UNDERSTANDING SOCIAL AND ECONOMIC BARRIERS TO 4R ADOPTION

SUMMARY OF SURVEY RESULTS

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Executive Summary

A set of agricultural best management practices (BMPs) for nutrient management, known as the 4R Nutrient Stewardship approach, is promoted in the Chesapeake Bay Watershed (CBW) as a mechanism to reduce agricultural runoff and improve water quality in the Bay. The 4Rs refer to using nutrients from the *right* source at the *right* rate, *right* time, and *right* place to help farmers select recommended nutrient application levels. Despite increasing promotion of the approach, the adoption of 4R practices has been insufficient to reach nutrient loading goals for the Chesapeake Bay (Osmond et al. 2015). This study examines farmer perceptions of 4R practices to understand the social and economic barriers limiting adoption, the factors that are important to incentivize farmer adoption of the practices, and how farmers prefer to receive information about nutrient management.

A survey of corn, soybean, and/or small grain farmers in Delaware, Maryland, Pennsylvania, and Virginia was conducted in December 2021 and January 2022. The survey was conducted by mail with an option to complete the questionnaire online through the Qualtrics survey platform. 204 useable responses were collected.

The results show most farmers currently have a written nutrient management plan on their farm, and several farmers use split nitrogen (N) application and variable rate N application (VRT), however there is room for increased adoption of other 4R practices. Approximately 40% of farmers that do not currently use the practice on at least half of their acres are interested in adopting N modeling in the next three years.

To better understand incentives and barriers to adoption, farmers were asked to rate the importance of a series of agronomic and economic factors in the decision to adopt select practices as well as to rate the extent to which they believe certain factors limit farmer's use of select practices. The practices included in-season N modeling, split N application, and VRT. Results show that farmers find economic factors such as profitability, input costs, and crop yields to be important factors in the decision to adopt/not adopt all three practices. Soil health and productivity is an important factor in the decision to adopt/not adopt in-season N modeling but is less important for the other practices. The level of importance farmers place on various factors differs by the education level of the farmer, age of the farmer, and proportion of gross income earned from farming. Perceived barriers tend to be more specific to the type of practice. For all three practices, farmers agree that having the right equipment limits farmers' use of the practice. Having the right technology, getting a return on investment, and the cost of the practice are perceived to limit the use of in-season N modeling and VRT. Difficulty implementing the practice due to timing and weather is a perceived barrier to split N application. Perceived barriers differ by the education level of the farmer, proportion of gross income earned from farming, whether the farmer is an experienced user of 4R practices, and the tillage system used.

In addition to barriers and incentives to adoption, the study investigates farmer preferences for information and communication. In the survey farmers were asked to rate the level of influence of different sources of information, the helpfulness of different types of information and the helpfulness of different methods of communication. Most farmers rely on personal experience with a practice, crop consultants (for a seed/fertilizer company and independent), university

researchers and university county extension agents as sources of information about nutrient management practices. The influence each source of information has varies by farmer education level, proportion of gross income earned from farming, and whether the farmer uses manure as fertilizer. On-farm trials are cited as the most helpful type of information. The helpfulness of different types of information varies by education level. In-person communication through farm demonstrations, field days, and farm school or trainings are cited as the most helpful mediums to learn about nutrient management practices. Preferred methods of communication vary by farmer education level, and whether the farmer uses manure as fertilizer.

The results from this report can be used to design a targeted communication strategy for promoting 4R practices in the CBW. Understanding the importance of different factors in the decision to adopt 4R practices, the perceived barriers to 4R practices, and farmers' preferences for information and communication can help stakeholders design farmer-centric programs to reduce agricultural runoff and improve water quality in the CBW.

Introduction

Agriculture is the dominant human land use across the Chesapeake Bay Watershed (CBW). Runoff and leached fertilizers used for agricultural purpose are the primary sources of nitrogen (N) and phosphorus (P) entering the Chesapeake Bay (Ator et al. 2020; Ribaudo, Savage, and Aillery 2014). The Environmental Protection Agency (EPA)'s target to improve water quality and valuable ecosystem services of the Bay and its tributaries by 2025 is challenged by excessive nutrient pollution from farmland to the Bay (Ritter 2019).

The promotion of the 4R Nutrient Stewardship approach helps farmers select recommended nutrient applications by different best management practices (BMPs) of fertilizer application choices. The 4 *Rs* refer to using nutrients from the *right* source at the *right* rate, *right* time, and *right* place. Despite increasing promotion, the adoption of 4R practices has been insufficient to reach nutrient loading goals for the Chesapeake Bay (Osmond et al. 2015). Thus, an investigation into the preferences influencing BMP adoption is warranted to inform targeted programs and policies. Understanding potential barriers to adoption and preferred sources or types of information can improve targeted communication strategies for 4R promotion.

The current study investigates potential barriers to adoption of 4R practices from a survey of corn, soybean, and/or small grain farmers in Delaware, Maryland, Pennsylvania, and Virginia. The results of the survey are presented in this report to highlight current adoption of 4R practices and perceptions of the practices including potential barriers to adoption. Regression analysis is used to examine differences in perceived barriers and important outcomes from adoption by farm type and farmer characteristics. The report also presents results that examine farmers' preferences for sources of information about nutrient management practices as well as preferred communication methods.

The information in this report can be used to develop more effective outreach toolkits and to inform the design of farmer-centric agri-environmental programs aiming to increase farmer engagement in 4R practices. Programs designed based on our findings will help to increase the adoption of BMPs. Such adoption will help to mitigate water pollution and reach the EPA's 2025 water quality targets for the CBW.

Survey of Farmer Nutrient Management Decisions in the Mid-Atlantic

Survey Sample and Response Rate

A survey of farmers in the Mid-Atlantic region of the United States was conducted from December 2021 through January 2022. Eligible farmers included growers of corn, soybeans, and/or small grains who were the primary decision-maker on their farm and were at least 18 years of age. Lists of eligible farmers in Delaware, Maryland, Pennsylvania, and Virginia were compiled with assistance from our partner organizations: The Nature Conservancy and the Mid-Atlantic 4R Alliance. The source of participant lists varied by state. Delaware and Maryland participant lists were provided by the state departments of agriculture and included all farmers who had registered a state-required nutrient management plan. To account for a large number of poultry growers in Delaware, the list excluded farms with zero acres of land. Eligible farmers in Virginia included those who were registered as certified private pesticide applicators. The list was provided by the Virginia Department of Agriculture. Penn State University Extension provided the Pennsylvania participant list, and farmers were identified as individuals who had registered to receive extension information about agronomic crops, cover crops, pesticide education, fertilizers, and/or forages. Since we seek to understand farmers whose decisions affect the CBW, Pennsylvania and Virginia participant lists were filtered to only include counties in the CBW. The final participant list included 18,472 farmers.

From the participant list, 2,700 farmers were randomly selected to receive the survey (651 farmers in DE and 683 farmers in each state for MD, VA, and PA). While the objective was to stratify the selection equally by state, the selection of DE farmers was constrained by the total number of farmers on the nutrient management list.

A paper survey and cover letter were mailed to the participant address. The cover letter included a web link and corresponding QR code by which the participant could complete the survey online in the Qualtrics web-based survey platform if he or she preferred. The survey was a voluntary survey incentivized through a raffle drawing. Farmers who completed the survey were eligible for a raffle prize drawing where participants were randomly selected to receive a Visa gift card in the amount of $250 (10 available), $100 (20 available), or $50 (99 available). These compensation rates were determined through consultation with our partner organizations.

The returned surveys included 204 useable responses from eligible farmers, for a response rate of 7.5%. Table 1 shows the number of responses by state.

Table 1. Number of survey respondents by state

	Delaware	Maryland	Pennsylvania	Virginia	Total sample
Number of respondents	84	56	40	24	204

Survey Design

The objective of the survey was to understand current use of 4R nutrient management practices and perceived barriers to adopting 4R practices. The survey instrument can be found in

Appendix A. The survey collected information about current adoption and likelihood of adopting the following eight 4R nutrient management practices:

(1) **Written nutrient management plan**: A site-specific plan written by a certified consultant that guides efficient nutrient applications based on university recommendations and/or soil test results. A nutrient management plan aims to improve nutrient use efficiency and reduce nutrient losses to the environment.

(2) **Grid soil sampling**: A systematic soil sampling methodology that allows for mapping of nutrient variability in the field. A grid of known size (e.g., 2 acres) is superimposed over a field and a composite soil sample of 5 to 10 soil cores is collected at each grid intersection. Each soil sample is submitted separately for soil analysis. Grid sampling is best for large, uniformly shaped fields.

(3) **Liquid manure injection (low disturbance)**: The application practice of placing manure under the soil surface with minimal soil disturbance. Injection is a viable option for liquid manure or fertilizer only. Common injection equipment includes shallow disk or shank injectors with closing disks.

(4) **Injection or incorporation of commercial nitrogen fertilizer**: The application practice of placing chemical fertilizer under the soil surface with minimal soil disturbance.

(5) **Cover crop**: A crop (e.g., small grains, brassicas, legumes) planted during the winter months in fields that would otherwise be bare or fallow to prevent the loss of soil nutrients, minimize soil erosion, and enhance soil properties; this crop is to benefit the soil and water quality and therefore, is not harvested (although it may be grazed).

(6) **Split nitrogen (N) application**: Applying a small amount of nitrogen early in the season (i.e., pre-plant or at-plant) followed by one or more applications of nitrogen in-season during the period of active plant growth (e.g. sidedress). Most of the nitrogen is applied in-season.

(7) **Variable Rate application (VRT)**: A type of application where the material (seed, fertilizer, irrigation, etc.) is applied based on a specific need-based prescription for different areas within a field based on soil or crop characteristics.

(8) **In-season nitrogen modeling tools**: Computer modeling systems that use local weather, site, and crop conditions to predict in-season crop nitrogen demands during the season in real-time. Several companies offer nitrogen modeling services to guide in-season N applications.

A key objective of the survey was to understand the barriers to adoption and factors that incentivize adoption of select nutrient management practices. To that end, the survey presented a series of in-depth perception questions about three practices: in-season N modeling tools, split N application, and VRT. The respondent was first asked to report perceptions about changes in economic and agronomic factors that would occur from adopting the practice and to rate the importance of each factor in his or her decision to implement or not implement the practice. Then, to elicit perceived barriers to adoption, the farmer was asked to rate the extent to which specified factors limit farmers' use of the practice. The factors included in the survey were informed by communication with farmers during focus group discussions and semi-structured interviews in a previous phase of the project.

In addition to questions about 4R nutrient management practices, the survey collected information about respondents' farming practices, sociodemographics, participation in other conservation/cost-share programs, and preferred methods for receiving information and communication about nutrient management practices.

Characteristics of Respondents

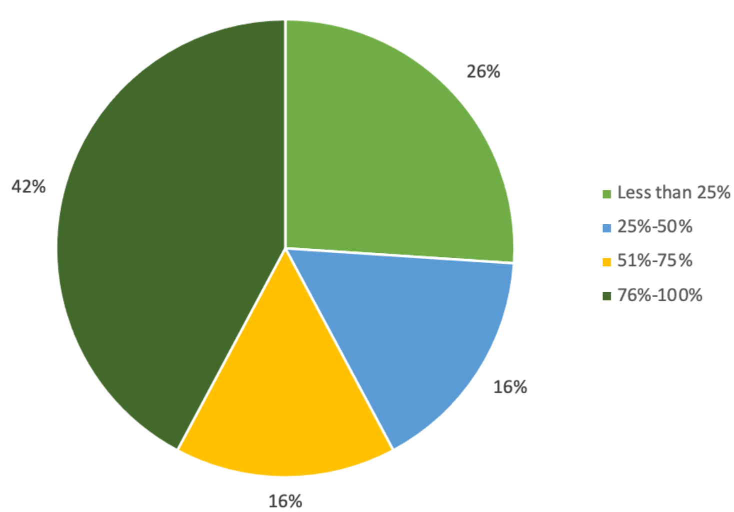
Among our survey respondents, the average farm size is 633 acres, with an average of 268 acres being land owned by the respondent and 372 acres leased on average (table 2). Our sample includes more experienced farmers with an average of 28 years of experience as the primary decision maker and a mean age of 60 years.

Table 2. Farm characteristics and demographics of respondents

Characteristic	Sample average
Farm size (acres)	633
Land owned (acres)	268
Land leased (acres)	372
Years of experience as primary decision maker	28
Age of primary decision maker	60

Over half of respondents, 58%, earned at least 51% of their household income in 2020 through farming (figure 1).

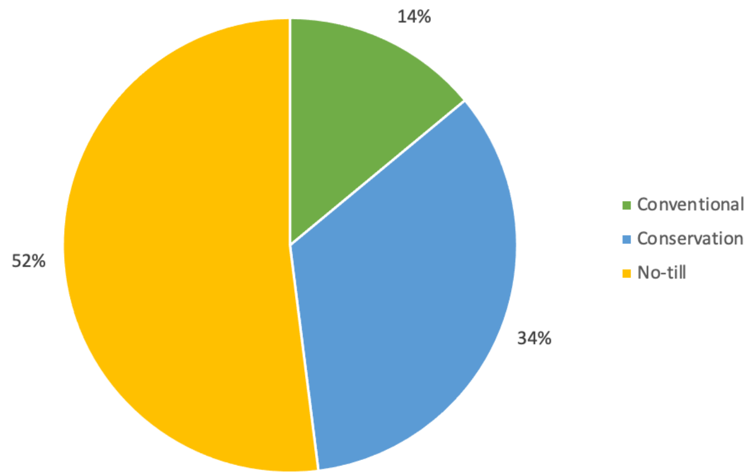
Figure 1. Proportion of household's gross income in 2020 earned through farming



Note: Sample size (N) = 192

The majority of respondents, 52%, reported no-till as the method that best describes their tillage system (figure 2). We suspect that this reflects the use of at least *some* no-till practice among respondents rather than a complete no-till system.

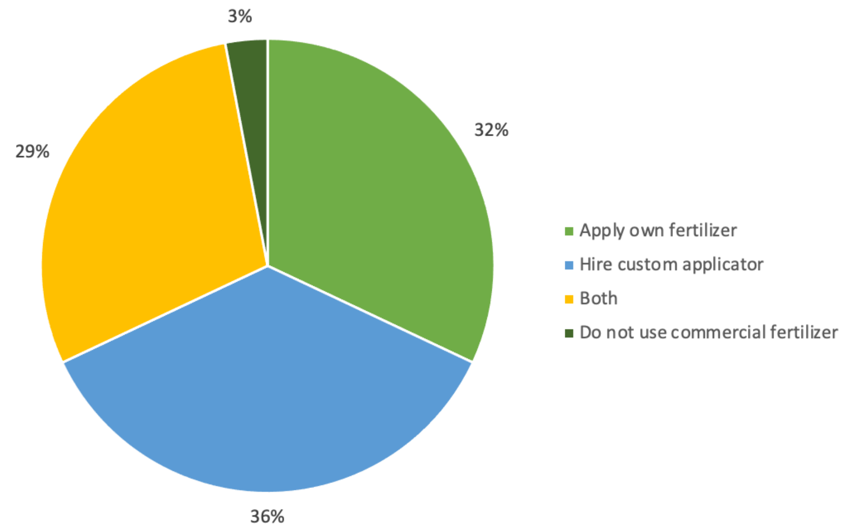
Figure 2. Proportion of respondents using conventional, conservation, or no-till tillage system



Note: N = 202

Since access to equipment could be a barrier to certain 4R practices, it is important to understand whether farmers apply their own fertilizer or hire a custom applicator. The survey asked participants to identify the respective method of fertilizer application. Figure 3 displays the results.

Figure 3. Method of commercial fertilizer application used by respondents



Note: N = 202

The responses are fairly evenly split, with 36% hiring a custom applicator, 32% applying their own fertilizer, and 29% using both methods (figure 3).

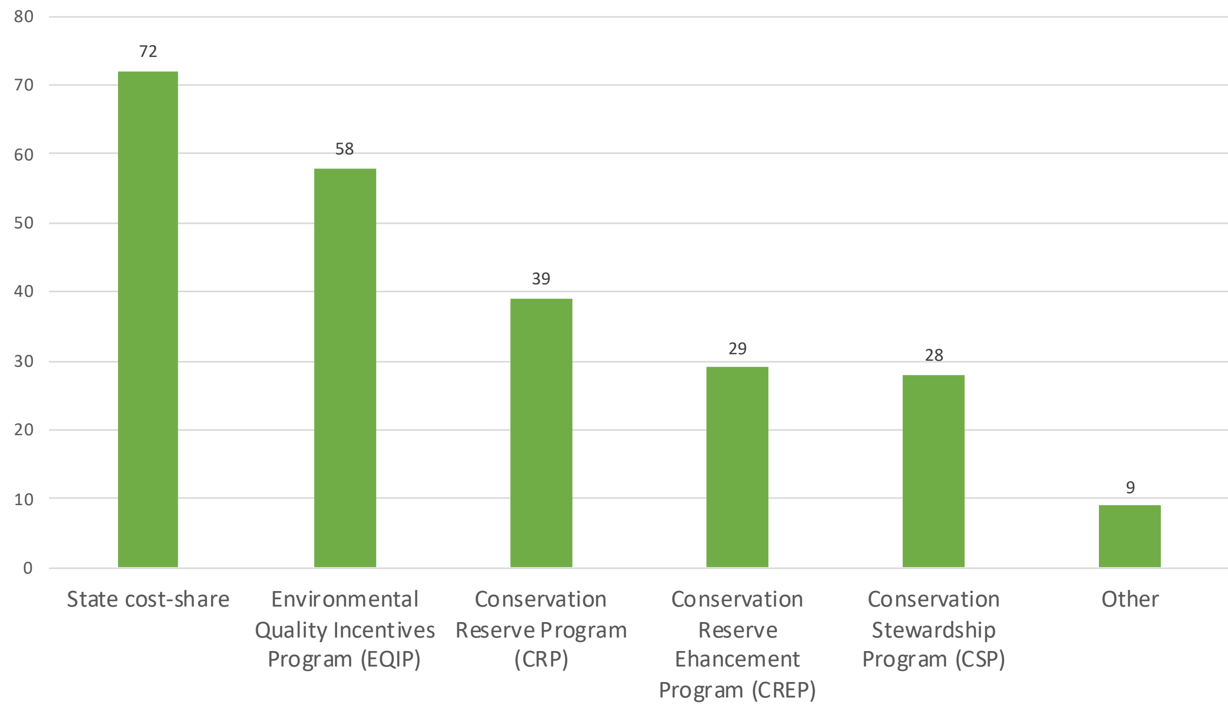
The use of manure for fertilizer is prevalent among survey respondents, with 67% reporting use (table 3). In some cases, respondents source manure from external entities, since only 48% of respondents report raising poultry or livestock on their own farm. Among those respondents that raise livestock, 42% report using manure for fertilizer.

