pest control application, yield maps or remote sensing maps, and soil testing. This measure ranges from 0 to 4, with higher values indicating more custom-hired tasks. Farm size is measured in three categories: 200 acres or less (reference), 201 to 500 acres or less, and 500 acres or more.

Modeling

Given the latent constructs described above, we use SEMLV to estimate our models (Bollen 1989; Hoyle 2012). SEMLV is a multi-equation regression technique that accommodates complex relationships between multiple exogenous and endogenous variables simultaneously, including both latent and observed variables. We use SAS 9.4 and AMOS 26 software for our data management and analyses, and the R package ggplot2 to create our figures.

Results

Who and how much: source access and intensity

Descriptive results for variables in our analyses are presented in Table 1 (for full question text, see Appendix Table B). Farmers actively sought information about new agronomic practices and land stewardship issues from six of the nine total sources on average. The two most frequently reported information sources were agricultural retail suppliers, specifically *chemical dealers* and *seed dealers*, utilized by nearly all farmers in our sample (96% for each one). The third most utilized source was *other farmers*, who were contacted by 91% of farmers. Nearly four out of five (79%) farmers reported contacting *USDA agencies*, 67% reported using *SWCDs*, and 64% consulted *university extension educators*. Fewer than half reported using *campus-based extension faculty* (46%), *independent crop consultants* (42%), and *growers associations* (31%).

<<Table 1 about here>>

Regarding intensity of information source access, we asked about annual, monthly, and weekly intervals, presented here as infrequent (yearly) or frequent (monthly or more) access (Figure 1). Majorities of farmers reported consulting three sources infrequently: *county extension* (53%), *USDA agencies* (53%), and *SWCDs* (52%), all of which are public information sources. Over half of farmers reported frequent access of two private sources, *chemical dealers* (66%) and *seed dealers* (56%), while an additional 30% and 39% of farmers reported infrequent access of these two sources, respectively. However, *other farmers* were the most intensively contacted source, with seven out of ten farmers reporting frequent contact with their peers. *Growers associations* and *independent crop consultants* were contacted the least and with the least intensity. <<Figure 1 about here>>

How: mode of communication with source

Farmers could have accessed each source in person on-farm, in person off-farm, or by phone or online. On average, farmers gathered information from two total sources in person on-farm, nearly four sources in person off-farm, and more than two sources by phone or online. Regarding private sources, majorities of farmers reported accessing agricultural retailers (*chemical* and *seed dealers*) in person on-farm (53% and 63%, respectively; Figure 2) and off-farm (59% and 50%). Roughly equal percentages of farmers reported accessing *independent crop consultants* across all three modes. For public sources, few farmers report on-farm access. Only 10% of respondents report meeting on-farm with *county extension*, 4% with *university extension*, 13% with *SWCDs*, and 9% with the *USDA*. In-person off-farm meetings were most used for three of the four public sources, namely *county extension*, *SWCDs*, and *USDA agencies*. More farmers reported off-farm meetings with the *USDA* (63%) than with *chemical dealers* (59%). Off-farm access was most common for farmers who reported meeting with *other farmers*, though on-farm access was also reported by almost half. Phone or online access to sources reveals a different information landscape, as the ranking shows *chemical* and *seed dealers* at the high end (39% and 38% respectively), but more than one-fourth of respondents also use phones or the internet to contact *county/regional extension educators*, *campus-based extension faculty*, *USDA agencies*, and *SWCDs*. <<Figure 2 about here>>

Which farmers: predicting total, public, and private source access

Figure 3 shows average values for outcome variables across all models discussed. Table 2 displays results for the SEMLV models for number of total, public, and private information sources accessed. Results indicate that perceived vulnerability, knowledge, and farmer demographics significantly affect total information source access. Farmers with higher self-reported knowledge (.102) and increased perceived vulnerability to on-farm environmental impacts (.177) access more total information sources for new agronomic practices and land stewardship issues. Having a college education led to an increase in the number of information sources accessed by 0.520 units on the nine-point scale. Compared with farmers aged 70 years and over, farmers in two of the three younger age categories sought out more total information for practices on their operations. Farmers with more custom-hired work (.142) and those with operations of at least 500 acres (.490) also consulted more sources. <<Figure 3 about here>>

Results reveal perceived vulnerability, knowledge, and some farm and farmer characteristics also affect public information source access. Farmers with greater perceived vulnerability to on-farm environmental impacts (.438) and with higher self-reported knowledge (.180) access more public information sources for new agronomic practices and land stewardship issues. Farmers having a college education (.965), having custom-hired work (.266) and those with larger operations (.861) likewise sought out more public information sources. <<Table 2 about here>>

Knowledge, farmer characteristics, and farm traits have significant effects on private information source access. Farmers with higher self-reported knowledge access more private information sources (.056). Having a college education led to an increase in the number of information sources accessed by 0.253 units. Compared with farmers over the age of 70 years, younger farmers in all three age categories sought out more agronomic information from private sources. Farmers with more custom-hired work (.147) and those having larger operations (.433) consulted more private information sources.

Our models explained about 11% of the variance in total information source use and about 8% of the variance in public and private information source use. Values for overall model fit statistics (e.g., IFI, CFI, TLI and RMSEA) are good (West et al. 2012). Our substantive findings align with expectations from previous scholarship (Kromm and White 1991; Schnitkey et al. 1992; Houser et al. 2019; Witzling et al. 2021).

How: predicting modes of communication

Total sources accessed by mode of communication

Our second set of analyses focuses on which farmers choose certain modes of communication to access their information sources, using the same predictors and modeling technique from the previous set of analyses. First, we examine the influences on number of sources contacted in person on-farm (Table 3, first column from left). A farmer's perceived operational vulnerability to environmental impacts significantly influences the number of total and public sources contacted in person on-farm (.133). All three categories of age (.658, .382,

.263) as well as custom hired work (.077) are shown to influence how many sources farmers contact in person on-farm. The largest category of farm size is also positively associated with on-farm visits with sources (.527). <<Table 3 about here>>

Like on-farm contacts, two categories of age (.500 and .395) and custom hired tasks (.067) influenced number of sources contacted in person off-farm. However, farm size was not associated with off-farm contacts, while having a college education was (.581). None of the attitudes, perceptions, and knowledge variables were significant predictors of off-farm source access.

For sources contacted by phone or online, however, knowledge predicted source access (.059). College-educated farmers (.456) and those with custom-hired tasks (.081) were shown to contact more sources by phone or online. Farmers in all three age categories also contacted more sources by phone or online compared to the oldest category of farmers (1.465, .737, .517). Finally, full-time farmers contacted more sources by phone or online compared to part-time farmers (.282).

Model fit statistics for all models of source access by mode of communication again indicate reasonable fit. Adjusted R-squared values reveal that our models explained about 7% of the variation in in-person on-farm total information source access, 5% for in-person off-farm total information source access, and 9% in phone or online total information access. Values for the overall model fit statistics indicate good fit. Our substantive findings again hold with expectations from extant literature (Houser et al. 2019; Witzling et al. 2021).

Public and private sources accessed by mode of communication

We also fit six models predicting the number of information sources accessed by each mode for public and private information sources (e.g., number of public sources accessed in person on-farm; see Appendix Tables C1 and C2 for results). Like total source access, public source access was associated with perceived operational vulnerability and farm size, while private source access was associated with age, custom hiring, and farm size for in-person on-farm communications. While college education affected in person off-farm contact with public and private sources, neither category of sources was associated with custom hiring or age, despite these variables' impacts on total source access. Number of public sources accessed by phone or online is associated with college education and custom hiring, while number of private sources accessed is not. Conversely, private source contact by phone or online is associated with full time farming and age, while public source contact is not (except for the youngest category of farmers).

Discussion

Evaluating the public/private divide in the information landscape

We set out to test whether the current agricultural information landscape truly reflects a shift away from public and toward private sources. Our results elaborate on the notion of a public to private shift, revealing additional complexity regarding farmers' consultation of public versus private information sources. An examination of the intensity of access or *how often* farmers contact these sources is informative. Most farmers reported infrequently contacting three out of four public sources included in our survey, suggesting that public sources serve as a reference for information needed only on an annual basis. Private sources, on the other hand, were generally contacted more frequently, often monthly. These contacts may provide information that is more reflective of changing conditions and relevant at different stages of the growing season. Although public sources were contacted less frequently than private sources, farmers still rely on a diverse mix of public and private sources, consistent with some recent literature (Stuart et al. 2018).

Additional depth is introduced when considering the modes of access farmers use to contact information sources. Our results show that farmers often contact information sources via in-person meetings both on- and off-farm. Furthermore, among the information sources we considered, chemical dealers, seed dealers, and other farmers consistently prompted in-person meetings. In-person contacts with input suppliers are largely driven by purchases, either when a farmer visits a store or when a supplier visits a farm to promote their products. Even such informal meetings, though seemingly innocuous, involve information exchange. Conversely, few farmers report contacting public sources in person on-farm, suggesting an unwillingness or inability on the part of these sources to meet individual farmers on their operations, perhaps due to previously identified trends in public agricultural organizations such as decreased staff levels and increased fees for services (Houser et al. 2018). Off-farm meetings remain an important access point for public sources, though campus extension relies most on phone and online contacts.

The mode difference between private and public sources may further widen the gap in access frequency between public and private sources. In-person contact can be more convenient, more likely to build trust, and may better convey the unique characteristics of the land farmers are managing (Ford and Babb 1989; Tavernier et al. 1996; Blackstock 2007; Bates and Arbuckle 2017). While it may seem that remote modes of communication act as a workaround for issues of accessibility with in-person meetings, these results offer some insight into why public sources are contacted less frequently. Campus extension, contacted mostly through phone and on-line contacts, misses out on the benefits of in-person contacts. In contrast, private sources appear to have diversified their availability through multiple modes of access, signaling capacity and willingness to remain accessible to farmers for various needs. Such differences also have implications for accessibility, impacting farmers who may have unreliable or no Internet access, are less educated, less affluent, and who operate smaller farms (Evans 1992; Prokopy et al. 2014).

Farm and farmer predictors across the public-private divide

Results from our empirical models reveal largely consistent predictors of total, public, and private information source access. Specifically, knowledge, education, custom hired work, and farm size positively predict source access across our empirical models. The finding that knowledge influences information source access by mode across total, public, and private sources suggests a strong link between information and knowledge. Custom hiring is associated with the number of public and private sources accessed as well as contact with total sources across all three modes of contact. Examining the modes of contact for private and public sources, we see that custom hiring is associated with private source access on-farm, but with public source access by phone or online.

Some notable differences exist between the predictors of public and private source access. Farmers with higher perceived operational vulnerability to environmental changes are found here to access more public sources and to meet with more public sources in person on-farm, suggesting that a farmer’s attitude influences both to whom they turn for information as well as how they choose to access that information. In contrast, all three groups of younger farmers are found to access more private sources compared to the oldest age category of farmers (seventy years of age or older). Age also predicts total and private sources contacted both in person on-farm and by phone or online. In general, age did not predict public source access by mode. This could highlight an important yet overlooked element of the shift, as younger farmers may be establishing relationships with private rather than public sources that have the potential to last longer as they become the trusted default contacts for agronomic information. Another explanation is that older farmers may rely more on their own experience than on external sources which increasingly require payment, while younger farmers may be motivated to consult sources to gain additional knowledge or confirm their own experience. While we did not find a significant effect of years of experience on information source consultation, experience and age are highly correlated. Additional research is needed to disentangle these findings.