Table 3. Livestock ownership and manure use among respondents

Livestock ownership and manure use	Percent of respondents (N =203)
Raise poultry or livestock	48%
Use manure for fertilizer	67%
Of those that raise livestock, percent that use manure for fertilizer	42%

In addition to farm characteristics, the survey asked respondents to report enrollment in environmental and conservation programs (figure 4). Participants could select multiple programs in which they are enrolled; thus, the sum of participation exceeds the sample size.

Figure 4. Number of respondents participating in state and federal environmental programs

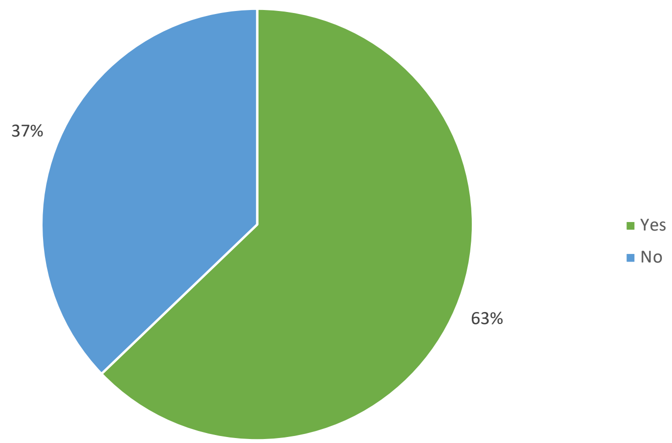


Note: N = 183

State agricultural cost-share programs are the most common, with 72 respondents reporting enrollment. Participation in federal programs followed, with 58 enrolled in the Environmental Quality Incentives Program (EQIP), 39 enrolled in the Conservation Reserve Program (CRP), 29 enrolled in the Conservation Reserve Enhancement Program (CREP), and 28 enrolled in the Conservation Stewardship Program (CSP). Other environmental programs reported by 9 respondents included district-level cover crop cost share programs that are supported by federal and state funds.

The survey also asked respondents to report on water recreation (figure 5) and surface water (figure 6) on their farm. The majority, 63%, state that they participate in water related recreation (e.g. boating, fishing, swimming in a lake, river, stream, etc.) at least once per year.

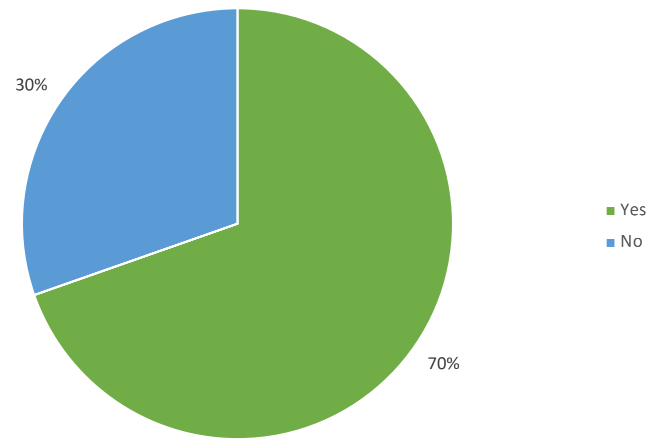
Figure 5. Proportion of respondents participating in water related recreation at least once per year



Note: N = 191

Most respondents, 70%, report having surface water on their land or flowing through their property under regular non-flooding situations such as a lake, stream, brook, creek, pond, etc.

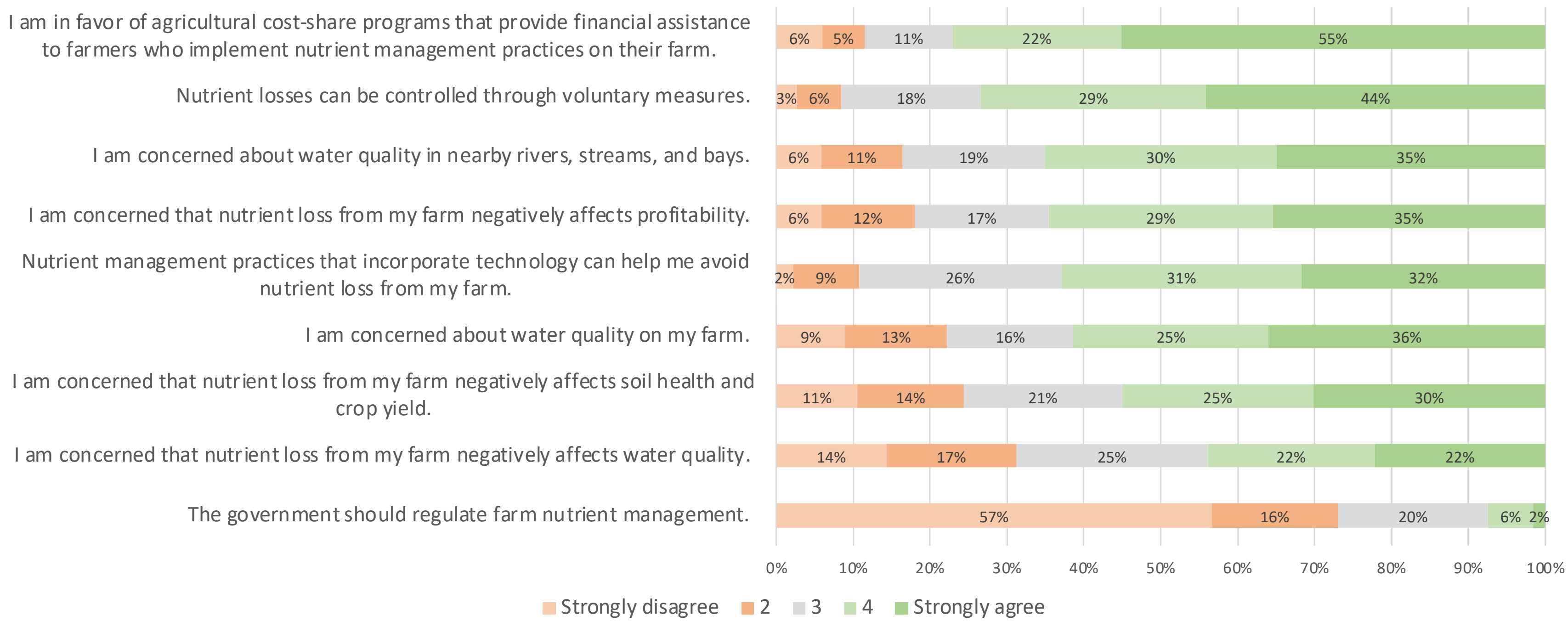
Figure 6. Proportion of respondents that have surface water on their land or flowing through their property



Note: N = 191

Finally, the survey asked respondents to express perceptions of nutrient management by rating their level of agreement (from strongly disagree = 1 to strongly agree = 5) with statements about nutrient loss on their farm, water quality, and programmatic considerations for nutrient management. Figure 7 displays the statements and results.

Figure 7. Respondents' perceptions of nutrient loss, water quality, and nutrient management programs

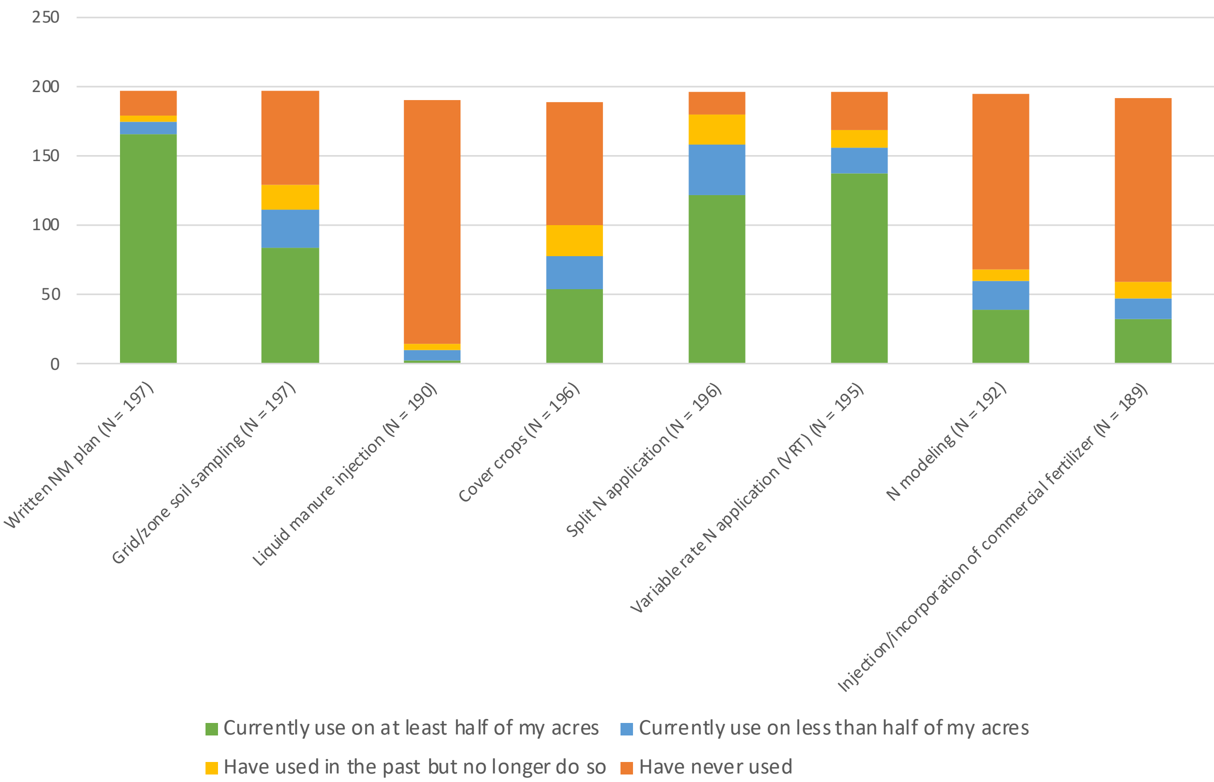


In general, respondents are in favor of agricultural cost-share programs for nutrient management practices, and they agree that nutrient losses can be controlled through voluntary measures. The majority of respondents disagree that the government should regulate farm nutrient management. The majority of farmers express some level of concern for nutrient loss on their farm and water quality in nearby rivers, streams, and bays. However, 31% of respondents disagree that nutrient loss from their farms negatively affect water quality.

Current Adoption of 4R Nutrient Management Practices

The survey asked farmers to identify their current use of select 4R nutrient management practices, defined above. The response options elicited whether farmers use the practice on most of their land versus some of their land. In this way, the survey identified farmers who are eligible to expand the use of 4R practices on their operations. The response options also identified previous adopters of the practice that no longer use it versus those who have never used the practice. Figure 8 shows the current adoption status for each of the target practices in the survey.

Figure 8. Current adoption of 4R nutrient management practices



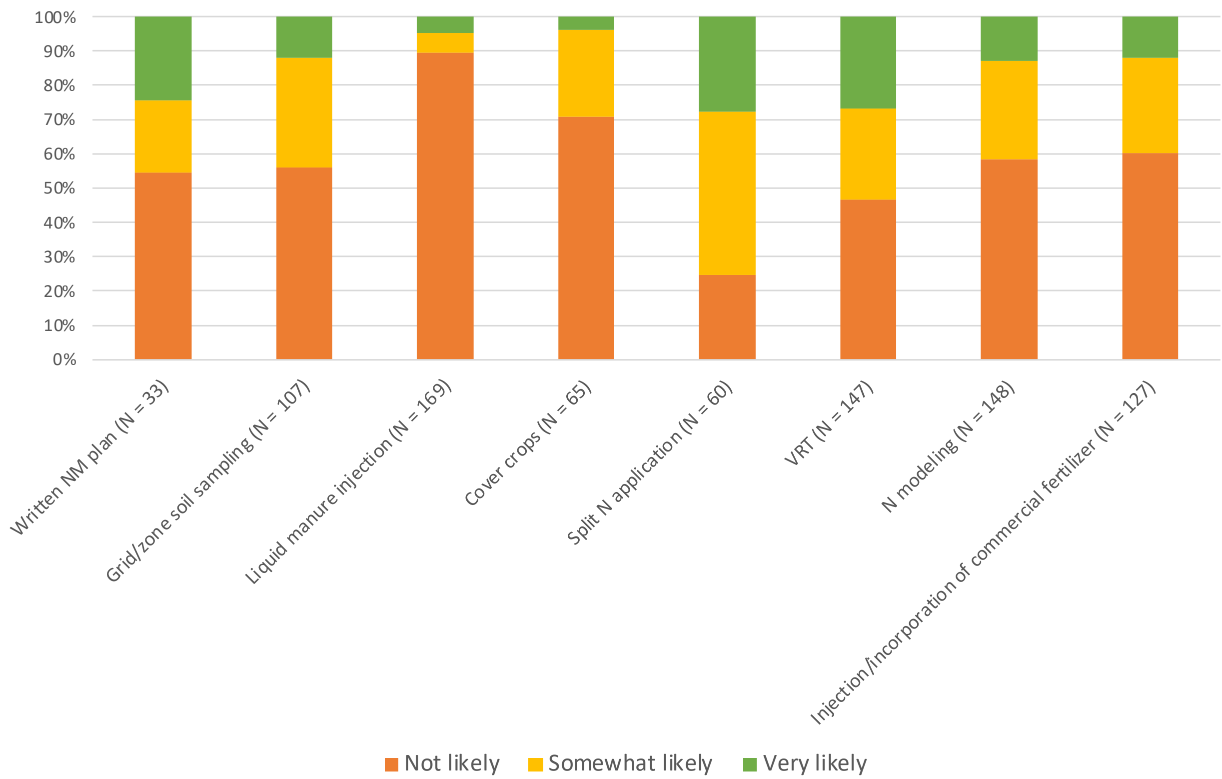
The majority of farmers in the survey have a written nutrient management plan on most of their farmland. Only 18 farmers have never used a written nutrient management plan. Among survey respondents, the adoption levels of split N application and VRT are relatively high, with 158 farmers using split N application on at least some acres and 156 implementing VRT on at least some acres. There is a greater tendency for farmers to use split N application on less than half of their acres compared to VRT. The responses also reveal that 22 farmers used split N application in the past but no longer do so. Grid or zone soil sampling is used on at least some acres by 111 farmers in the sample. In the past, 18 farmers have tried grid or zone sampling but no longer use it and 68 farmers have never used the practice.

In-season N modeling tools and injection/incorporation of commercial fertilizer have lower rates of adoption among survey respondents. 60 farmers are currently using in-season N modeling tools on at least some acres, while 127 have never used the practice. 47 farmers are currently using injection/incorporation of commercial fertilizer on at least some acres, while 133 have never used the practice.

While 78 farmers currently use incorporation or injection of commercial fertilizer on at least some of their acres, 89 farmers have never done so. Liquid manure injection is largely unadopted in the survey sample, with only 14 farmers having ever used the practice.

In addition to current adoption, the survey elicits interest in future adoption. Respondents were asked "If you are not currently using a practice on at least half of your acres, indicate how likely you are to start using or expand acreage for each practice." Figure 9 presents the results.

Figure 9. Percent of respondents that are likely to start using or expand acreage for each 4R nutrient management practice



The results show the most interest in adopting or expanding the use of split N application and VRT. There is little interest among farmers in using liquid manure injection and 71% of eligible farmers said they were not likely to start using or expand acreage for cover crops. There appears to be some interest in in-season N modeling tools and injection/incorporation of commercial fertilizer, where approximately 40% of eligible farmers said they were somewhat or very likely to start using or expand acreage for the practice.

Farmer Perceptions of Select Nutrient Management Practices

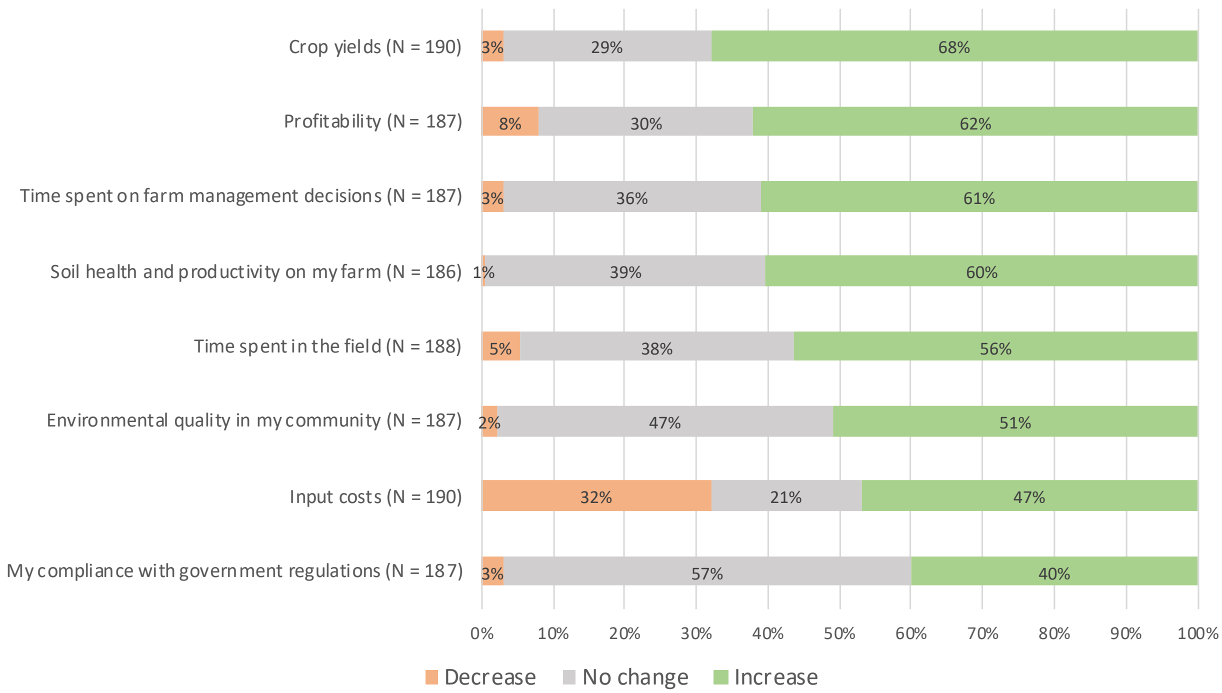
The following sections summarize the reported perceptions about changes in economic and agronomic factors that would occur from adopting select nutrient management practices, the importance of each factor, and the extent to which the respondent believes that specified factors limit farmers' use of the practice. The survey elicited this information about three practices of interest: in-season N modeling tools, split N application, and VRT.

In-Season N Modeling Tools

Perceived Changes from Adopting In-Season N Modeling Tools and Importance of those Factors

Figure 10 presents respondents' perceived changes that would occur from adopting in-season N modeling tools.