Predictors of modes of access reveal some additional variation between public and private source access. Interestingly, knowledge was positively associated only with total sources contacted by phone or online, which could indicate that remote sources serve as reliable references for information. Full-time farming is associated with contact with total and private sources by phone or online, perhaps because farmers with full-time operations have a greater need for remote access of information due to demands on their time. Farm size is positively associated with on-farm contact with all three source types. Farmers with the largest farms may have enough resources and motivation to seek out information specific to their farm through an in-person visit by the source, or they may be viewed by sources as more worth visiting (Evans 1992).

Farmers' access of public or private information sources has implications for the content of information they receive, how much they trust that information, and ultimately what actions they take based on the advice received. Conservation behaviors, such as enrolling in a conservation program or changing management to reflect best practices, are likely discussed differently across information sources. While seeking and using information is positively associated with conservation practice use (Prokopy et al. 2019), farmers assign more weight to certain sources based on their values, perceptions, and attitudes (Houser et al. 2019). The differences in access based on age and perceptions identified in our findings could indirectly impact conservation among these groups. Farmers who do not perceive their operations as vulnerable to environmental impacts access fewer public sources and may therefore receive less information on how to conserve resources on-farm and adapt their operations to environmental threats. Similarly, farmers accessing fewer total sources—namely those with less knowledge, lower levels of education, fewer custom hired farm tasks, and smaller farms—may face information deficits that could impact their ability to adjust their management and hamper future decision-making.

Outside of the public-private divide, our results show that nearly a third of our sample contact other farmers at least once a week. This conspicuous difference in frequency between other farmers and most public and private information sources suggests that farmers' peers may act as a source of more accessible, trustworthy, and experiential knowledge. Despite shifts in information use patterns over the past several decades, other farmers have maintained a consistent presence as an influential information source (Stuart et al. 2018; Houser et al. 2019). Even with options from both the public and private spheres, farmers may most value the practical, relatable knowledge of other farmers with whom they are in frequent contact for general information.

Implications

Information-seeking occurs when farmers seek to fill a knowledge gap, and whether farmers use public, private, or peer sources influences how and which knowledge gaps are filled. Since private sources have been identified as concerned with increasing sales and maintaining customers while public sources focus on conservation (Stuart et al. 2018), farmers are likely receiving different information from these sources. Although interactions with extension agents and conservation staff have been linked to increased conservation practice adoption (Liu et al. 2018), Midwestern corn producers rank both sources as among the least influential on their overall management decisions (Davidson et al. 2015) and are shown here to contact these sources infrequently. An example of competing private and public information comes from nitrogen management practices, for which farmers have been found to prefer fertilizer dealer's recommendations for nitrogen application rates to those made by university extension (Osmund et al. 2015). Nitrogen application rates are a major factor influencing water quality and have been a focus within conservation circles (Houser 2022). While there are many contributing factors to a farmer's trust in and decision to use information from a source, our findings suggest continuing relevance of the mode of delivery. A farmer may trust recommendations from a chemical dealer who has visited their farm more than those from an extension agent who has not. The trends reported here regarding number, frequency, and mode of access to information sources could therefore have profound effects on farmers' management and ultimately the delivery of ecosystem services.

Despite differences between sources accessed via distinct modes, predictors of overall source use generally align across public and private sources. Such consistency in predicting *which farmers* access distinct sources suggests that changes driving the decline of public sources may lie with the sources themselves. Public sources like extension may benefit from increasing outreach targeted toward younger farmers, who currently are more likely to contact private sources. Public sources may also wish to increase contacts with different farmer audiences in mind by stressing relevant scientific content that aligns with environmentally conscious farmers alongside information for farmers who do not display environmental concern. However, sources like extension may be facing an image crisis based on farmers' reported perceptions of them (Luloff et al. 2012; Stuart et al. 2018). Public sources may be able to increase their relevance to farmers by offering more opportunities for tailored information through on-farm meetings. Since farmers value the personalized, specific nature of information conveyed in person and on-farm (Tavernier et al. 1996; Blackstock 2007; Bates and Arbuckle 2017), additional face-to-face meetings with farmers on their own land may also lead to increased trust of public sources. This is especially true for university extension, for which the primary mode of access in our sample is by phone or online. Another, perhaps more feasible strategy could be to focus on increasing frequency of contact with farmers already using public sources infrequently, which may increase the amount of information provided and establish trust between farmers and public sources like extension. Directing public resources toward in-person and on-farm discussions of conservation practices and resource management information will ensure extension agents recognize farmers' affinity for information tailored to their operational characteristics, including business structure, geography, and current management. Moreover, in-person, on-farm visits may uncover compromises that can help achieve the respective management goals of both extension agents and farmers. Asking farmers directly what will get them to participate avoids an all or nothing approach, while regular check-ins could help inform the design and dissemination of conservation programs themselves. Our findings suggest that extension and other public sources have transitioned from a "go-to" source to an infrequent reference for general agronomic information. Increasing the prevalence and salience of public sources by strengthening the social relations between extension agents and farmers could increase the amount of conservation information available to farmers and keep agronomic and land stewardship information accessible. Additionally, as Prokopy et al. (2015) note, public extension has the potential to collaborate with private sources to provide important information to more farmers.