Figure 10. Perceived changes in economic and agronomic factors from adopting in-season N modeling tools

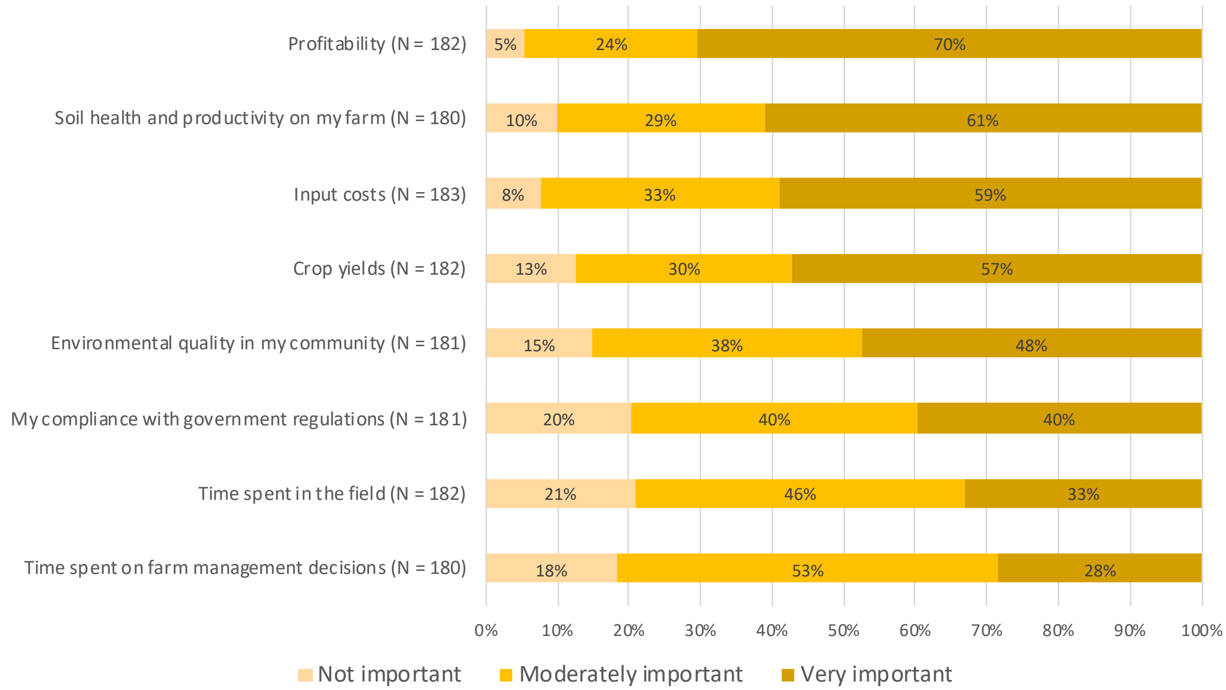


Note: Bars do not always add to 100% due to rounding.

In general, respondents believe the adoption of in-season N modeling tools would lead to economic benefits such as increased profitability and reduced input costs as well as agronomic benefits through improved crop yields and soil health and productivity. Although farmers generally perceive the technology to have benefits, there is a perception that in-season N modeling tools are costly in terms of increases in the time spent in the field and time spent on farm management decisions.

In addition to understanding the perceived changes from adopting in-season N modeling tools, it is important to identify how much emphasis farmers place on these factors in the decision to adopt the tools. Figure 11 reports the level of importance for each factor.

Figure 11. Level of importance of economic and agronomic factors in the decision to adopt in-season N modeling tools



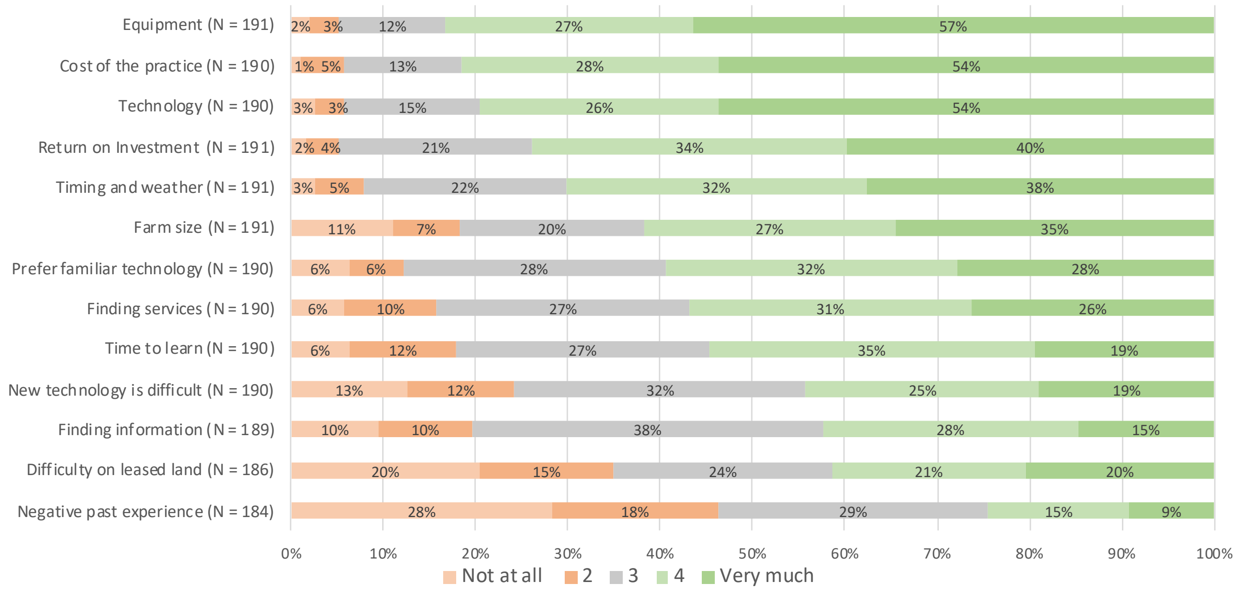
Note: Bars do not always add to 100% due to rounding.

The results suggest profitability is the most important factor in the decision to adopt in-season N modeling tools while soil health and productivity and crop yields are also important factors. While there is a perception that the practice will increase time spent in the field and on management decisions, around half of participants say this is only “moderately important,” and approximately 20% of respondents rated time constraints as “not important.”

Perceived Barriers to Adopting In-Season N Modeling Tools

Finally, the survey asks respondents to rate the extent to which various factors limit farmers’ use of in-season N modeling tools. Figure 12 presents the results.

Figure 12. Extent to which potential barriers limit farmers' use of in-season N modeling tools



Note: Bars do not always add to 100% due to rounding.

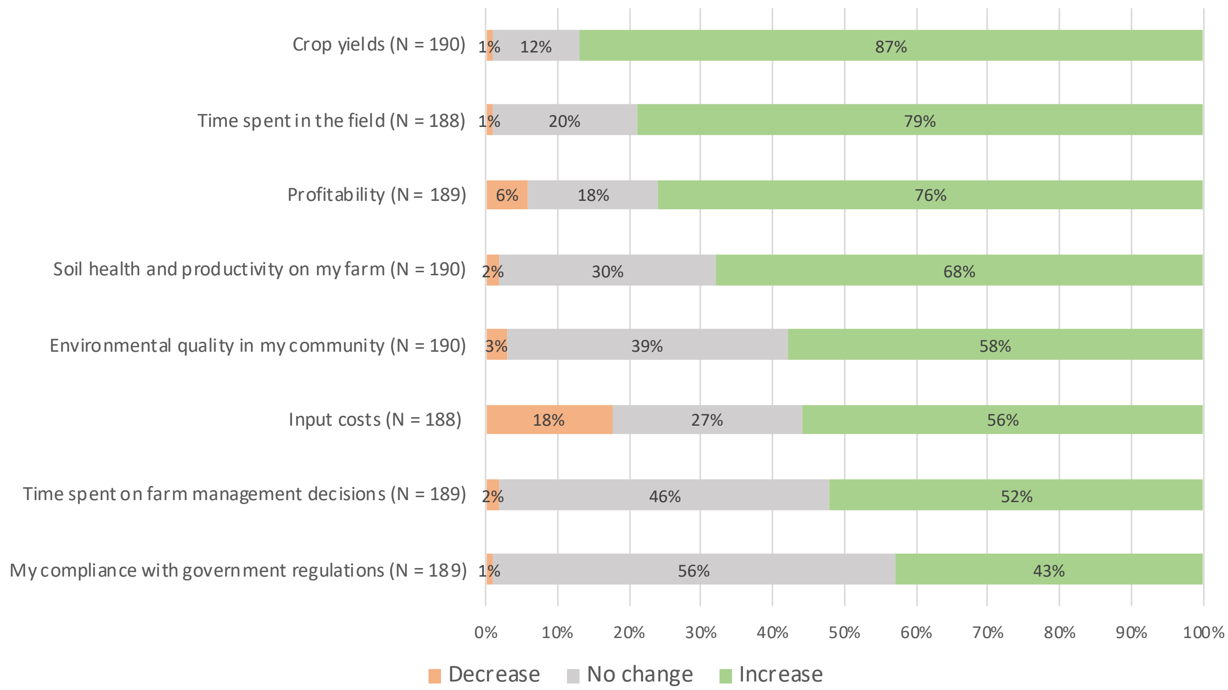
The most commonly cited barriers to adoption of in-season N modeling tools are cost of the practice (82%), getting a return on investment from the practice (74%), and having the right equipment (84%) and technology (80%) to implement the practice. 70% of respondents view timing and weather as constraints to in-season N modeling tools. 62% of respondents view farm size as a barrier to adoption, stating that the belief that in-season N modeling tools are better suited for larger operations limits the use of the practice. 57% of respondents state that finding services related to the practice (e.g. crop advisor or custom applicator) limits farmers' use of the practice, and 43% of respondents believe that finding information about in-season N modeling tools is a constraint to adoption. 60% of respondents believe that farmers prefer to use practices they are more familiar with, but only 44% of respondents state that a belief that new technologies are too difficult to use limit farmers' adoption of in-season N modeling tools. Consistent with the results that time constraints are only moderately important, 54% of respondents believe that time to learn the practice may limit adoption. 41% of respondents stated that difficulty implementing the practice on leased land may limit adoption of in-season N modeling tools. Only 24% of respondents perceive negative past experience with in-season N modeling tools to be a barrier to adoption – this likely reflects the fact that the majority of our sample has never used the practice.

Split N Application

Perceived Changes from Adopting Split N Application and Importance of those Factors

Figure 13 reports respondents' perceived changes that would occur from adopting split N application.

Figure 13. Perceived changes in economic and agronomic factors from adopting split N application

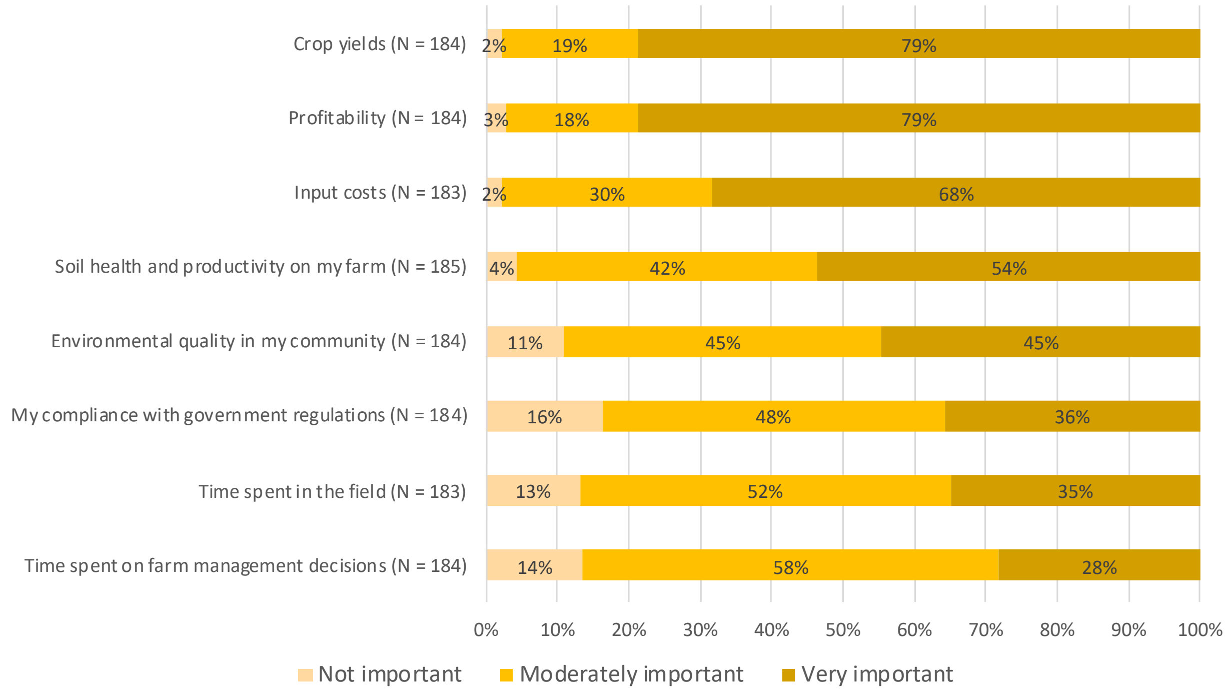


Note: Bars do not always add to 100% due to rounding.

Farmers perceive split N application to have agronomic benefits in terms of increases in crop yields and soil health and productivity. The practice also has perceived economic benefits in terms of increased profitability, however 56% of respondents believe the practice will increase input costs. Not surprisingly, time spent in the field is perceived to increase with split N application, and about half of the respondents believe time spent on farm management decisions will increase.

Figure 14 reports the extent to which respondents believe economic and agronomic factors are important in farmers' decision to adopt split N application.

Figure 14. Level of importance of economic and agronomic factors in the decision to adopt split N application



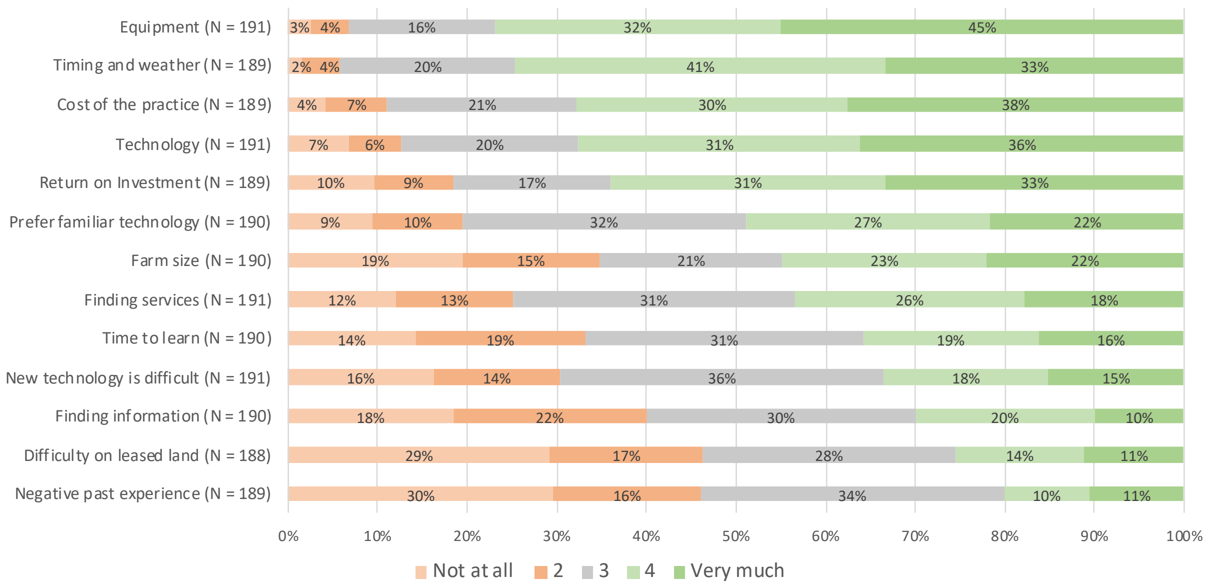
Note: Bars do not always add to 100% due to rounding.

Crop yields, profitability and input costs are the most important factors in farmers' decision to implement split N application. 54% of respondents view on-farm soil health and productivity as very important in the decision to implement considering split N application. Time spent in the field and on farm management decisions is "moderately important" for the decision to implement split N application.

Perceived Barriers to Adopting Split N Application

Figure 15 presents the extent to which potential barriers to adoption influence farmers' use of split N application.

Figure 15. Extent to which potential barriers limit farmers' use of split N application



Note: Bars do not always add to 100% due to rounding.

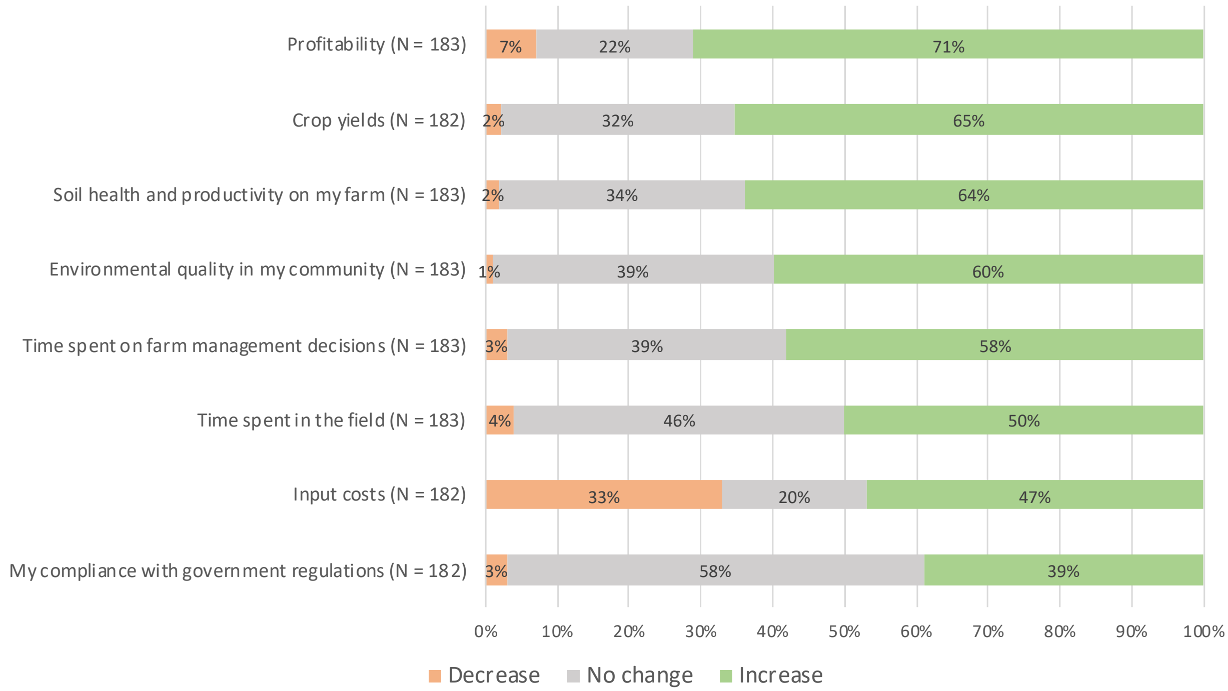
Difficulty implementing split N application due to timing and weather is perceived to limit farmers' use of the practice among 74% of respondents. Having the right equipment (77%) and technology (67%) are also perceived barriers to adoption. Respondents also believe economic outcomes such as the cost of split N application (68%) and getting a return on investment from the practice (64%) limit adoption. About half of the respondents, 49%, believe that farmers prefer to use practices they are more familiar with. 45% of respondents state that believing split N application is better suited for larger operations limits adoption of the practice. Less than half of respondents, 44%, believe that finding services related to split N application (e.g. crop advisor, custom applicator) is a barrier while only 30% believe that finding information about split N application limits farmers' use of the practice. Having enough time to learn about split N application is only perceived to be a barrier of the practice by 35% of respondents and only 33% of respondents state that the belief that new technologies are difficult to use limits farmers' use of the practice. 25% of respondents believe that difficulty implementing the practice on leased land may limit the adoption of split N application. Only 21% of respondents perceive negative past experience with split N application to limit farmers' use of the practice.