While infrequent contact of public sources raises concerns around the continued use and spread of conservation practices, farmers can and do receive conservation information from contacts besides public sources (Luloff et al. 2012; Eanes et al. 2017). Past research has identified other farmers as the most frequently accessed source of information on conservation practices specifically (Luloff et al. 2012), suggesting that farmers are still learning about best management practices despite a decline in public provision of information. Farmers' peers are also a key influence on soil management practices (Rust et al. 2022). One striking finding from our data is the sustained prevalence of other farmers as a source, aligning with more than thirty years of scholarship identifying farmers' peers as a consistent presence for information, even as options for information have changed (Luloff et al. 2012; Stuart et al. 2018; Houser et al. 2019). In our sample, most farmers reported at least some contact with their peers, many reported frequent contact, and contact was high across multiple modes of access. Farmer-to-farmer communication may relay information from other sources, as in facilitated on-farm demonstrations, and a single farmer with public contacts could potentially disseminate that information to multiple other farmers. However, it is worth questioning whether the conservation information shared between farmers equals that provided by public sources. Peer knowledge can provide evidence of the outcomes for trialed practices and techniques and may be more accessible and locally relevant than that provided by extension or government agencies, especially if farmers are interacting with their neighbors or local groups (Rust et al. 2022). Peer learning often occurs in groups through events like farm demonstrations and field days (Sutherland and Marchand 2021). However, while such knowledge may serve farmers' needs, it may not comprehensively account for farming's environmental externalities, making additional information necessary to account for the full socio-ecological scope of agriculture's impact.

Future research

Our findings point to several promising avenues for future work on how information factors into farmer decision-making about new agronomic practices and stewardship issues. First, future work should use qualitative methods to further explore why farmers select the information sources they do and how they evaluate information from different sources. Additional research can also explore whether the divisions between public and private information source consultation affect practice adoption. Many studies examining farmers' information seeking have done so in the context of practice adoption, with varying results;

incorporating the public/private distinction may prove illuminating to this work. Future work should also introduce complexity to the study of information's effect on practice adoption by examining feedback loops between information, knowledge, and practice uptake. Our study showed relationships between knowledge and information along with custom hired practices and information, providing evidence to support further investigation of such epistemic feedback loops in farmer decision-making.

Rather than binary measures or counts of different information sources accessed to predict practice adoption, future work may wish to include measures of intensity of access and/or mode of contact as predictors. In our study, farmers contacted sources with varying intensity and by various modes, and these factors may differentially influence farmers' decisions. Relatedly, research should explore whether the intensity and mode of source contact is related to farmers' trust in them, and whether trust is a mediating factor between source contact and practice adoption. Farmers' trust may be a key factor influencing whether they accept or reject information from a given source and should be included in future studies relating information to conservation practice use.

Examining farmers' intensity and mode of access to public and private information sources is a starting point for asking questions about the content of information exchanged, since farmers tend to seek information on a given topic from some sources more than others (Ortmann et al. 1993; Diekmann et al. 2009; Arbuckle et al. 2012). While several studies have focused on information on nutrient management (Houser et al. 2018; Stuart et al. 2018; Houser et al. 2019; Houser 2022), other topics have been explored less. The study of the current information landscape would benefit greatly from additional research into the various topics on which farmers seek information, at what temporal frequency, whether farmers turn primarily to public or private sources for information on those topics, and whether content-specific knowledge is more prevalent in decision-making than general knowledge. Additionally, other factors not examined here including social and cultural capital, roles, perceived need, and personality traits may play a role in models of farmer information access (Heinstrom 2003; Case 2007).[2] Some farmers may be more curious or open-minded, which may influence the frequency with which they seek information and to which sources they turn. Relatedly, not all information is the same either in content or form. Information includes a farmer's experience, data collected from on-

[2] We thank an anonymous reviewer for this point.

farm samples, and technical or "how-to" information. Additional research is needed to establish predictors of content and type of information accessed by farmers.

Conclusion

In this piece, we examined patterns of information source access among row crop farmers in the U.S. Midwest, introducing nuance by examining *which* sources farmers contact, *how often* they contact them, and *how* they communicate with them. Regarding the question of whether there has been a shift from public to private information source consultation in the agricultural information landscape, our results reveal a complex answer. While public and private sources differ by frequency and mode of access, farmers still utilize both. We find that general information source access is motivated by attitudes, farmer characteristics, and farm structure. Key differences emerge in both the number of sources and mode of access to public and private sources. In short, farmers' use of information is complex and multidimensional, and our results illuminate the diverse topography of the agricultural information landscape.

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Navigating the Information Landscape: Public and Private Information Source Access by Midwest Farmers

Attachment to Manuscript – Appendix

Appx. Table A. Component Fit and Overall Model Fit Statistics for Latent Variables

Overall Model Fit	Chi-sq (df)	p	TLI	IFI & CFI	RMSEA (CI)
Economic Productivity Values	5.14 (df=1)	0.023	0.99	1.00	.04 (.01, .07)
Perceived Operational Vulnerability	2.03 (df=2)	0.362	1.00	1.00	.00 (.00,.04)
Environmental Stewardship Values	--	--	--	--	--
Component Fit	Std factor loadings	Unstd factor loadings	Reliability estimates (SMC)		
Economic Productivity Value Orientation					
Earn a high income	0.765	1.000	0.586		
Maximize farm/company profit	0.646	0.692	0.417		
Build up wealth and family assets	0.748	0.937	0.559		
Be among the best in the industry	0.554	0.778	0.307		
Perceived Operational Vulnerability					
Impact of extreme weather events on my farm.	0.843	1.000	0.710		
Impact of droughts on my farm.	0.845	0.992	0.714		
Impact of warmer temperatures on my farm.	0.756	0.854	0.571		
Impact of climate change on my farm.	0.628	0.749	0.395		
Impact of floods on my farm.	0.727	0.915	0.528		
Environmental Stewardship Values					
Look after the environment	0.759	1.000	0.575		
Pass on land in good condition	0.462	0.569	0.240		
Have good-looking fields	0.644	0.910	0.415		

Appx. Table B. Survey Questions for Variables in Empirical Models

Question	Response Options
Information source use	
When seeking information about new agronomic practices and land stewardship issues, how frequently do you consult the following sources?	1=never, 2=once a year, 3=once a month, 4=once a week, 5=daily
How do you access them?	In-person, on-farm; in-person off-farm; phone or internet
Economic productivity	
When you think about being a farmer and managing your operation, how important are the following to you?	1=not at all important to 5=very important
Earn a high income	
Maximize farm/company profit	
Build up wealth and family assets	
Be among the best in the industry	
Environmental stewardship values	
Look after the environment	1=not at all important to 5=very important
Pass on land in good condition	
Have good-looking fields	
Perceived operational vulnerability	
Below are some potential environmental issues related to agriculture. How concerned are you about their impact on your farm?	1=low to 5=high
Extreme weather events. Droughts.	
Warmer temperatures. Climate change	
Impact of floods on my farm.	
Management Knowledge Scale	
How much do you feel you know about the following?	1=nothing at all to 5=a great deal
Nutrient management and soil conservation	
Minimizing nutrient loss	
Nitrogen fertilizer application	
Using crop rotation to manage weeds & insect pests	
Custom hiring	
Which of the following tasks did you perform on your farm or hire a technical or consultant service to do in 2017?	nutrient, and/or pest control recommendations, application, yield maps, soil testing
Full time farmer	
How many days did you work off the farm in 2017? Indicate how many days in which you worked at least 4 hours in an off-farm job.	None, 1-49, 50-99, 100-199, 200 days or more
Years of farming	
In what year did you become the primary decision maker for crops on this farm?	Write-in year
Education	
Which category best describes your formal years of education?	Less than high school, high school, some college, bachelor's degree or higher
Age	
In what year were you born?	Write-in Year
Farm size	
In 2017, how many acres of cropland did your operation own?	Write-in Acres

Appx. Table C1. SEMLV Results for Models of Public Information Use by Mode of Access (n =1718)

	In Person, On Farm		**In Person, Off Farm**		**By Phone or Online**	
	Unstd. coefs. (std. errors)	Std. coefs.	Unstd. coefs. (std. errors)	Std. coefs.	Unstd. coefs. (std. errors)	Std. coefs.
Attitudes and Knowledge						
Economic Productivity	-.062	-.015	-.588	-.082	.500	.068
	(.240)		(.403)		(.411)	
Perceived Vulnerability	.187*	.067	.096	.021	.256	.053
	(.080)		(.134)		(.136)	
Envr. Stewardship Values	.173	.038	.411	.053	.339	.043
	(.254)		(.427)		(.434)	
Knowledge	.042	.041	.099	.057	.039	.022
	(.031)		(.052)		(.053)	
Farmer Characteristics						
Years of Experience	.011	.062	-.013	-.041	.014	.046
	(.007)		(.011)		(.011)	
College Education	.168	.032	.645**	.072	.892***	.098
	(.145)		(.244)		(.248)	
Age: up to 49 years	.199	.027	.331	.027	1.541**	.123
	(.307)		(.516)		(.524)	
Age: 50 to 59 years	-.128	-.020	.585	.054	.769	.070
	(.241)		(.404)		(.410)	
Age: 60 to 69 years	-.024	-.004	.528	.059	.643	.070
	(.193)		(.325)		(.330)	
Full-time farmer	-.006	-.001	.123	.014	.262	.028
	(.153)		(.257)		(.260)	
Farm Characteristics						
Custom Hire	.000	.000	.087	.036	.168*	.068
	(.039)		(.065)		(.066)	
Farm Size: Medium	.122	.022	.486	.052	.084	.009
	(.168)		(.283)		(.287)	
Farm Size: Large	.395*	.069	.513	.053	.131	.013
	(.179)		(.300)		(.305)	
Indiana	.358	.059	.905**	.088	.199	.019
	(.190)		(.320)		(.325)	
Michigan	.704**	.097	-.096	-.008	-.256	-.020
	(.225)		(.378)		(.384)	
Ohio	.295	.052	1.247***	.129	.564	.057
	(.180)		(.302)		(.306)	
Adjusted R-Squared	.027		.039		.051	
Chi-square (df)	633.072*** (173)		632.427*** (173)		633.337*** (173)	
TLI		.922		.923		.923
IFI & CFI		.962		.962		.962
RMSEA (90% CI)	.039 (.036, .043)		.039 (.036, .043)		.039 (.036, .043)	

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$ (two-tailed)

Appx. Table C2. SEMLV Results for Models of Private Information Use by Mode of Access (n =1718)

	In Person, On Farm		In Person, Off Farm		By Phone or Online	
	Unstd. coefs. (std. errors)	Std. coefs.	Unstd. coefs. (std. errors)	Std. coefs.	Unstd. coefs. (std. errors)	Std. coefs.
Attitudes and Knowledge						
Economic Productivity	.456	.080	.244	.044	.328	.054
	(.314)		(.314)		(.336)	
Perceived Vulnerability	.158	.042	-.173	-.047	.138	.035
	(.104)		(.104)		(.111)	
Envr. Stewardship Values	-.022	-.004	-.007	-.001	.276	.042
	(.331)		(.332)		(.354)	
Knowledge	.055	.040	-.019	-.014	.076	.052
	(.040)		(.041)		(.043)	
Farmer Characteristics						
Years of Experience	.005	.020	-.002	-.009	-.005	-.019
	(.008)		(.009)		(.009)	
College Education	.200	.028	.563**	.081	.381	.051
	(.189)		(.190)		(.203)	
Age: up to 49 years	1.734***	.178	.790	.083	2.220***	.214
	(.399)		(.402)		(.428)	
Age: 50 to 59 years	1.169***	.137	.588	.070	1.340***	.147
	(.312)		(.315)		(.335)	
Age: 60 to 69 years	.734**	.103	.428	.061	.756**	.099
	(.251)		(.253)		(.269)	
Full-time farmer	.360	.050	-.279	-.040	.525*	.069
	(.198)		(.200)		(.213)	
Farm Characteristics						
Custom Hire	.242***	.126	.100	.053	.049	.024
	(.051)		(.051)		(.054)	
Farm Size: Medium	.321	.043	.117	.016	.120	.015
	(.219)		(.220)		(.235)	
Farm Size: Large	1.188***	.156	-.391	-.052	.221	.027
	(.232)		(.234)		(.249)	
Indiana	.157	.019	.844***	.105	.363	.042
	(.247)		(.249)		(.266)	
Michigan	-.113	-.012	.233	.024	.280	.027
	(.292)		(.294)		(.314)	
Ohio	.024	.003	.376	.050	.065	.008
	(.233)		(.235)		(.251)	
Adjusted R-Squared	.091		.033		.073	
Chi-square (df)	640.599*** (173)		627.164*** (173)		632.246*** (173)	
TLI	.922		.923		.923	
IFI & CFI	.961		.962		.962	
RMSEA (90% CI)	.040 (.036, .043)		.039 (.036, .042)		.039 (.036, .043)	