Variable Rate Nitrogen Application (VRT)

Perceived Changes from Adopting VRT and Importance of those Factors

Figure 16 reports respondents' perceived changes that would occur from adopting VRT.

Figure 16. Perceived changes in economic and agronomic factors from adopting VRT

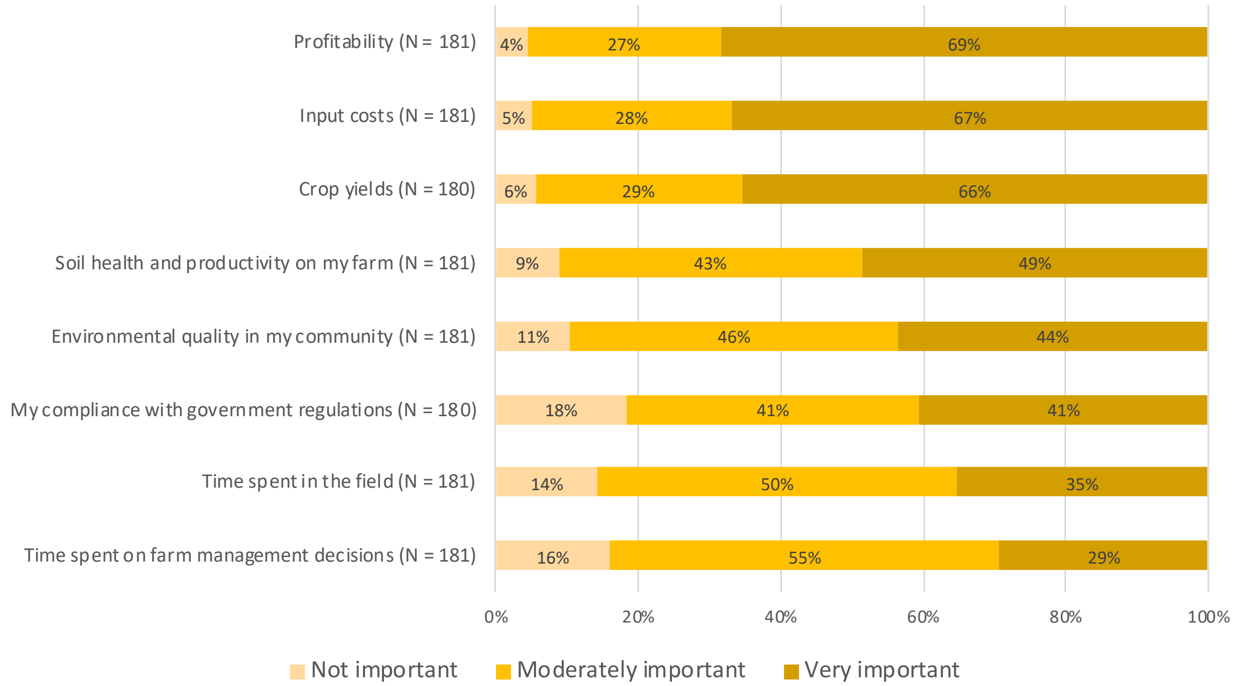


Note: Bars do not always add to 100% due to rounding.

In general, respondents perceive that adopting VRT will lead to increases in profitability, crop yields, and soil health and productivity. 33% of respondents believe VRT will reduce input costs. 60% of respondents think that VRT will increase environmental quality. Similar to the previously discussed practices, there is a perception that implementing VRT will increase the time spent in the field and time spent on farm management decisions.

Figure 17 reports the extent to which respondents believe economic and agronomic factors are important in farmers' decision to adopt VRT.

Figure 17. Level of importance of economic and agronomic factors in the decision to adopt VRT



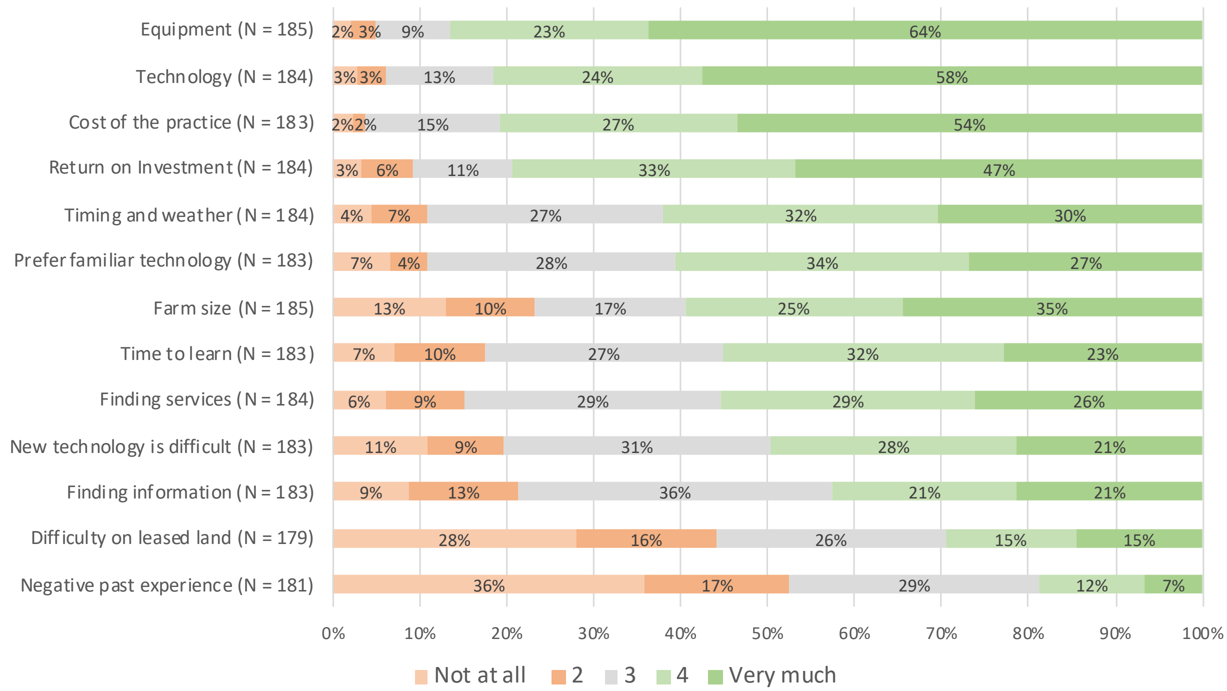
Note: Bars do not always add to 100% due to rounding.

Profitability, input costs, and crop yields are perceived as most important in the decision to adopt VRT. Interestingly, fewer respondents view soil health and productivity as a very important factor in the decision to adopt VRT compared to the other practices evaluated. Time spent in the field and time spent on farm management decisions is "moderately important."

Perceived Barriers to Adopting VRT

Potential barriers that limit farmers' use of VRT are presented in figure 18.

Figure 18. Extent to which potential barriers limit farmers' use of VRT



Note: Bars do not always add to 100% due to rounding.

Having the right equipment (87%) and technology (82%) to implement the practice are seen as barriers to VRT among respondents. The cost of the practice (81%) and getting a return on investment from VRT (80%) are also seen as factors that limit farmers' use of VRT. 62% of respondents find difficulty implementing VRT because of timing and weather to be a potential barrier. 61% of respondents believe that farmers prefer to use practices they are more familiar with rather than adopt VRT and 60% think that farmers' belief that VRT is better suited for larger operations limits use of the practice. 55% of respondents cite having time to learn about the practice as a barrier to adoption. Finding services related to VRT (e.g. crop advisor, custom applicator, soil testing) is seen as a barrier to adoption by 55% of respondents, while only 42% say farmers are limited by the ability to find information about the VRT. 49% of respondents say farmers limit the use of VRT because they believe new technologies are difficult to use. 30% of respondents believe difficulty implementing VRT on leased land limits farmers' use of the practice, while only 19% believe that negative past experience with VRT is a barrier.

Comparison of Preferences by Practice

Perceived changes in agronomic and economic factors vary slightly by practice. While only 68% of respondents believe that in-season N modeling tools will increase crop yields, 87% of respondents say split N application will increase crop yields. This may reflect the differences in experience and familiarities with the practices. 33% of respondents believe VRT will reduce input costs; this is similar to the 32% of respondents that believe in-season N modeling tools will reduce input costs compared to only 18% of respondents that think split N application will lower costs. For all practices, there is a perception that implementing the practice will increase the time spent in the field and time spent on farm management decisions.

A higher percentage of respondents cited input costs and crop yields as important factors in the decisions to adopt split N application or VRT compared to in-season N modeling tools. On-farm soil health and productivity is slightly less important to respondents considering split N application than in the decision to implement in-season N modeling tools, and even less important for VRT. Although there is a perception that time allocation will increase, respondents have similar views on time constraints in the decision to adopt/not adopt all practices: time spent in the field and on farm management decisions is “moderately important.”

For all practices, having the right equipment or technology and economic factors such as cost of the practice or return on investment are perceived to limit farmers’ use of the practice. However, more farmers agree that these factors are barriers to in-season N modeling and VRT compared to split N application. Instead, many farmers agree that difficulty implementing the practice due to timing and weather limits farmers’ adoption of split N application. A higher percent of respondents finds the use of VRT is limited by farmers’ perceptions about preferred use of practices and farm size compared to other practices.

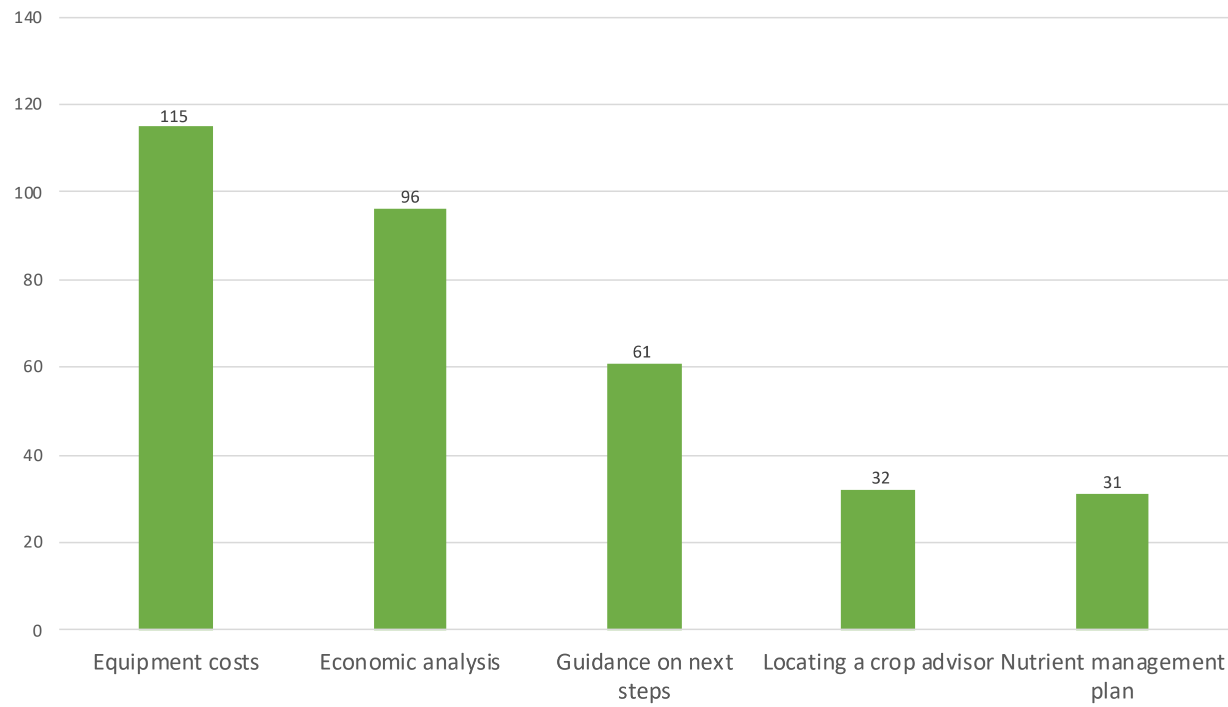
Farmer Preferences for Information and Communication about Nutrient Management Practices

In addition to understanding barriers to adoption for nutrient management practices, a secondary objective of the survey was to identify farmer preferences for information and communication about 4R practices. The survey asked farmers about preferred types of assistance, sources of information, and communication methods.

Assistance

A number of programs could be designed to overcome barriers and incentivize 4R adoption. The survey elicited farmer perspectives on the type of program that would be most beneficial to encourage adoption. Specifically, the survey asked, “What type of assistance would help you make the decision to implement *additional* nutrient management practices (beyond those you currently use)?” Participants could select multiple responses. Figure 19 highlights the responses.

Figure 19. Type of assistance needed to implement additional nutrient management practices



Note: Participants could select multiple responses. N = 156

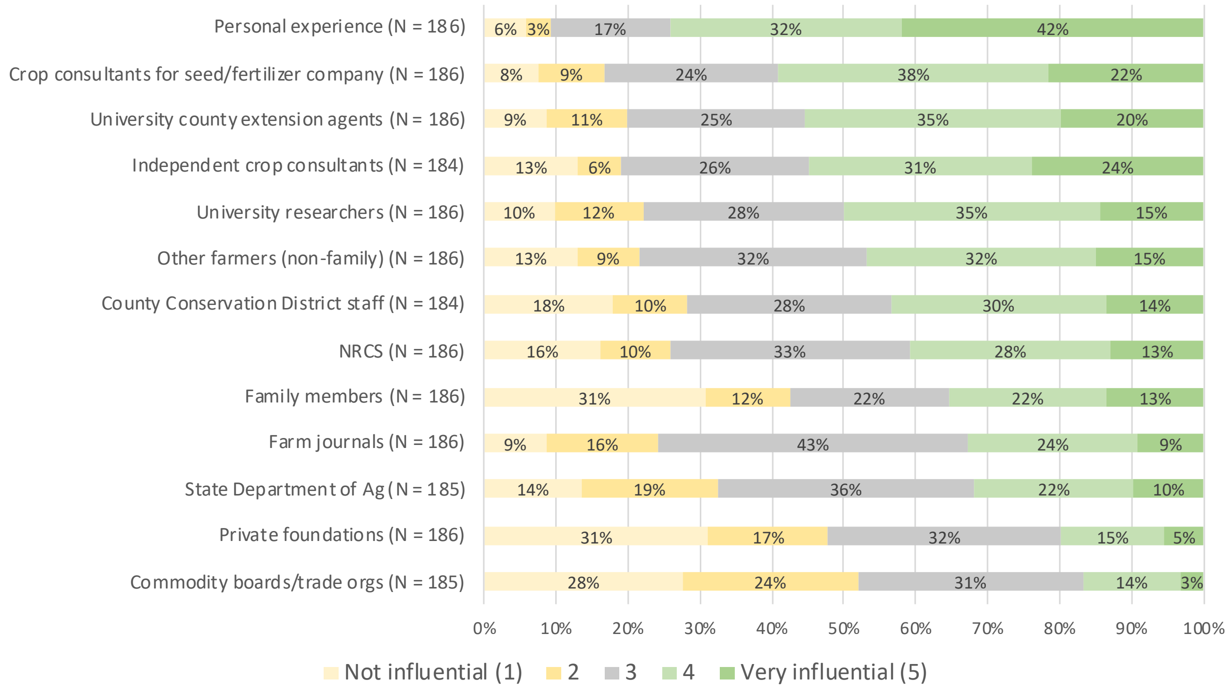
The results indicate that economic assistance is important to farmers. On one hand, farmers seek direct economic assistance with equipment costs, but there is also a desire to better understand the economic implications of adopting a practice (e.g. calculating return on investment). Guidance on how to take the next step in implementing a practice and assistance locating a crop advisor or constructing a written nutrient management plan were less frequently cited as types of assistance that would propel a farmer to implement additional nutrient management practices beyond those currently being used.

Information and Communication

Sources of Information

Understanding how farmers value different sources of information can facilitate stakeholders' communication efforts about 4R practices. The survey asked respondents to rate how influential different sources of information were in their decision to implement nutrient management practices. The response options were constructed based on qualitative interviews with farmers and discussions with project partners. Figure 20 reports the results.

Figure 20. Influence of different information sources on nutrient management decisions

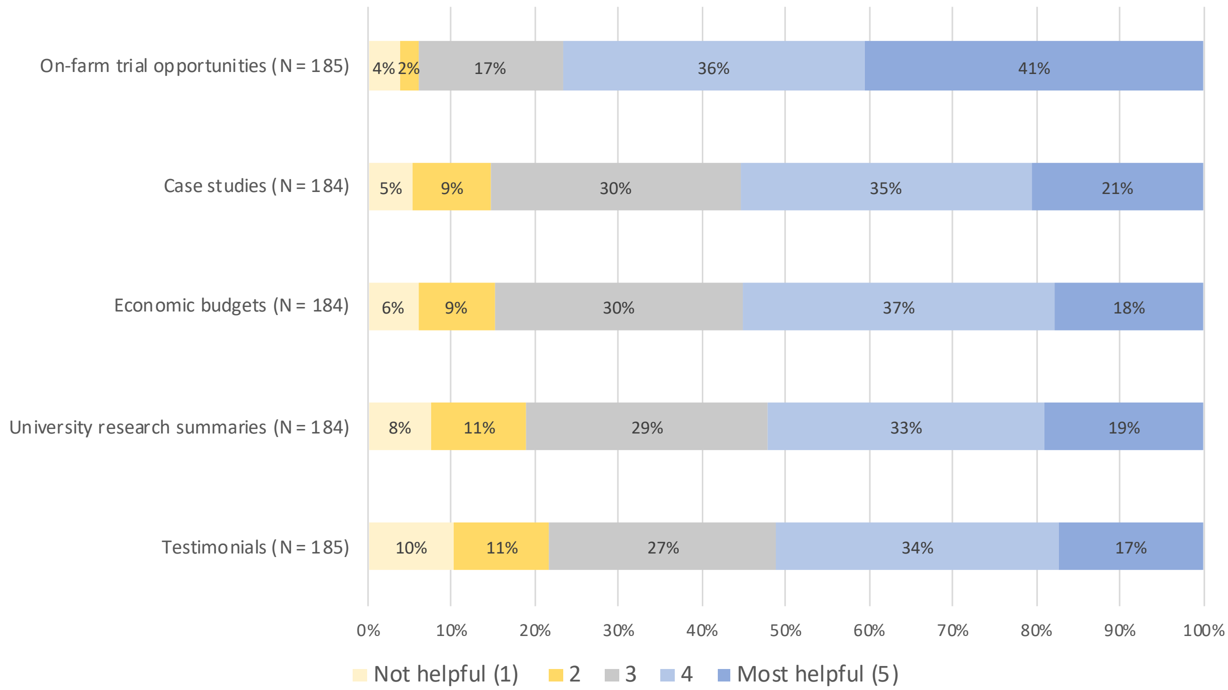


Participants report personal experience with using a practice as most influential in their decision to implement nutrient management practices. Crop consultants – both independent consultants and those associated with a seed or fertilizer company – are important external sources of information, and respondents also find university researchers and county extension agents to influence their decisions. Private foundations and commodity boards or trade organizations are less influential in farmers' decision to implement nutrient management practices.