$^*p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$ (two-tailed)

Tables

Table 1. Descriptive Statistics (n=1718)				
	Mean	Std. dev.	Min.	Max.
Economic Productivity Attitudes (latent)				
Earn a high income	3.68	0.93	1.00	5.00
Maximize farm/company profit	4.31	0.76	1.00	5.00
Build up wealth and family assets	4.04	0.90	1.00	5.00
Be among the best in the industry	3.78	0.99	1.00	5.00
Environmental Stewardship Values (latent)				
Look after the environment	4.30	0.75	1.00	5.00
Pass on land in good condition	4.22	0.79	1.00	5.00
Have good-looking fields	4.57	0.69	1.00	5.00
Perceived Operational Vulnerability to Climate Change (latent)				
Impact of warmer temperatures on my farm	3.02	1.20	1.00	5.00
Impact of droughts on my farm	3.44	1.23	1.00	5.00
Impact of extreme weather events on my farm	3.47	1.24	1.00	5.00
Impact of climate change on my farm	2.74	1.27	1.00	5.00
Impact of floods on my farm	3.07	1.32	1.00	5.00
Management Knowledge Scale	14.98	2.50	4.00	20.00
Years of experience as primary decision-maker	32.58	14.51	1.00	76.00
Education (college degree or some college)	0.50	0.50	0.00	1.00
Age Category 1: less than 49 years	0.15	0.35	0.00	1.00
Age Category 2: 50 to 59 years	0.22	0.41	0.00	1.00
Age Category 3: 60 to 69 years	0.38	0.49	0.00	1.00
Age Category 4: 70 or more years (reference)	0.25	0.43	0.00	1.00
Full-time Farmer	0.56	0.50	0.00	1.00
Custom Hired Work	2.78	1.84	0.00	6.00
Farm Size: Small (1-200 acres) (reference)	0.43	0.45	0.00	1.00
Farm Size: Medium (201-500 acres)	0.29	0.45	0.00	1.00
Farm Size: Large (501 or more acres)	0.28	0.46	0.00	1.00
Illinois (reference)	0.32	0.47	0.00	1.00
Indiana	0.24	0.43	0.00	1.00
Michigan	0.15	0.36	0.00	1.00
Ohio	0.29	0.46	0.00	1.00

Data: Panel Farmer Survey 2018 (Marquart-Pyatt 2022)

Table 2. SEMLV Results for Models Predicting Number of Information Sources Accessed (n = 1718)

	Total Info Sources		Public Info Sources		Private Info Sources	
	Unstd. coefs. (std. errors)	Std. coefs.	Unstd. coefs. (std. errors)	Std. coefs.	Unstd. coefs. (std. errors)	Std. coefs.
Attitudes and Knowledge						
Economic Productivity	-.008	-.002	-.418	-.057	.287	.087
	(.157)		(.366)		(.167)	
Perceived Vulnerability	.177***	.085	.438***	.092	.090	.042
	(.052)		(.122)		(.055)	
Envr. Stewardship Values	.164	.048	.607	.077	-.061	-.017
	(.166)		(.391)		(.175)	
Knowledge	.102***	.133	.180***	.102	.056**	.070
	(.020)		(.048)		(.021)	
Farmer Characteristics						
Years of Experience	.005	.036	.013	.041	.003	.018
	(.004)		(.010)		(.004)	
College Education	.520***	.131	.965***	.106	.253*	.062
	(.095)		(.221)		(.100)	
Age: up to 49 years	.412*	.076	.339	.027	.688**	.122
	(.200)		(.468)		(.211)	
Age: 50 to 59 years	.304	.064	.255	.023	.478**	.096
	(.157)		(.366)		(.165)	
Age: 60 to 69 years	.357**	.089	.488	.053	.417**	.101
	(.126)		(.294)		(.133)	
Full-time farmer	-.058	-.014	-.124	-.013	.011	.003
	(.099)		(.233)		(.105)	
Farm Characteristics						
Custom Hire	.142***	.133	.266***	.108	.147***	.132
	(.025)		(.059)		(.027)	
Farm Size: Medium	.164	.039	.382	.040	.125	.029
	(.110)		(.257)		(.116)	
Farm Size: Large	.490***	.115	.861**	.088	.433***	.098
	(.116)		(.272)		(.123)	
Indiana	.400**	.087	1.015***	.096	.476***	.100
	(.124)		(.290)		(.131)	
Michigan	.168	.031	.212	.017	-.044	-.008
	(.147)		(.343)		(.155)	
Ohio	.454***	.106	1.326***	.135	.139	.031
	(.117)		(.274)		(.124)	
Adjusted R-Squared	.109		.078		.079	
Chi-square (df)		644.32 (173)		650.16 (173)		632.13 (173)
TLI		.922		.920		.923
IFI & CFI		.961		.961		.963
RMSEA (90% CI)		.040 (.037, .043)		.040 (.037, .043)		.039 (.036, .043)

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$ (two-tailed)

Table 3. SEMLV Results for Models of Total Information Access by Mode of Contact (n = 1718)

	In Person, On-Farm		In Person, Off-Farm		By Phone or Online	
	Unstd. coefs. (std. errors)	Std. coefs.	Unstd. coefs. (std. errors)	Std. coefs.	Unstd. coefs. (std. errors)	Std. coefs.
Attitudes and Knowledge						
Economic Productivity	.119	.041	-.056	-.015	.368	.091
	(.159)		(.203)		(.225)	
Perceived Vulnerability	.133**	.071	-.030	-.013	.130	.049
	(.053)		(.068)		(.074)	
Envr. Stewardship Values	.089	.029	.156	.040	.142	.032
	(.168)		(.215)		(.236)	
Knowledge	.036	.052	.024	.027	.059*	.060
	(.021)		(.026)		(.029)	
Farmer Characteristics						
Years of Experience	.001	.009	-.003	-.021	.001	.005
	(.004)		(.006)		(.006)	
College Education	.141	.039	.581***	.129	.456***	.090
	(.096)		(.123)		(.135)	
Age: up to 49 years	.658**	.134	.470	.076	1.465***	.211
	(.203)		(.260)		(.285)	
Age: 50 to 59 years	.382*	.089	.500*	.092	.737***	.121
	(.159)		(.204)		(.223)	
Age: 60 to 69 years	.263*	.073	.395*	.087	.517**	.101
	(.128)		(.164)		(.179)	
Full-time farmer	.113	.031	-.087	-.019	.282*	.055
	(.101)		(.129)		(.142)	
Farm Characteristics						
Custom Hire	.077**	.080	.067*	.055	.081*	.060
	(.026)		(.033)		(.036)	
Farm Size: Medium	.177	.047	.221	.046	.081	.015
	(.111)		(.143)		(.156)	
Farm Size: Large	.527***	.137	.095	.019	.138	.025
	(.118)		(.151)		(.166)	
Indiana	.164	.040	.562***	.107	.181	.031
	(.126)		(.161)		(.177)	
Michigan	.289	.059	.144	.023	.177	.025
	(.149)		(.191)		(.209)	
Ohio	.146	.038	.569***	.116	.219	.040
	(.119)		(.152)		(.167)	
Adjusted R-Squared	.069		.047		.087	
Chi-square (df)		632.06 (173)		629.38 (173)		638.67 (173)
TLI		.923		.923		.922
IFI & CFI		.963		.963		.962
RMSEA (90% CI)		.039 (.036, .043)		.039 (.036, .043)		.040 (.036, .043)

**p* < 0.05; ***p* < 0.01; ****p* < 0.001 (two-tailed)

Figures

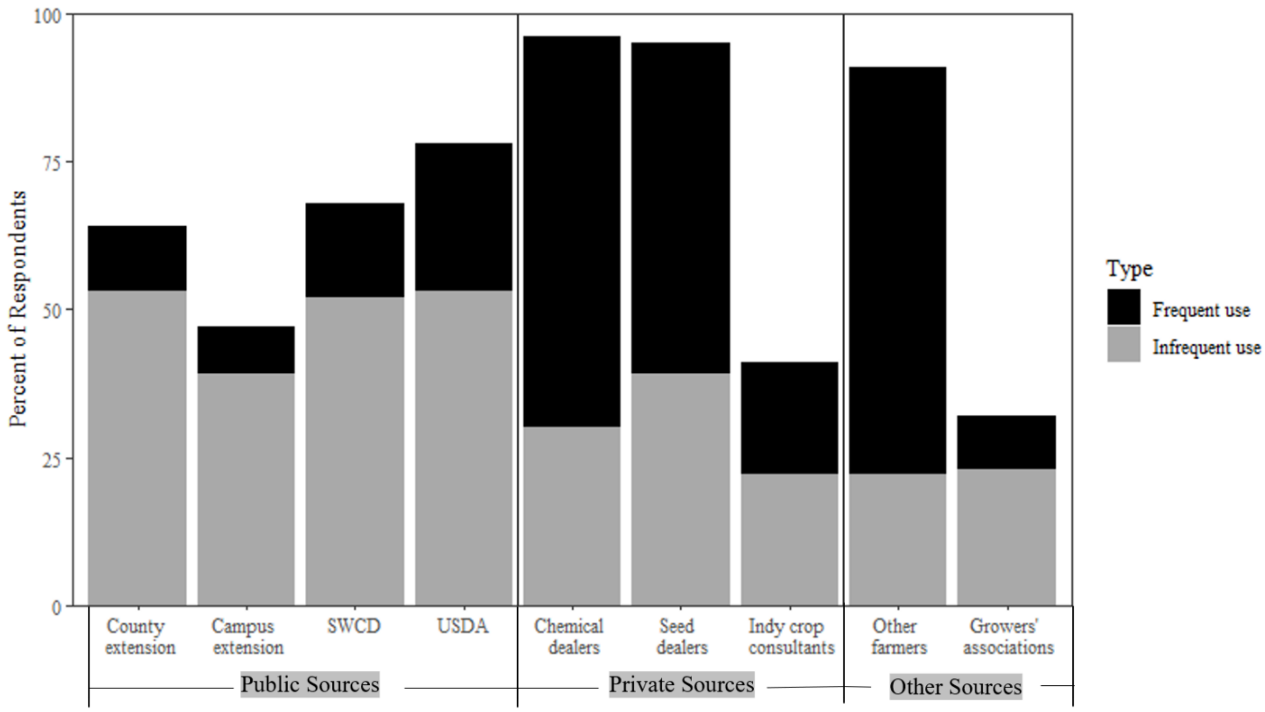

Fig. 1 Percent of respondents who consult information sources frequently and infrequently, grouped by public, private, and other sources