Type of Information

In addition to understanding the influence of different sources of information, the survey sought to identify the type of information that was most helpful for farmers. Respondents were asked to rate common modes of information dissemination from least to most helpful. Figure 21 presents the results.

Figure 21. Helpfulness of different types of information about nutrient management practices

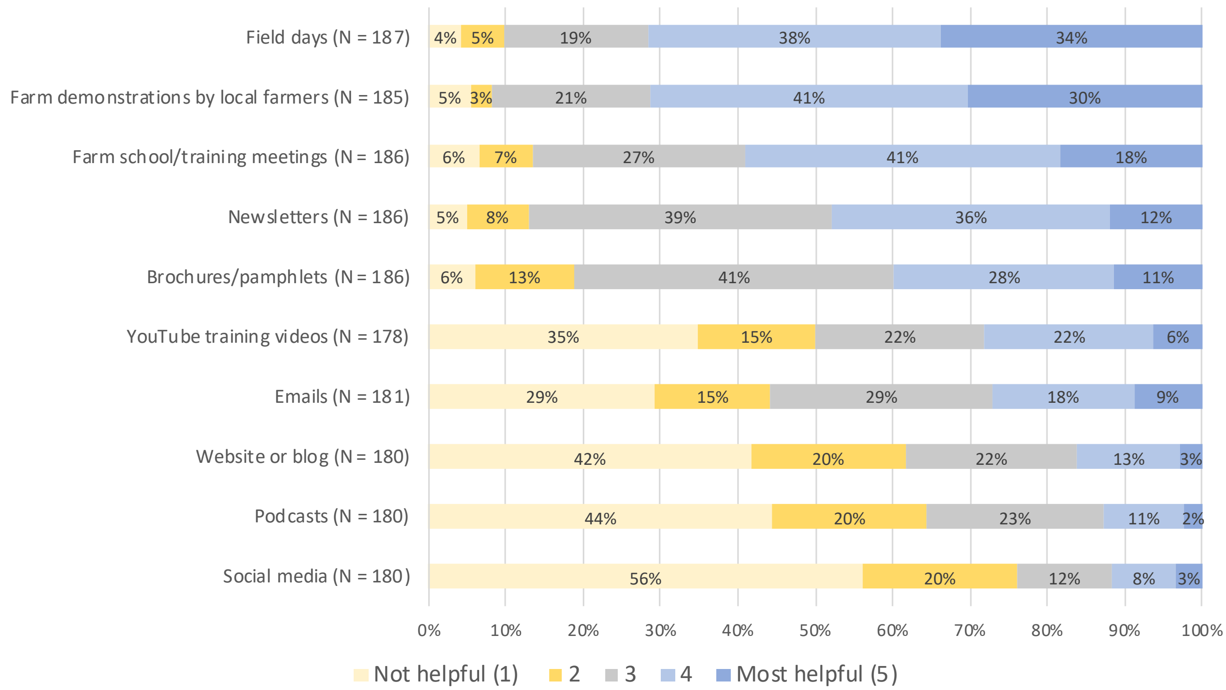


These results show a strong preference among farmers that on-farm trial opportunities are most helpful. Other types of information are relatively equal in helpfulness.

Method of Communication

In addition to sources and types of information, it is important to understand the modes by which farmers prefer to receive communication. The survey asked respondents to rate the helpfulness of common types of communication methods, including different methods of print, in-person, and online communication. Figure 22 presents the results.

Figure 22. Helpfulness of different methods of communication about nutrient management practices



Overall, respondents express a preference for in-person events such as farm demonstrations, field days, and farm school or training meetings. Printed materials in the form of newsletters or brochures are also helpful. Electronic communication via emails, podcasts, social media, websites or YouTube are cited as the least helpful methods of communication.

Analysis of Differences in Results by Farm Type and Farmer Characteristics

Regression analyses were used to determine the extent to which perceived barriers, important factors, and information preferences vary by farm type and farmer characteristics. The purpose of this report is to conduct exploratory analysis on the heterogeneity (differences) in outcomes. Thus, Ordinary Least Squares (OLS) regression analysis is suitable to examine the associations between select farm/farmer characteristics and outcomes. Regression coefficients, standard errors, and statistical significance can be found in tables B-1 through B-24 in Appendix B. The statistically significant findings ($p<0.05$) are detailed in the following sections of this report. Each set of analyses concludes with a summary of key findings from the regressions.

Table 4 defines the farm and farmer characteristics used as independent variables in the analysis. The variable names match the variable names in the regression results tables.

Table 4. Description of independent variables used in regression analyses to measure differences in outcomes by farm type and farmer characteristics

Variable	Description of variable
under60	Binary variable equal to 1 if age is less than 60 years old
prlandlease	Proportion of land leased divided by total land where total land is the sum of land leased and land owned
smallfarm	Binary variable equal to 1 if total land is less than 200 acres where total land is the sum of land leased and land owned
medfarm	Binary variable equal to 1 if total land is between 200 – 999 acres where total land is the sum of land leased and land owned
largefarm	Binary variable equal to 1 if total land is greater than or equal to 1000 acres where total land is the sum of land leased and land owned
lessthan25	Binary variable equal to 1 if the proportion of gross income earned through farming is less than 25%
inc25to50	Binary variable equal to 1 if the proportion of gross income earned through farming is 26%-50%
inc51to75	Binary variable equal to 1 if the proportion of gross income earned through farming is 51%-75%
inc76to100	Binary variable equal to 1 if the proportion of gross income earned through farming is 76%-100%
expuser	Binary variable equal to 1 if the respondent has adopted 5 or more of the 8 nutrient management practices on at least some of their acres
usemanure	Binary variable equal to 1 if the respondent uses manure for fertilizer
customapp	Binary variable equal to 1 if the respondent only hires a custom applicator or both owns equipment and hires a custom applicator
conventional	Binary variable equal to 1 if conventional tillage best describes the respondent's tillage system
conservation	Binary variable equal to 1 if conservation tillage best describes the respondent's tillage system
notill	Binary variable equal to 1 if no-till best describes the respondent's tillage system
delaware	Binary variable equal to 1 if most of the respondent's cropland is located in Delaware
pennsylvania	Binary variable equal to 1 if most of the respondent's cropland is located in Pennsylvania
maryland	Binary variable equal to 1 if most of the respondent's cropland is located in Maryland
virginia	Binary variable equal to 1 if most of the respondent's cropland is located in Virginia
lessthanhs	Binary variable equal to 1 if the respondent's highest level of education is less than high school
hs	Binary variable equal to 1 if the respondent's highest level of education is high school
somecollege	Binary variable equal to 1 if the respondent's highest level of education is some college

Table 4. Continued.

Variable	Description of variable
assoctech	Binary variable equal to 1 if the respondent's highest level of education is an associate's degree and/or technical training
bs	Binary variable equal to 1 if the respondent's highest level of education is a bachelor's degree
gradprof	Binary variable equal to 1 if the respondent's highest level of education is a graduate or professional degree

Table 5 presents descriptive statistics (sample size (N), mean, and standard deviation) for each of the independent variables used in the regression analyses.

Table 5. Descriptive statistics of independent variables

	N	Mean	Std.Dev.
under60	184	0.34	0.48
prlandlease	201	0.40	0.35
smallfarm	201	0.43	0.50
medfarm	201	0.37	0.48
largefarm	201	0.20	0.40
lessthan25	192	0.26	0.44
inc25to50	192	0.16	0.37
inc51to75	192	0.16	0.36
inc76to100	192	0.42	0.50
expuser	180	0.39	0.49
usemanure	203	0.67	0.47
conventional	202	0.14	0.35
conservation	202	0.34	0.47
notill	202	0.52	0.50
customapp	202	0.65	0.48
delaware	204	0.41	0.49
pennsylvania	204	0.20	0.40
maryland	204	0.27	0.45
virginia	204	0.12	0.32
lessthanhs	193	0.08	0.28
hs	193	0.39	0.49
somecollege	193	0.15	0.36
assoctech	193	0.10	0.31
bs	193	0.19	0.39
gradprof	193	0.08	0.28

Regression Results: Differences in Important Factors in the Decision to Adopt a Practice

Regression results for important factors in the decision to adopt in-season N modeling, split N application, and VRT can be found in tables B-1 through B-8 in Appendix B. The dependent variables in this series of regressions are ratings from a scale of 1 (not important) to 3 (very important) indicating how important each factor is in the respondent's decision to implement/not implement the practice. Table 6 presents the descriptive statistics for important factors as the dependent variables. Statistically significant ($p>0.05$) findings from each regression follow the table.

Table 6. Descriptive statistics of important factors in the decision to implement/not implement a practice

		In-season N modeling		Split N		VRT
	N	Mean (Std. Dev.)	N	Mean (Std. Dev.)	N	Mean (Std. Dev.)
Crop yields	182	2.45 (0.71)	184	2.77 (0.47)	180	2.60 (0.59)
Input costs	183	2.51 (0.64)	183	2.66 (0.52)	181	2.62 (0.58)
Profitability	182	2.65 (0.58)	184	2.76 (0.49)	181	2.64 (0.57)
Time in field	182	2.12 (0.73)	183	2.22 (0.66)	181	2.21 (0.68)
Time on mgt	180	2.10 (0.68)	184	2.15 (0.63)	181	2.13 (0.66)
Soil health/prod	180	2.51 (0.67)	185	2.49 (0.58)	181	2.40 (0.65)
Env. quality	181	2.33 (0.72)	184	2.34 (0.67)	181	2.33 (0.66)
Govt. regulation	181	2.19 (0.75)	184	2.20 (0.70)	180	2.22 (0.74)

Crop Yields

In-season N modeling

- Farmers who earn less than 25 percent of their gross income from farming say crop yields are less important in the decision to adopt in-season N modeling tools compared to farmers where the majority of income (76-100%) comes from farming.
- Experienced users of 4R practices say crop yields are more important in the decision to adopt in-season N modeling tools compared to farmers who are less experienced with 4R.

Split N application

- No evidence of heterogeneous impacts on the importance of crop yields in the decision to adopt split N application.

VRT

- No evidence of heterogeneous impacts on the importance of crop yields in the decision to adopt VRT.

Input Costs

In-season N modeling

- Farmers under the age of 60 view input costs as more important in the decision to adopt in-season N modeling compared to farmers 60 and over.

Split N application

- Farmers under the age of 60 view input costs as more important in the decision to adopt split N application compared to farmers 60 and over.

VRT

- No evidence of heterogeneous impacts on the importance of input costs in the decision to adopt VRT.

Profitability

In-season N modeling

- Farmers under the age of 60 view profitability as more important in the decision to adopt in-season N modeling compared to farmers 60 and over.
- Farmers who use manure view profitability as more important in the decision to adopt in-season N modeling compared to farmers who do not use manure.

Split N application

- Farmers under the age of 60 view profitability as more important in the decision to adopt split N application compared to farmers 60 and over.
- Farmers who practice no-till view profitability as more important in the decision to adopt split N application compared to farmers who practice conventional tillage.

VRT

- No evidence of heterogeneous impacts on the importance of profitability in the decision to adopt VRT.

Time Spent in the Field

In-season N modeling

- Pennsylvania farmers view time spent in the field as less important in the decision to adopt in-season N modeling compared to Delaware farmers.
- Farmers who have completed a bachelor’s degree view time spent in the field as more important in the decision to adopt in-season N modeling compared to farmers who have a high school diploma.

Split N application

- Farmers who earn 51 to 75 percent of their gross income from farming view time spent in the field as less important in the decision to adopt split N application compared to farmers who earn 76 to 100 percent of their gross income from farming.

VRT

- No evidence of heterogeneous impacts on the importance of time spent in the field in the decision to adopt VRT.

Time Spent on Farm Management

In-season N modeling

- Pennsylvania farmers view time spent on farm management as less important in the decision to adopt in-season N modeling compared to Delaware farmers.

- Farmers who have completed a bachelor’s degree view time spent on farm management as more important in the decision to adopt in-season N modeling compared to farmers who have a high school diploma.

Split N application

- Farmers who earn less than 25 percent of their gross income from farming view time spent on farm management decisions as less important in the decision to adopt split N application compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who earn 51 to 75 percent of their gross income from farming view time spent on farm management decisions as less important in the decision to adopt split N application compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Maryland farmers view time spent on farm management as more important in the decision to adopt split N application compared to Delaware farmers.

VRT

- Farmers who earn 51 to 75 percent of their gross income from farming view time spent on farm management decisions as less important in the decision to adopt VRT compared to farmers who earn 76 to 100 percent of their gross income from farming.

Soil Health and Productivity

In-season N modeling

- Farmers who earn less than 25 percent of their gross income from farming view soil health and productivity as less important in the decision to adopt in-season N modeling compared to farmers who earn 76 to 100 percent of their gross income from farming.

Split N application

- Farmers who have a graduate or professional degree view soil health and productivity as less important in the decision to adopt split N application compared to farmers who have a high school diploma.

VRT

- Experienced users of 4R practices view soil health and productivity as more important in the decision to adopt VRT compared to less experienced users of 4R practices.
- Virginia farmers view soil health and productivity as more important in the decision to adopt VRT compared to Delaware farmers.

Environmental Quality in My Community

In-season N modeling

- Farmers who lease the majority of their land view environmental quality in their community as more important in the decision to adopt in-season N modeling compared to those who own the majority of their land.
- Farmers who earn less than 25 percent of their gross income from farming view environmental quality in their community as less important in the decision to adopt in-season N modeling compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who earn 25 to 50 percent of their gross income from farming view environmental quality in their community as less important in the decision to adopt in-

season N modeling compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who earn 51 to 75 percent of their gross income from farming view environmental quality in their community as less important in the decision to adopt in-season N modeling compared to farmers who earn 76 to 100 percent of their gross income from farming.

Split N application
- Farmers who lease the majority of their land view environmental quality in their community as more important in the decision to adopt split N application compared to those who own the majority of their land.
- Farmers who earn 51 to 75 percent of their gross income from farming view environmental quality in their community as less important in the decision to adopt split N application compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who have completed less than high school view environmental quality in their community as less important in the decision to adopt split N application compared to those with a high school diploma.

VRT
- Farmers under the age of 60 view environmental quality in their community as less important in the decision to adopt VRT compared to farmers 60 and over.
- Farmers who earn less than 25 percent of their gross income from farming view environmental quality in their community as less important in the decision to adopt VRT compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who earn 25 to 50 percent of their gross income from farming view environmental quality in their community as less important in the decision to adopt VRT compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who earn 51 to 75 percent of their gross income from farming view environmental quality in their community as less important in the decision to adopt VRT compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who have completed less than high school view environmental quality in their community as less important in the decision to adopt VRT compared to those with a high school diploma.
- Farmers who have a graduate or professional degree view environmental quality in their community as less important in the decision to adopt VRT compared to farmers who have a high school diploma.

Compliance with Government Regulation

In-season N modeling
- Farmers who earn less than 25 percent of their gross income from farming view compliance with government regulation as less important in the decision to adopt in-season N modeling compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who earn 25 to 50 percent of their gross income from farming view compliance with government regulation as less important in the decision to adopt in-season N

modeling compared to farmers who earn 76 to 100 percent of their gross income from farming.

- Farmers who earn 51 to 75 percent of their gross income from farming view compliance with government regulation as less important in the decision to adopt in-season N modeling compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Maryland farmers view compliance with government regulation as less important in the decision to adopt in-season N modeling compared to Delaware farmers.
- Farmers who have a graduate or professional degree view compliance with government regulation as less important in the decision to adopt in-season N modeling compared to farmers who have a high school diploma.

Split N application

- Farmers who have completed less than high school view compliance with government regulation as less important in the decision to adopt split N application compared to those with a high school diploma.
- Farmers who have a graduate or professional degree view compliance with government regulation as less important in the decision to adopt split N application compared to farmers who have a high school diploma.

VRT

- Farmers under the age of 60 view compliance with government regulation as less important in the decision to adopt VRT compared to farmers 60 years and older.
- Farmers who earn 25 to 50 percent of their gross income from farming view compliance with government regulation as less important in the decision to adopt VRT compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who have completed less than high school view compliance with government regulation as less important in the decision to adopt VRT compared to those with a high school diploma.
- Farmers who have a graduate or professional degree view compliance with government regulation as less important in the decision to adopt VRT compared to farmers who have a high school diploma.

Summary of Key Findings: Differences in Important Factors in the Decision to Adopt a Practice

In summary, the importance of various factors in the decision to adopt a practice are affected by farmer education, farmer age, and the proportion of gross income that comes from farming.

Education

Farmers with lower education (less than high school) and higher education (graduate or professional degree) view soil health and productivity, environmental quality, and compliance with government regulation as less important factors in the decision to adopt 4R practices compared to farmers with a high school diploma.

Age of farmer
Farmers under the age of 60 place more importance on economic factors such as input costs and profitability compared to farmers 60 and over.

Proportion of income from farming
Farmers who depend less on gross income from farming place less importance on time spent on farm management decisions, environmental quality, and compliance with government regulation compared to farmers who earn 76 to 100 percent of income from farming.

Regression Results: Differences in Perceived Barriers by Farm Type and Farmer Characteristics

Regression results for perceived barriers to in-season N modeling, split N application, and VRT can be found in tables B-9 through B-21 in Appendix B. The dependent variables for this series of regressions are ratings on a scale from 1 (not at all) to 5 (very much) where respondents indicate how much they think each potential barrier limits farmers' use of the practice. Table 7 presents descriptive statistics on perceived barriers used as dependent variables. Statistically significant ($p>0.05$) findings from each regression follow the table.

Table 7. Descriptive statistics of perceived barriers that limit farmers' use of the practice

	In-season N modeling		Split N		VRT	
	N	Mean (Std. Dev.)	N	Mean (Std. Dev.)	N	Mean (Std. Dev.)
Finding information about the practice	189	3.28 (1.13)	190	2.82 (1.24)	183	3.34 (1.20)
Having enough time to learn about the practice	190	3.50 (1.12)	190	3.05 (1.27)	183	3.54 (1.16)
Getting a return on investment from the practice	191	4.07 (0.95)	189	3.69 (1.28)	184	4.14 (1.05)
Cost of the practice	190	4.28 (0.93)	189	3.90 (1.11)	183	4.28 (0.94)
Difficulty with timing and weather	191	3.97 (1.02)	189	4.01 (0.92)	184	3.77 (1.09)
Having the right equipment	191	4.32 (0.95)	191	4.13 (1.00)	185	4.43 (0.92)
Having the right technology	190	4.25 (1.00)	191	3.84 (1.18)	184	4.30 (0.99)
Finding services related to the practice	190	3.62 (1.15)	191	3.24 (1.24)	184	3.60 (1.15)
Believing the practice is better suited for larger farms	191	3.67 (1.31)	190	3.13 (1.43)	185	3.58 (1.39)
Difficulty implementing on leased land	186	3.06 (1.41)	188	2.61 (1.34)	179	2.72 (1.39)
Having a negative previous experience	184	2.59 (1.29)	189	2.55 (1.29)	181	2.37 (1.27)
Preferring to use practices they are more familiar with	190	3.69 (1.13)	190	3.42 (1.20)	183	3.70 (1.11)
Believing new technologies are too difficult to use	190	3.26 (1.25)	191	3.02 (1.26)	183	3.40 (1.23)

Finding Information about the Practice

In-season N modeling

- Farmers who earn less than 25 percent of their gross income from farming say finding information is less of a barrier to in-season N modeling tools compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who have completed less than high school say finding information is less of a barrier for N modeling compared to those with a high school diploma.

Split N application

- Farmers under the age of 60 view finding information as less of a barrier to split N application compared to farmers 60 and over.
- Virginia farmers say finding information is more of a barrier to split N compared to Delaware farmers.
- Farmers who have completed an associate's degree or technical training say finding information is less of a barrier to split N application compared to farmers with a high school diploma.

VRT

- Small farmers perceive finding information to be more of a barrier to VRT compared to medium farmers.
- Farmers who have completed less than high school say finding information is less of a barrier for VRT compared to those with a high school diploma.

Having Enough Time to Learn about the Practice

In-season N modeling

- Farmers with a bachelor's degree say having enough time to learn about the practice is more of a barrier to N modeling compared to those with a high school diploma.

Split N application

- Farmers under the age of 60 view having enough time to learn about the practice as less of a barrier to split N application compared to farmers 60 and over.

VRT

- No evidence of heterogeneous impacts on having enough time to learn about the practice.

Getting a Return on Investment from the Practice

In-season N modeling

- Farmers who earn less than 25 percent of their gross income from farming say getting a ROI is less of a barrier to in-season N modeling tools compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who hire a custom applicator say getting a ROI is less of a barrier to in-season N modeling compared to those who use their own equipment.

Split N application

- Farmers who have completed less than high school say getting a ROI is less of a barrier for split N application compared to those with a high school diploma.
- Farmers who have completed an associate's degree or technical training say getting a ROI is less of a barrier to split N application compared to farmers with a high school diploma.

VRT

- No evidence of heterogeneous impacts on getting a ROI as a barrier to adoption.

Cost of the Practice

In-season N modeling

- No evidence of heterogeneous impacts on cost of the practice as a barrier to adoption.

Split N application

- Farmers who have completed an associate's degree or technical training say the cost of the practice is less of a barrier to split N application compared to farmers with a high school diploma.

VRT

- No evidence of heterogeneous impacts on cost of the practice as a barrier to adoption.

Difficulty Implementing the Practice Because of Timing and Weather

In-season N modeling

- Farmers who earn less than 25 percent of their gross income from farming say difficulty with timing and weather is less of a barrier to in-season N modeling tools compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who have completed less than high school say difficulty with timing and weather is less of a barrier for N modeling compared to those with a high school diploma.

Split N application

- Farmers who have completed some college view difficulty with timing and weather as more of a barrier to split N application compared to those who have a high school diploma.

VRT

- No evidence of heterogeneous impacts on difficulty with timing and weather as a barrier to adoption.

Having the Right Equipment

In-season N modeling

- Farmers who practice conservation tillage view having the right equipment as less of a barrier to in-season N modeling compared to those who use conventional tillage.
- Pennsylvania farmers view having the right equipment as less of a barrier to in-season N modeling compared to Delaware farmers.
- Farmers who have completed an associate's degree or technical training say having the right equipment is less of a barrier to in-season N modeling compared to farmers with a high school diploma.

Split N application

- Farmers who have completed some college view having the right equipment as more of a barrier to split N application compared to those who have a high school diploma.
- Farmers who have completed an associate's degree or technical training say having the right equipment is less of a barrier to split N application compared to farmers with a high school diploma.

VRT

- Farmers with a bachelor's degree say having the right equipment is more of a barrier to VRT compared to those with a high school diploma.

Having the Right Technology

In-season N modeling

- Small farmers view having the right technology as more of a barrier to in-season N modeling compared to medium farmers.
- Farmers who have completed an associate's degree or technical training say having the right technology is less of a barrier to N modeling compared to farmers with a high school diploma.
- Farmers with a bachelor's degree say having the right technology is more of a barrier to in-season N modeling compared to those with a high school diploma.

Split N application

- Farmers who have completed some college view having the right technology as more of a barrier to split N application compared to those who have a high school diploma.
- Farmers who have completed an associate's degree or technical training say having the right technology is less of a barrier to split N application compared to farmers with a high school diploma.

VRT

- Farmers with a bachelor's degree say having the right technology is more of a barrier to VRT compared to those with a high school diploma.

Finding Services Related to the Practice

In-season N modeling

- Farmers who use manure as fertilizer view finding services related to the practice as more of a barrier to in-season N modeling compared to those who do not use manure.
- Farmers with a bachelor's degree say finding services related to the practice is more of a barrier to in-season N modeling compared to those with a high school diploma.

Split N application

- Farmers who lease the majority of their land say finding service related to the practice is less of a barrier to split N application compared to those who own the majority of their land.
- Farmers who practice conservation tillage say finding services related to the practice is less of a barrier to split N application compared to those who practice conventional tillage.
- Maryland farmers view finding services related to the practice to be more of a barrier to split N application compared to Delaware farmers.
- Farmers who have completed some college view finding services related to the practice as more of a barrier to split N application compared to those who have a high school diploma.
- Farmers who have completed an associate's degree or technical training say finding services related to the practice is less of a barrier to split N application compared to farmers with a high school diploma.

VRT

- No evidence of heterogeneous impacts on finding services related to the practice as a barrier to VRT adoption.

Believing the Practice is Better Suited for Larger Operations

In-season N modeling

- Experienced users of 4R practices say believing the practice is better suited for larger operations is less of a barrier to in-season N modeling compared to farmers who are less experienced with 4R.

Split N application

- Small farmers say believing the practice is better suited for larger operations is more of a barrier to split N application compared to medium farmers.
- Experienced users of 4R practices say believing the practice is better suited for larger operations is less of a barrier to split N application compared to farmers who are less experienced with 4R.

VRT

- Small farmers say believing the practice is better suited for larger operations is more of a barrier to VRT compared to medium farmers.
- Experienced users of 4R practices say believing the practice is better suited for larger operations is less of a barrier to VRT compared to farmers who are less experienced with 4R.
- Virginia farmers say believing the practice is better suited for larger operations is less of a barrier to VRT compared to Delaware farmers.

Difficulty Implementing the Practice on Leased Land

In-season N modeling

- Farmers who lease the majority of their land say difficulty implementing the practice on leased land is more of a barrier to in-season N modeling compared to those who own the majority of their land.

Split N application

- No evidence of heterogeneous impacts on difficulty implementing the practice on leased land as a barrier to split N application adoption.

VRT

- Experienced users of 4R practices say difficulty implementing the practice on leased land is less of a barrier to VRT compared to farmers who are less experienced with 4R.

Having a Previous Negative Experience with the Practice

In-season N modeling

- No evidence of heterogeneous impacts on having a negative previous experience with the practice.

Split N application

- No evidence of heterogeneous impacts on having a negative previous experience with the practice.

VRT

- No evidence of heterogeneous impacts on having a negative previous experience with the practice.

Preferring to Use Practices They Are More Familiar With

In-season N modeling

- No evidence of heterogeneous impacts on preferring to use practices they are more familiar with.

Split N application

- Experienced users of 4R practices say preferring to use practices they are more familiar with is less of a barrier to split N application compared to farmers who are less experienced with 4R.

VRT

- No evidence of heterogeneous impacts on preferring to use practices they are more familiar with.

Believing New Technologies Are Too Difficult To Use

In-season N modeling

- Farmers who have completed an associate's degree or technical training say believing new technologies are difficult to use is less of a barrier to N modeling compared to farmers with a high school diploma.

Split N application

- Experienced users of 4R practices say believing new technologies are difficult to use is less of a barrier to split N application compared to farmers who are less experienced with 4R.

VRT

- No evidence of heterogeneous impacts on believing new technologies are difficult to use.

Summary of Findings: Differences in Perceived Barriers

In summary, the results show perceived barriers differ by farmer education level, proportion of gross income earned from farming and farm size, experienced use of 4R practices, and tillage system used.

Education

Farmers who have completed less than high school perceive fewer barriers for all three practices compared to those who have a high school diploma. Those who have completed an associate's degree or technical training perceive fewer barriers for in-season N modeling and split N application compared to those who have a high school diploma. On the other hand, farmers with higher education perceive more barriers for all three practices compared to those who have a high school diploma. Specifically, farmers who have completed some college agree that barriers such as having the right equipment, technology, or finding services limit farmers' use of split N application, while farmers who have completed a bachelor's degree agree that equipment and technology are barriers to VRT and time to learn about the practice is a barrier to in-season N modeling.

Proportion of income from farming and farm size
Part-time farmers who earn less than 25% of their income from farming perceive fewer barriers to in-season N modeling compared to farmers where the majority of their gross income comes from farming. Specifically, farmers who earn less gross income from farming disagree that finding information about the practice and getting a ROI from the practice are barriers to in-season N modeling. Small farmers perceive more barriers compared to medium farmers, particularly for split N application and VRT. Of note is that small farmers agree that believing the practice is better suited for larger operations is a barrier to split N application and VRT.

Experienced users of 4R practices
Experienced users of 4R practices disagree that believing the practice is better suited for larger farms is a barrier to the three practices. They also disagree that the implementation of split N application is limited by a preference by farmers to use practices they are more familiar with or a belief that new technologies are too difficult to use.

Tillage system
Farmers who practice conservation tillage perceive fewer barriers to practices compared to those who practice conventional tillage. Specifically, these farmers disagree that finding services related to split N application or having the right equipment for in-season N modeling limit farmers' use of the practices.

Regression Results: Differences in Preferred Sources of Information about 4R Practices

Regression results for preferred sources of information can be found in table B22 in Appendix B. The dependent variables for this series of regressions are ratings on a scale from 1 (not influential) to 5 (very influential) where respondents indicate how important information from each source was in the decision to implement/not implement nutrient management practices. Note: this question pertains to information about all nutrient management practices, not the select three that were previously examined. Table 8 presents descriptive statistics on preferred information sources. Statistically significant ($p>0.05$) findings follow the table.

Table 8. Descriptive statistics on the level of influence of different information sources

	N	Mean	Std.Dev.
Family	186	2.76	1.43
Other farmers	186	3.27	1.21
Personal experience	186	4.01	1.12
University researchers	186	3.33	1.16
University county extension agents	186	3.47	1.18
Private foundations	186	2.46	1.22
State Department of Agriculture	185	2.96	1.16
Natural Resources Conservation Service (NRCS)	186	3.12	1.24
County Conservation District staff	184	3.11	1.29
Crop consultants for a seed/fertilizer company	186	3.56	1.15
Independent crop consultants	184	3.47	1.28
Farm journals	186	3.09	1.05
Commodity boards and/or trade organizations	185	2.41	1.12

Family

- No evidence of heterogeneous impacts on the level of influence of family members.

Other Farmers

- Farmers with a graduate or professional degree find other farmers to be more influential compared to farmers with a high school diploma.

Personal Experience

- Farmers with a graduate or professional degree find personal experience to be more influential compared to farmers with a high school diploma.

University Researchers

- Farmers who earn less than 25 percent of their gross income from farming find university researchers to be less influential compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Maryland farmers find university researchers to be less influential compared to Delaware farmers.
- Farmers with some college find university researchers to be more influential compared to farmers with a high school diploma.
- Farmers with a graduate or professional degree find university researchers to be more influential compared to farmers with a high school diploma.

University County Extension Agents

- Farmers with a bachelor's degree find county extension to be more influential compared to farmers with a high school diploma.

Private Foundations

- Farmers who earn 25 to 50 percent of their gross income from farming find private foundations to be less influential compared to farmers who earn 76 to 100 percent of their gross income from farming.

Farm Journals

- Large farmers find farm journals to be less influential compared to medium farmers.
- Farmers who earn less than 25 percent of their gross income from farming find farm journals to be less influential compared to farmers who earn 76 to 100 percent of their gross income from farming.

State Department of Agriculture

- Farmers under the age of 60 find the State Department of Agriculture to be less influential compared to farmers 60 and over.

Natural Resources Conservation Service (NRCS)

- Farmers under the age of 60 find NRCS to be less influential compared to farmers 60 and over.
- Farmers who earn less than 25 percent of their gross income from farming find NRCS to be less influential compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who earn 25 to 50 percent of their gross income from farming find NRCS to be less influential compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who use manure find NRCS to be more influential compared to farmers who do not use manure.

- Farmers who have completed less than high school find NRCS to be less influential compared to farmers who have a high school diploma.

County Conservation District Staff

- Farmers under the age of 60 find County Conservation District staff to be less influential compared to farmers 60 and over.
- Farmers who earn less than 25 percent of their gross income from farming find County Conservation District staff to be less influential compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Farmers who earn 25 to 50 percent of their gross income from farming find County Conservation District staff to be less influential compared to farmers who earn 76 to 100 percent of their gross income from farming.
- Maryland farmers find County Conservation District staff to be less influential compared to Delaware farmers.
- Farmers who have completed less than high school find County Conservation District staff to be less influential compared to farmers who have a high school diploma.

Crop Consultants for a Seed or Fertilizer Company

- No evidence of heterogeneous impacts on the influence of the crop consultants for a seed or fertilizer company.

Independent Crop Consultants

- Small farmers find independent crop consultants to be less influential compared to medium farmers.
- Farmers who use manure find independent crop consultants to be more influential compared to farmers who do not use manure.
- Maryland farmers find independent crop consultants to be less influential compared to Delaware farmers.
- Farmers with a graduate or professional degree find independent crop consultants to be more influential compared to farmers with a high school diploma.

Commodity Boards and/or Trade Organizations

- Experienced users of 4R practices find commodity boards and/or trade organizations to be more influential compared to less experienced users of 4R practices.
- No-till farmers find commodity boards and/or trade organizations to be more influential compared to farmers who practice conventional tillage.
- Maryland farmers find commodity boards and/or trade organizations to be less influential compared to Delaware farmers.
- Farmers who have completed less than high school find commodity boards and/or trade organizations to be less influential compared to farmers who have a high school diploma.

Summary of Key Findings: Differences in Preferred Sources of Information about 4R Practices

In summary, the influence of different sources of information varies by farmer education, proportion of gross income that comes from farming, and whether the farmer uses manure as fertilizer.

Education
Farmers with more education rely on other farmers, personal experience, university research, county extension agents, and independent crop consultants compared to farmers with a high school diploma. Farmers who have completed less than high school find NRCS and County Conservation District staff to be less influential compared to farmers with a high school diploma.

Proportion of income from farming
The influence of information sources varies by farmers with different levels of income generated through farming. Farmers who rely less on income from farming place less emphasis on information from university researchers, private foundations, NRCS, County Conservation District staff, and farm journals relative to those who earn 76 to 100 percent of gross income from farming.

Use of manure
Farmers who use manure rely more on information from NRCS and independent crop consultants compared to farmers who do not use manure as fertilizer.

Regression Results: Differences in Preferred Types of Information

Regression results for types of information can be found in table B23 of Appendix B. The dependent variables in this series of regressions are ratings from 1 (not helpful) to 5 (most helpful) where respondents indicate what type of information would be most helpful for them to learn about nutrient management practices. Table 9 presents descriptive statistics on the helpfulness of different types of information used as dependent variables. Statistically significant ($p>0.05$) findings from each regression follow the table.

Table 9. Descriptive statistics on the helpfulness of different types of information

	N	Mean	Std.Dev.
Case studies	184	3.45	1.15
Economic budgets	184	3.36	1.20
On-farm trials	185	4.08	1.00
Testimonials	185	3.52	1.07
University research summaries	184	3.56	1.08

Case Studies
- Farmers with a bachelor's degree find case studies to be more helpful compared to farmers with a high school diploma.

Economic Budgets
- Virginia farmers find economic budgets to be more helpful compared to Delaware farmers.
- Farmers with a bachelor's degree find economic budgets to be more helpful compared to farmers with a high school diploma.

On-farm Trials
- Farmers with a graduate or professional degree find on-farm trials to be more helpful compared to farmers with a high school diploma.

Testimonials

- No evidence of heterogeneous impacts on the helpfulness of testimonials.

University Research Summaries

- Maryland farmers find university research summaries to be less helpful compared to Delaware farmers.
- Farmers who have completed less than high school find university research summaries to be less helpful compared to farmers who have a high school diploma.

Summary of Key Findings: Differences in Preferred Types of Information

In summary, the helpfulness of different types of information varies by farmer education level.

Education
Farmers with higher education find case studies, economic budgets, and on-farm trials to be more helpful relative to farmers with a high school diploma. Farmers who have completed less than high school find university research summaries to be less helpful compared to farmers with a high school diploma.

Regression Results: Differences in Preferred Methods of Communication

Regression results for methods of communication can be found in table B24 of Appendix B. The dependent variables in this series of regressions are ratings from 1 (not helpful) to 5 (most helpful) where respondents indicate what methods of communication they find most helpful for receiving information about nutrient management practices. Table 10 presents descriptive statistics on the helpfulness of different methods of communication used as dependent variables. Statistically significant ($p>0.05$) findings from each regression follow the table.

Table 10. Descriptive statistics on the helpfulness of different methods of communication

	N	Mean	Std.Dev.
Brochures/pamphlets	186	3.26	1.02
Emails	181	2.62	1.31
Farm demonstrations	185	3.88	1.05
Field days	187	3.91	1.06
Farm school/training meetings	186	3.58	1.07
Newsletters	186	3.42	0.97
Podcasts	180	2.06	1.14
Social media	180	1.83	1.14
Website or blog	180	2.16	1.19
YouTube training videos	178	2.49	1.33

Brochures

- Farmers with a graduate or professional degree find brochures to be more helpful compared to farmers with a high school diploma.

Emails

- No evidence of heterogeneous impacts on the helpfulness of emails.

Farm Demonstrations

- Farmers who use manure find farm demonstrations to be more helpful compared to farmers who do not use manure.

Field Days

- No evidence of heterogeneous impacts on the helpfulness of field days.