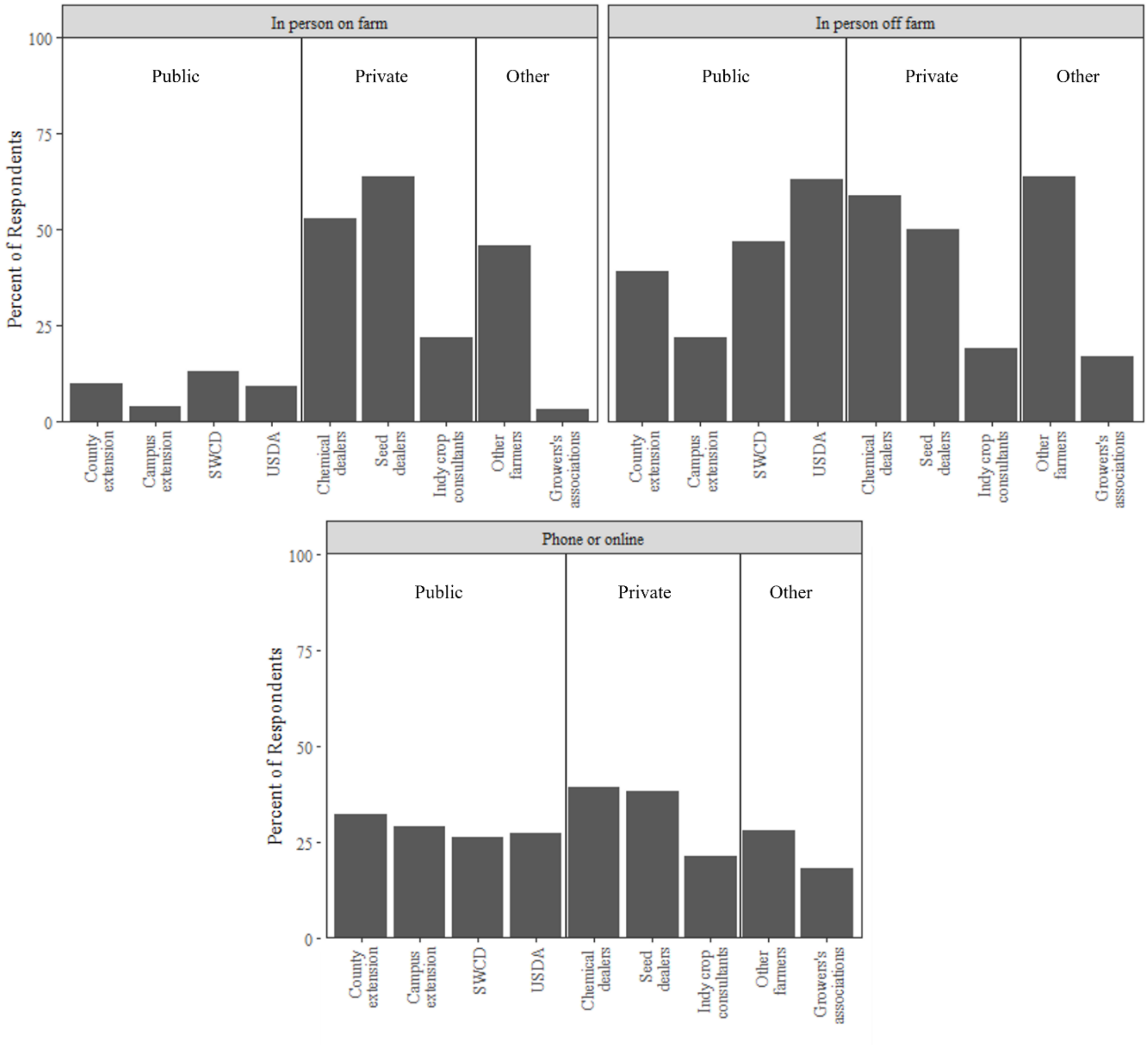

Fig. 2 Percent of respondents accessing information sources through individual modes

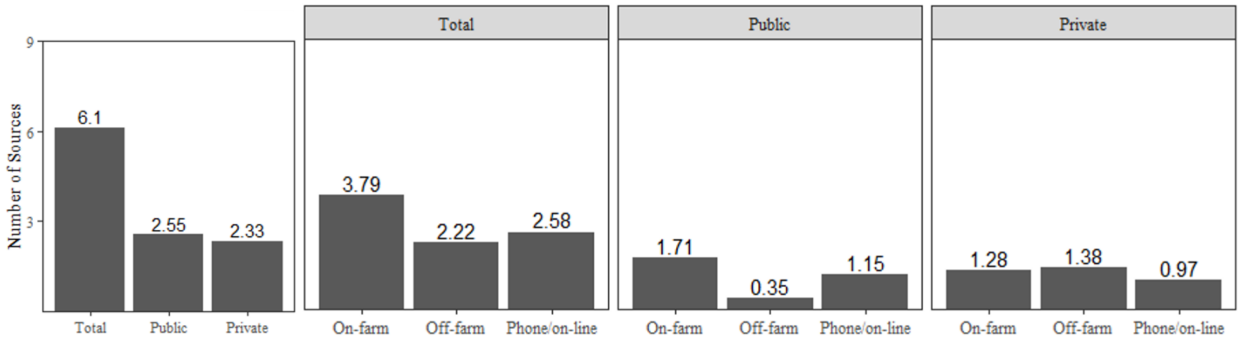

Fig. 3 Average Number of Sources Accessed, by Source Type and Mode of Contact[3]

[3] Range for total sources is 0-9, for public sources is 0-4, and for private sources is 0-3.