Farm School

- No evidence of heterogeneous impacts on the helpfulness of farm school.

Newsletters

- Farmers who earn less than 25 percent of their gross income from farming find newsletters to be less helpful compared to farmers who earn 76 to 100 percent of their gross income from farming.

Podcasts

- Farmers who use manure find podcasts to be more helpful compared to farmers who do not use manure.
- Virginia farmers find podcasts to be more helpful compared to Delaware farmers.
- Farmers who have completed less than high school find podcasts to be less helpful compared to farmers who have a high school diploma.

Social Media

- No evidence of heterogeneous impacts on the helpfulness of social media.

Website or Blog

- Farmers with a bachelor's degree find a website or blog to be more helpful compared to farmers with a high school diploma.

YouTube

- Large farmers find YouTube to be more helpful compared to medium farmers.
- Farmers who use manure find YouTube to be more helpful compared to farmers who do not use manure.
- Farmers who have completed less than high school find YouTube to be less helpful compared to farmers who have a high school diploma.
- Farmers who have completed an associate's degree or technical training find YouTube to be more helpful compared to farmers who have a high school diploma.

Summary of Key Findings: Differences in Preferred Methods of Communication

In summary, the helpfulness of different methods of communication varies by farmer education level, age of the farmer, and whether the farmer uses manure as fertilizer.

Education
Farmers with a graduate or professional degree find brochures to be helpful, farmers with a bachelor's degree find a website or blog to be helpful, and farmers with some college or an associate's degree or technical training find YouTube videos to be helpful. Farmers who have completed less than high school find podcasts and YouTube to be less helpful.

Use of manure
Farmers who use manure find farm demonstrations, podcasts, and YouTube to be more helpful compared to farmers who do not use manure.

Conclusions

Most of the farmers in our sample have a written nutrient management plan for their cropland. However, adoption rates of other 4R practices vary. Split N application and VRT adoption rates are relatively high, but most farmers have never used many other practices on their land, including in-season N modeling and injection/incorporation of commercial fertilizer. This study investigates potential adoption of 4R practices by asking farmers the likelihood that they will adopt or expand use of the practice in the next three years. Farmers are eligible to adopt or expand use if they are not currently using the practice on at least half of their acres. Among eligible farmers there is most interest in expanding the use or adopting the use of split N application and VRT. Approximately 40% of eligible farmers expressed interest in adopting in-season N modeling tools in the next three years.

If the goal is to increase adoption of underutilized 4R practices, it is important to understand farmers' perceptions of those practices and the factors that motivate them to adopt. The study examines the importance of agronomic and economic factors, time management, and environmental stewardship as well as perceived barriers for three practices: in-season N modeling tools, split N application, and VRT.

For all practices, profitability is an important factor in the adoption decision. Input costs and crop yields are also important in the decisions to adopt split N application or VRT, and soil health and productivity is important in the decision to adopt in-season N modeling. There are some differences in the level of importance farmers under the age of 60 place on economic factors in the decision to adopt in-season N modeling or split N application. However, the results show no differences by farm type or farmer characteristics in the importance of economic factors in the decision to adopt VRT.

Perceived barriers tend to be more specific to the type of practice. For all practices, farmers agree that having the right equipment limits farmers' use of the practice. Having the right technology, getting a return on investment, and the cost of the practice are perceived to limit the use of in-season N modeling and VRT. Difficulty implementing the practice due to timing and weather is a perceived barrier to split N application. Perceived barriers vary in particular by farmer education level with farmers who have completed some college or a bachelor's degree having higher levels of agreement that equipment and technology are barriers, whereas farmers who have an associate's degree or technical training disagree that these are barriers.

Most farmers rely on personal experience with a practice, crop consultants (for a seed/fertilizer company and independent), university researchers and university county extension agents as sources of information about nutrient management practices. The influence each source of information has varies by farmer education level, with higher educated farmers placing more emphasis on personal experience and university resources. On-farm trials are cited as the most helpful type of information and are especially helpful for farmers with a graduate or professional degree. In-person communication through farm demonstrations, field days, and farm school or trainings are cited as the most helpful mediums to learn about nutrient management practices.

The findings from this study can be used to inform outreach and communication for 4R practices. Understanding the factors that are important in farmers' decision-making process can guide stakeholders to construct farmer-centric, targeted information campaigns about the 4R practices. Furthermore, acknowledging the perceived barriers and limitations of practices allows stakeholder to evaluate how those perceived barriers can be addressed to promote further adoption of 4R practices. Results about preferred sources of information, types of information, and methods of communication can be used to meet farmers through their preferred channels of communication. Programs designed based on these findings will help to increase the adoption of 4R practices with the goal of reaching the EPA's 2025 water quality targets for the CBW.

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Appendix A: Survey Instrument

Survey of Farmer Nutrient Management Decisions in the Mid-Atlantic

Thank you for participating in our study! Please return the completed questionnaire by placing it in the enclosed postage-paid envelope. We appreciate your time.

University of Delaware

4R Mid-Atlantic

Who should complete this survey?

This questionnaire should be completed by the person who is the primary decision-maker for crop management and who is at least 18 years old. If you are not the primary decision-maker, please request that the primary decision-maker complete the survey.

1. Are you the primary decision-maker on your farm?

   ☐ Yes ☐ No

   If you selected "no," we do not need you to complete this survey, but your response is still important to us. <u>Please return the survey in the postage paid envelope.</u>

2. This survey is intended for growers of corn, soybeans, and/or small grains. How many acres of corn, soybeans, and/or small grains did you plant in 2021?

   _________ acres of corn _________ acres of soybeans _________ acres of small grains

   ☐ I do not grow corn, soybeans, or small grains.

   If you selected "I do not grow corn, soybeans or small grains," we do not need you to complete this survey, but your response is still important to us. <u>Please return the survey in the postage paid envelope.</u>

Thank you for completing this survey. First, we'd like to know a little more about your farm. If you have questions about the practices listed, please see the **glossary at the end of the survey**.

3. How many total acres of cropland do you own? __________ acres

4. How many total acres of cropland do you lease from others? __________ acres

5. Where is most of your cropland that you farm located?

   _____________________ County _______ State

6. How many years have you been the primary decision-maker on your farm? _______ years

7. Which of the following best describes your tillage system?

   ☐ Conventional tillage ☐ Conservation tillage ☐ No-till

8. Do you currently raise poultry or livestock?

   ☐ Yes ☐ No

9. Do you use manure for fertilizer?

   ☐ Yes ☐ No

10. Do you apply your own commercial fertilizer or hire a custom applicator?

    ☐ Apply own ☐ Hire custom applicator ☐ Both ☐ I do not use commercial fertilizer

11. For each of the following practices:

- Select the response that best describes your current experience with the practice.
- Then, if you are **not** currently using a practice on ***at least half*** of your acres, indicate how likely you are to *start using or expand acreage* for each practice.

	What is your current experience with the practice?				How likely are you to start using or expand acreage for the practice in the next 3 years?			
*all practices are defined in the glossary at the end of the survey	I **currently** use this practice on **at least half** of my acres.	I **currently** use this practice on **less than half** of my acres.	I have used this practice **in the past**, but **no longer use** it.	I have **never** used this practice.	Not likely	Somewhat likely	Very likely	**N/A** I already use this practice on **at least half** of my acres
Follow a written nutrient management plan	☐	☐	☐	☐	☐	☐	☐	☐
Grid/zone soil sampling	☐	☐	☐	☐	☐	☐	☐	☐
Liquid manure injection (low-disturbance)	☐	☐	☐	☐	☐	☐	☐	☐
Injection or incorporation of commercial nitrogen fertilizer	☐	☐	☐	☐	☐	☐	☐	☐
Cover crops	☐	☐	☐	☐	☐	☐	☐	☐
Split nitrogen application (e.g. pre-plant + sidedress, fertigation, split spring application, etc.)	☐	☐	☐	☐	☐	☐	☐	☐
Variable rate nitrogen application (VRT)	☐	☐	☐	☐	☐	☐	☐	☐
In-season nitrogen modeling tools (e.g. Adapt-N, Granular, Encirca, Climate Field View)	☐	☐	☐	☐	☐	☐	☐	☐

12. Consider each of the practices listed in the table below. If an agricultural cost-share program offered you a one-time **«cs_bid»% cost-share** to implement that practice for one year *in addition* to your current practices, would you be willing to adopt or expand acreage for that practice within the next 3 years?
    - If you are **currently** using the practice on **less than half** of your acres, check "yes" if you would be willing to adopt the practice for **at least half of your acres**.
    - If you are **currently** using the practice on **at least half of your acres**, check "yes" if you would be willing to adopt the practice **for the remainder of your acres**.

    Please consider each practice individually and select "Yes" or "No" for that practice. If you already use the practice on all of your acres, please select "N/A."

*all practices are defined in the glossary at the end of the survey	Yes	No	N/A I already use this practice on all of my acres
Follow a written nutrient management plan	☐	☐	☐
Grid/zone soil sampling	☐	☐	☐
Liquid manure injection (low-disturbance)	☐	☐	☐
Injection or incorporation of commercial nitrogen fertilizer	☐	☐	☐
Cover crops	☐	☐	☐
Split nitrogen application (e.g. pre-plant + sidedress, fertigation, split spring application, etc.)	☐	☐	☐
Variable rate nitrogen application (VRT)	☐	☐	☐
In-season nitrogen modeling tools (e.g. Adapt-N, Granular, Encirca, Climate Field View)	☐	☐	☐

13. How sure are you of the answers you gave for each practice?
    ☐ Definitely sure ☐ Probably sure ☐ Unsure

14. Do you believe that the results of surveys such as this can influence the design and implementation of agricultural cost-share programs?
    ☐ Yes ☐ No

Questions 15-20 ask about your perceptions and experience with specific practices. Please answer each question as it relates to the practice indicated in bold font.

15. In the table below:

- Indicate if you think using **in-season nitrogen modeling tools** will cause an increase, no change, or a decrease in each of the following factors. If you are already implementing the practice, answer based on your experience.
- Then, on a scale from 1 to 3, indicate how important each factor was in your decision to implement/not implement **in-season nitrogen modeling tools**.

	Impact of the practice			Importance in decision to implement		
The impact of the practice on	Decrease	No change	Increase	Not important	Moderately important	Very important
…crop yields	☐	☐	☐	1	2	3
…input costs	☐	☐	☐	1	2	3
…profitability	☐	☐	☐	1	2	3
…time spent in the field	☐	☐	☐	1	2	3
…time spent on farm management decisions	☐	☐	☐	1	2	3
…soil health and productivity on my farm	☐	☐	☐	1	2	3
…environmental quality in my community	☐	☐	☐	1	2	3
…my compliance with government regulations	☐	☐	☐	1	2	3
Other (please specify)	☐	☐	☐	1	2	3

16. How much do you think each of the following factors limit farmers' use of **in-season nitrogen modeling tools**? Please rate each factor on a scale from 1 to 5, where 1 is not at all and 5 is very much. Circle your response.

	Limits farmers' use of practice				
	Not at all				Very much
Finding information about the practice.	1	2	3	4	5
Having enough time to learn about the practice.	1	2	3	4	5
Getting a return on investment from the practice.	1	2	3	4	5
Cost of the practice.	1	2	3	4	5
Difficulty implementing the practice because of timing and weather.	1	2	3	4	5
Having the right equipment to implement the practice.	1	2	3	4	5
Having the right technology to implement the practice.	1	2	3	4	5
Finding services related to the practice (e.g. crop advisor, custom applicator, soil testing)	1	2	3	4	5
Believing the practice is better suited for larger operations.	1	2	3	4	5
Difficulty implementing the practice on leased land.	1	2	3	4	5
Having a previous negative experience trying the practice.	1	2	3	4	5
Preferring to use practices they are more familiar with.	1	2	3	4	5
Believing that new technologies are too difficult to use.	1	2	3	4	5
Other (please describe)	1	2	3	4	5

17. In the table below:

- Indicate if you think using **split nitrogen application** will cause an increase, no change, or a decrease in each of the following factors. If you are already implementing the practice, answer based on your experience.
- Then, on a scale from 1 to 3, indicate how important each factor was in your decision to implement/not implement **split nitrogen application.**

	Impact of the practice			Importance in decision to implement		
The impact of the practice on	Decrease	No change	Increase	Not important	Moderately important	Very important
…crop yields	☐	☐	☐	1	2	3
…input costs	☐	☐	☐	1	2	3
…profitability	☐	☐	☐	1	2	3
…time spent in the field	☐	☐	☐	1	2	3
…time spent on farm management decisions	☐	☐	☐	1	2	3
…soil health and productivity on my farm	☐	☐	☐	1	2	3
…environmental quality in my community	☐	☐	☐	1	2	3
…my compliance with government regulations	☐	☐	☐	1	2	3
Other (please specify)	☐	☐	☐	1	2	3

18. How much do you think each of the following factors limit farmers’ use of **split nitrogen application**? Please rate each factor on a scale from 1 to 5, where 1 is not at all and 5 is very much. Circle your response.

	Limits farmers’ use of practice				
	Not at all				Very Much
Finding information about the practice.	1	2	3	4	5
Having enough time to learn about the practice.	1	2	3	4	5
Getting a return on investment from the practice.	1	2	3	4	5
Cost of the practice.	1	2	3	4	5
Difficulty implementing the practice because of timing and weather.	1	2	3	4	5
Having the right equipment to implement the practice.	1	2	3	4	5
Having the right technology to implement the practice.	1	2	3	4	5
Finding services related to the practice (e.g. crop advisor, custom applicator, soil testing)	1	2	3	4	5
Believing the practice is better suited for larger operations.	1	2	3	4	5
Difficulty implementing the practice on leased land.	1	2	3	4	5
Having a previous negative experience trying the practice.	1	2	3	4	5
Preferring to use practices they are more familiar with.	1	2	3	4	5
Believing that new technologies are too difficult to use.	1	2	3	4	5
Other (please describe)	1	2	3	4	5

19. In the table below:

- Indicate if you think using **variable rate nitrogen application (VRT)** will cause an increase, no change, or a decrease in each of the following factors. If you are already implementing the practice, answer based on your experience.
- Then, on a scale from 1 to 3, indicate how important each factor was in your decision to implement/not implement **variable rate nitrogen application (VRT) .**

	Impact of the practice			Importance in decision to implement		
The impact of the practice on	Decrease	No change	Increase	Not important	Moderately important	Very important
…crop yields	☐	☐	☐	1	2	3
…input costs	☐	☐	☐	1	2	3
…profitability	☐	☐	☐	1	2	3
…time spent in the field	☐	☐	☐	1	2	3
…time spent on farm management decisions	☐	☐	☐	1	2	3
…soil health and productivity on my farm	☐	☐	☐	1	2	3
…environmental quality in my community	☐	☐	☐	1	2	3
…my compliance with government regulations	☐	☐	☐	1	2	3
Other (please specify)	☐	☐	☐	1	2	3

20. How much do you think each of the following factors limit farmers' use of **variable rate nitrogen application (VRT)**? Please rate each factor on a scale from 1 to 5, where 1 is not at all and 5 is very much. Circle your response.

	Limits farmers' use of practice				
	Not at all				Very much
Finding information about the practice.	1	2	3	4	5
Having enough time to learn about the practice.	1	2	3	4	5
Getting a return on investment from the practice.	1	2	3	4	5
Cost of the practice.	1	2	3	4	5
Difficulty implementing the practice because of timing and weather.	1	2	3	4	5
Having the right equipment to implement the practice.	1	2	3	4	5
Having the right technology to implement the practice.	1	2	3	4	5
Finding services related to the practice (e.g. crop advisor, custom applicator, soil testing)	1	2	3	4	5
Believing the practice is better suited for larger operations.	1	2	3	4	5
Difficulty implementing the practice on leased land.	1	2	3	4	5
Having a previous negative experience trying the practice.	1	2	3	4	5
Preferring to use practices they are more familiar with.	1	2	3	4	5
Believing that new technologies are too difficult to use.	1	2	3	4	5
Other (please describe)	1	2	3	4	5

21. What type of assistance would help you make the decision to implement *additional* nutrient management practices (beyond those you currently use)? Select all that apply.
   - ☐ Assistance locating a crop advisor
   - ☐ Consultation on creating a nutrient management plan or a more advanced plan
   - ☐ Guidance on how to take the next step in implementing the practice
   - ☐ Assistance with equipment costs
   - ☐ Economic analysis of implementing a new practice (i.e. calculating return on investment)
   - ☐ Other (please describe) ____
   - ☐ None of the above

22. How important is information from the following sources in your decision to implement nutrient management practices? Please rate each factor on a scale from 1 to 5, where 1 is not influential and 5 is very influential. Circle your response.

	Not influential				Very influential
Family members	1	2	3	4	5
Other farmers (non-family)	1	2	3	4	5
Personal experience with using a practice	1	2	3	4	5
University researchers	1	2	3	4	5
University county extension agents	1	2	3	4	5
Private foundations	1	2	3	4	5
State Department of Agriculture	1	2	3	4	5
Natural Resources Conservation Service (NRCS)	1	2	3	4	5
County Conservation District staff	1	2	3	4	5
Crop consultants for a seed or fertilizer company	1	2	3	4	5
Independent crop consultants	1	2	3	4	5
Farm journals (e.g. Delmarva Farmer)	1	2	3	4	5
Commodity boards and/or trade organizations	1	2	3	4	5
Other (please describe)	1	2	3	4	5

23. What type of information would be most helpful for you to learn about nutrient management practices? Please rate each type of information from 1 to 5, where 1 is not helpful and 5 is most helpful. Circle your response.

	Not helpful				Most helpful
Case studies	1	2	3	4	5
Economic budgets	1	2	3	4	5
On-farm trial opportunities	1	2	3	4	5
Testimonials (short stories) from local farmers	1	2	3	4	5
University research summaries	1	2	3	4	5
Other (please describe)	1	2	3	4	5

24. What methods of communication do you find most helpful for receiving information about nutrient management practices? Please rate each communication method from 1 to 5, where 1 is not helpful and 5 is most helpful. Circle your response.

	Not helpful				Most helpful
Brochures/pamphlets	1	2	3	4	5
Emails	1	2	3	4	5
Farm demonstrations by local farmers	1	2	3	4	5
Field days	1	2	3	4	5
Farm school/training meetings	1	2	3	4	5
Newsletters	1	2	3	4	5
Podcasts	1	2	3	4	5
Social media (e.g. Facebook, Twitter, Instagram)	1	2	3	4	5
Website or blog	1	2	3	4	5
YouTube training videos	1	2	3	4	5
Other (please describe)	1	2	3	4	5

25. Now we'd like to ask you some general questions about your perceptions of nutrient management. Please rate the following statements from 1 to 5, where 1 is strongly disagree and 5 is strongly agree.

	Strongly disagree				Strongly agree
I am concerned that nutrient loss from my farm negatively affects soil health and crop yield.	1	2	3	4	5
I am concerned that nutrient loss from my farm negatively affects farm profitability.	1	2	3	4	5
Nutrient management practices that incorporate technology can help me avoid nutrient loss from my farm.	1	2	3	4	5
I am concerned that nutrient loss from my farm negatively affects water quality.	1	2	3	4	5
I am concerned about water quality on my farm.	1	2	3	4	5
I am concerned about water quality in nearby rivers, streams, and bays.	1	2	3	4	5
The government should regulate farm nutrient management.	1	2	3	4	5
Nutrient losses can be controlled through voluntary measures.	1	2	3	4	5
I am in favor of agricultural cost-share programs that provide financial assistance to farmers who implement nutrient management practices on their farm.	1	2	3	4	5

26. Are you enrolled in any of the following programs? (Select all that apply)
   - ☐ Conservation Reserve Program (CRP)
   - ☐ Conservation Reserve Enhancement Program (CREP)
   - ☐ Conservation Stewardship Program (CSP)
   - ☐ Environmental Quality Incentives Program (EQIP)
   - ☐ State agricultural cost-share program
   - ☐ Other (please describe)___________________________
   - ☐ None of the above

27. Do you participate in water related recreation at least once per year? (e.g. boating, fishing, swimming in a lake, river, stream, etc.)
   ☐ Yes ☐ No

28. Do you have surface water on your land or flowing through your property under regular non-flooding situations such as a lake, river, stream, brook, creek, pond, etc.?
   - ☐ Yes ☐ No

29. In what year were you born? _________

30. What is the highest level of education you have completed?
   - ☐ Less than 12 years
   - ☐ High school diploma or GED
   - ☐ Some college
   - ☐ Associate's degree and/or technical training
   - ☐ Bachelor's degree
   - ☐ Graduate or professional degree

31. What proportion of your household's gross income in 2020 was earned through farming?
   - ☐ Less than 25%
   - ☐ 25%-50%
   - ☐ 51%-75%
   - ☐ 76%-100%

32. What is your plan for your farm when you retire? (Check the option that best fits your situation. Please select only one response.)
   - ☐ Someone related to me will operate the farm.
   - ☐ Someone who is not related to me will operate the farm.
   - ☐ The farm will be converted into non-farm use or sold for development.
   - ☐ The farm will be enrolled in a farmland preservation program.
   - ☐ I am uncertain.

If there is anything else you would like us to know about your nutrient management decisions, please comment below.

____

____

____

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Thank you for your time completing this survey. <u>Please return the survey in the postage paid envelope.</u> By completing this survey, you are eligible to enter a drawing for a $250 Visa gift card (10 available), a $100 Visa gift card (20 available) or a $50 Visa gift card (99 available). To enter the drawing, please complete the enclosed postcard with your name and address. To be eligible for the drawing, surveys must be returned by January 15, 2022.

«surveyid»

GLOSSARY

Conservation tillage: The practice of surface tilling prior to planting to prepare the seedbed for planting but also retain crop residues on the field, including vertical or mulch tillage, ridge tillage, chiseling, or disking.

Conventional tillage: The practice of full width tillage prior to planting to prepare the seedbed for planting using chisels, field cultivators, or disks.

Cost-share: A program that reimburses farmers and other land-managers for a portion of the cost of using certain conservation practices if all guidelines are met.

Cover crop: A crop (e.g., small grains, brassicas, legumes) planted during the winter months in fields that would otherwise be bare or fallow to prevent the loss of soil nutrients, minimize soil erosion, and enhance soil properties; this crop is to benefit the soil and water quality and therefore, is not harvested (although it may be grazed).

Grid soil sampling: A systematic soil sampling methodology that allows for mapping of nutrient variability in the field. A grid of known size (e.g., 2 acres) is superimposed over a field and a composite soil sample of 5 to 10 soil cores is collected at each grid intersection. Each soil sample is submitted separately for soil analysis. Grid sampling is best for large, uniformly shaped fields.

Incorporation: The practice of mixing manure or commercial fertilizer into the soil profile using tillage.

Injection: The application practice of placing manure and/or chemical fertilizer under the soil surface with minimal soil disturbance. Injection is a viable option for liquid manures or commercial fertilizers only. Common injection equipment includes shallow disk or shank injectors with closing disks.

In-season nitrogen modeling tools: Computer modelling systems that use local weather, site, and crop conditions to predict in-season crop nitrogen demands during the season in real time. Several companies offer nitrogen modeling services to guide in-season N applications (e.g. Adapt-N, Granular, Encirca, Climate Field View)

No-till: Plants are established and grown in a field that was not tilled following the previous crop. This tillage management maintains the highest level of crop residue.

Nutrient management plan: A site-specific plan written by a certified consultant that provides guidance for efficient nutrient applications based on University recommendations and/or soil test results. The goal of a nutrient management plan is to improve nutrient use efficiency and reduce nutrient losses to the environment.

Pre-plant fertilization: The application of fertilizer days or weeks prior to planting crop

Split nitrogen application: Applying a small amount of nitrogen early in the season (i.e., pre-plant or at-plant) followed by one or more applications of nitrogen in-season during the period of active plant growth (e.g. sidedress). Most of the nitrogen is applied in-season.

Variable Rate application: A type of application where the material (seed, fertilizer, irrigation, etc.) is applied based on a specific need-based prescription for different areas within a field based on soil or crop characteristics.

Zone soil sampling: A soil sampling methodology that allows areas of known or suspected variability to be sampled individually. Individual composite soil samples are collected from specified field areas by soil type, management history, landscape positioning, drainage type, etc. Each soil sample is submitted separately for analysis. This soil sampling method is best for irregularly shaped or small fields.

Appendix B: Regression Results

Regression Results Tables: Important Factors in the Decision to Implement a Practice

Table B-1. Differences in impacts on the importance of crop yields in the decision to implement a practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	0.0692	0.190*	0.129
	(0.139)	(0.0997)	(0.127)
prlandlease	0.221	0.202	0.0466
	(0.183)	(0.128)	(0.164)
smallfarm	0.102	-0.113	-0.0878
	(0.156)	(0.113)	(0.141)
largefarm	-0.285	0.0582	0.00505
	(0.183)	(0.125)	(0.160)
lessthan25	-0.404**	-0.110	-0.0556
	(0.186)	(0.137)	(0.168)
inc25to50	-0.193	-0.142	-0.132
	(0.168)	(0.119)	(0.154)
inc51to75	-0.151	-0.0453	-0.0934
	(0.171)	(0.119)	(0.152)
expuser	0.307**	0.112	0.125
	(0.137)	(0.0964)	(0.121)
usemanure	0.0999	-0.0996	0.0889
	(0.137)	(0.0960)	(0.123)
customapp	-0.0914	0.0223	-0.00246
	(0.142)	(0.0996)	(0.126)
conservation	-0.0565	-0.0275	-0.0523
	(0.198)	(0.139)	(0.176)
notill	-0.0336	0.0374	-0.0729
	(0.189)	(0.134)	(0.166)
pennsylvania	-0.310	0.0505	-0.0862
	(0.203)	(0.143)	(0.177)
maryland	-0.201	0.101	-0.0207
	(0.148)	(0.105)	(0.134)
virginia	-0.139	0.0778	0.272
	(0.212)	(0.145)	(0.189)
lessthanhs	0.370	0.0956	0.0588
	(0.280)	(0.183)	(0.245)
somecollege	0.234	0.153	0.0424
	(0.178)	(0.125)	(0.161)

Table B-1. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
assoctech	0.118	0.241*	0.166
	(0.202)	(0.142)	(0.180)
bs	0.156	0.139	0.121
	(0.166)	(0.117)	(0.151)
gradprof	-0.0652	0.194	0.0729
	(0.232)	(0.168)	(0.214)
Constant	2.443***	2.540***	2.500***
	(0.245)	(0.175)	(0.221)
Observations	148	150	148
R-squared	0.157	0.191	0.088

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-2. Differences in impacts on the importance of input costs in the decision to implement a practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	0.388***	0.220**	0.108
	(0.122)	(0.110)	(0.127)
prlandlease	0.194	0.155	0.0763
	(0.161)	(0.142)	(0.164)
smallfarm	0.189	0.0658	-0.164
	(0.137)	(0.124)	(0.141)
largefarm	-0.156	-0.136	-0.125
	(0.161)	(0.139)	(0.160)
lessthan25	-0.292*	-0.144	-0.0198
	(0.164)	(0.149)	(0.168)
inc25to50	-0.206	-0.0951	-0.126
	(0.148)	(0.135)	(0.154)
inc51to75	-0.192	0.0972	-0.0481
	(0.151)	(0.132)	(0.152)
expuser	-0.0814	-0.00369	0.0898
	(0.120)	(0.106)	(0.121)
usemanure	0.152	0.0218	0.116
	(0.120)	(0.107)	(0.123)
customapp	-0.0655	-0.0878	0.0110
	(0.125)	(0.111)	(0.125)
conservation	0.0188	-0.0538	-0.0314
	(0.174)	(0.155)	(0.175)
notill	0.136	0.179	-0.0119
	(0.166)	(0.149)	(0.166)
pennsylvania	-0.227	-0.128	-0.124
	(0.179)	(0.157)	(0.177)
maryland	0.0940	0.0484	-0.0614
	(0.130)	(0.117)	(0.133)
virginia	-0.148	0.0918	0.132
	(0.186)	(0.161)	(0.188)
lessthanhs	-0.102	-0.1000	0.0522
	(0.247)	(0.207)	(0.245)
somecollege	-0.0211	0.102	0.0270
	(0.156)	(0.140)	(0.161)
assoctech	-0.116	0.0184	0.0318
	(0.178)	(0.159)	(0.180)
bs	0.0408	0.238*	0.147
	(0.146)	(0.130)	(0.151)

Table B-2. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	-0.194	0.0871	0.173
	(0.204)	(0.187)	(0.214)
Constant	2.337***	2.394***	2.525***
	(0.216)	(0.194)	(0.220)
Observations	148	148	148
R-squared	0.167	0.164	0.088

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-3. Differences in impacts on the importance of profitability in the decision to implement a practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	0.283**	0.257**	0.106
	(0.109)	(0.0997)	(0.119)
prlandlease	0.0629	-0.00638	0.146
	(0.144)	(0.130)	(0.154)
smallfarm	0.0160	-0.0464	-0.135
	(0.122)	(0.112)	(0.132)
largefarm	-0.0604	-0.0799	0.0431
	(0.143)	(0.126)	(0.150)
lessthan25	-0.283*	-0.157	-0.0608
	(0.146)	(0.135)	(0.157)
inc25to50	-0.0999	-0.166	-0.212
	(0.132)	(0.121)	(0.145)
inc51to75	-0.111	-0.184	-0.127
	(0.135)	(0.119)	(0.143)
expuser	0.113	0.0352	0.0507
	(0.108)	(0.0960)	(0.114)
usemanure	0.230**	-0.0476	0.0702
	(0.107)	(0.0971)	(0.115)
customapp	-0.00384	-0.0374	-0.0542
	(0.113)	(0.100)	(0.118)
conservation	-0.180	0.147	-0.0169
	(0.155)	(0.140)	(0.164)
notill	-0.0591	0.292**	0.0289
	(0.148)	(0.135)	(0.156)
pennsylvania	-0.195	-0.0925	-0.0914
	(0.160)	(0.141)	(0.166)
maryland	0.0571	0.144	-0.0478
	(0.116)	(0.105)	(0.125)
virginia	-0.0601	-0.0381	0.0736
	(0.166)	(0.150)	(0.177)
lessthanhs	-0.115	-0.148	-0.0626
	(0.219)	(0.185)	(0.230)
somecollege	-0.0307	0.0957	-0.0784
	(0.139)	(0.126)	(0.151)
assoctech	-0.102	-0.0161	0.0271
	(0.158)	(0.143)	(0.169)
bs	0.0651	0.0762	0.0308
	(0.130)	(0.119)	(0.141)

Table B-3. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	-0.160	-0.0632	0.211
	(0.182)	(0.170)	(0.201)
Constant	2.587***	2.598***	2.629***
	(0.194)	(0.176)	(0.207)
Observations	147	150	148
R-squared	0.212	0.156	0.109

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-4. Differences in impacts on the importance of time spent in the field in the decision to implement a practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	0.0995	-0.131	-0.165
	(0.142)	(0.132)	(0.139)
prlandlease	-0.0884	-0.236	-0.0583
	(0.186)	(0.172)	(0.179)
smallfarm	-0.140	-0.171	-0.174
	(0.159)	(0.149)	(0.153)
largefarm	-0.131	0.0482	0.0850
	(0.186)	(0.167)	(0.174)
lessthan25	-0.125	-0.00505	0.205
	(0.189)	(0.179)	(0.183)
inc25to50	-0.106	0.147	0.221
	(0.173)	(0.161)	(0.168)
inc51to75	-0.314*	-0.362**	-0.210
	(0.174)	(0.159)	(0.166)
expuser	-0.0470	0.0443	-0.00524
	(0.140)	(0.127)	(0.132)
usemanure	-0.0590	0.109	0.152
	(0.139)	(0.129)	(0.134)
customapp	-0.165	-0.166	-0.200
	(0.145)	(0.133)	(0.137)
conservation	-0.205	-0.0253	0.0506
	(0.201)	(0.186)	(0.191)
notill	-0.0627	0.185	0.166
	(0.192)	(0.179)	(0.181)
pennsylvania	-0.667***	0.0581	-0.349*
	(0.207)	(0.188)	(0.193)
maryland	-0.157	0.101	-0.162
	(0.151)	(0.140)	(0.145)
virginia	-0.364*	-0.0546	-0.175
	(0.215)	(0.199)	(0.206)
lessthanhs	0.189	0.0241	-0.205
	(0.285)	(0.249)	(0.267)
somecollege	0.0288	0.0333	0.0871
	(0.181)	(0.166)	(0.175)
assoctech	0.0884	-0.00187	0.0744
	(0.206)	(0.190)	(0.196)
bs	0.339**	0.187	0.241
	(0.169)	(0.157)	(0.164)

Table B-4. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	-0.193	-0.00493	0.173
	(0.243)	(0.225)	(0.233)
Constant	2.699***	2.266***	2.258***
	(0.249)	(0.233)	(0.240)
Observations	147	149	148
R-squared	0.160	0.140	0.143

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-5. Differences in impacts on the importance of time spent on farm management in the decision to implement a practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	-0.100	0.0507	-0.132
	(0.130)	(0.125)	(0.140)
prlandlease	0.0374	-0.116	-0.143
	(0.170)	(0.162)	(0.181)
smallfarm	-0.0632	0.0543	-0.104
	(0.148)	(0.141)	(0.155)
largefarm	-0.294*	0.102	0.135
	(0.170)	(0.158)	(0.176)
lessthan25	-0.255	-0.386**	-0.0472
	(0.177)	(0.169)	(0.185)
inc25to50	0.0255	0.0853	-0.0440
	(0.157)	(0.152)	(0.170)
inc51to75	-0.189	-0.386**	-0.341**
	(0.159)	(0.149)	(0.168)
expuser	0.00950	-0.0103	-0.0248
	(0.129)	(0.120)	(0.134)
usemanure	0.0150	0.0915	0.136
	(0.127)	(0.121)	(0.136)
customapp	-0.0981	-0.216*	-0.0948
	(0.132)	(0.125)	(0.138)
conservation	-0.190	-0.130	-0.00868
	(0.184)	(0.175)	(0.194)
notill	0.0105	0.110	0.215
	(0.175)	(0.168)	(0.183)
pennsylvania	-0.555***	-0.0690	-0.0803
	(0.189)	(0.177)	(0.195)
maryland	-0.127	0.370***	-0.0247
	(0.139)	(0.132)	(0.147)
virginia	-0.274	-0.0866	-0.0720
	(0.197)	(0.187)	(0.208)
lessthanhs	0.309	-0.0817	-0.0825
	(0.260)	(0.234)	(0.270)
somecollege	-0.00667	0.184	0.0940
	(0.165)	(0.157)	(0.177)
assoctech	0.256	0.179	0.0150
	(0.188)	(0.179)	(0.198)
bs	0.411***	0.188	0.188
	(0.156)	(0.148)	(0.166)

Table B-5. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.0216	-0.00993	0.0921
	(0.222)	(0.212)	(0.236)
Constant	2.428***	2.156***	2.161***
	(0.228)	(0.220)	(0.243)
Observations	146	149	148
R-squared	0.196	0.197	0.095

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table B-6. Differences in impacts on the importance of soil health and productivity in the decision to implement a practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	-0.114	0.219*	-0.000173
	(0.136)	(0.117)	(0.137)
prlandlease	0.244	-0.00527	0.122
	(0.178)	(0.152)	(0.177)
smallfarm	0.276*	0.0486	0.102
	(0.151)	(0.132)	(0.152)
largefarm	-0.154	-0.0270	-0.00683
	(0.178)	(0.149)	(0.172)
lessthan25	-0.563***	-0.305*	-0.211
	(0.180)	(0.158)	(0.181)
inc25to50	-0.187	-0.282*	-0.169
	(0.165)	(0.143)	(0.166)
inc51to75	-0.232	-0.270*	-0.248
	(0.166)	(0.140)	(0.164)
expuser	0.171	0.0967	0.268**
	(0.134)	(0.113)	(0.131)
usemanure	0.159	-0.00748	-0.0729
	(0.133)	(0.114)	(0.133)
customapp	-0.0195	0.0968	-0.0149
	(0.138)	(0.118)	(0.135)
conservation	-0.323*	-0.298*	0.0204
	(0.192)	(0.165)	(0.189)
notill	-0.271	0.0306	-0.0314
	(0.183)	(0.158)	(0.179)
pennsylvania	-0.101	0.0186	0.182
	(0.197)	(0.166)	(0.191)
maryland	-0.0825	0.156	0.160
	(0.144)	(0.124)	(0.144)
virginia	0.0418	0.295*	0.586***
	(0.205)	(0.176)	(0.203)
lessthanhs	-0.0185	-0.424*	-0.114
	(0.271)	(0.217)	(0.264)
somecollege	0.123	-0.0702	0.161
	(0.172)	(0.148)	(0.174)
assoctech	-0.122	-0.0718	0.0535
	(0.196)	(0.169)	(0.194)
bs	0.105	0.0528	0.0122
	(0.161)	(0.140)	(0.162)

Table B-6. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	-0.270	-0.543***	-0.404*
	(0.231)	(0.200)	(0.231)
Constant	2.723***	2.519***	2.242***
	(0.237)	(0.207)	(0.238)
Observations	146	150	148
R-squared	0.156	0.210	0.123

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-7. Differences in impacts on the importance of environmental quality in my community in the decision to implement a practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	-0.261*	-0.209	-0.247**
	(0.142)	(0.131)	(0.125)
prlandlease	0.394**	0.338**	0.233
	(0.185)	(0.170)	(0.161)
smallfarm	0.267*	0.125	0.0826
	(0.159)	(0.148)	(0.138)
largefarm	0.0403	0.0129	0.0354
	(0.185)	(0.166)	(0.157)
lessthan25	-0.531***	-0.276	-0.362**
	(0.189)	(0.177)	(0.165)
inc25to50	-0.396**	-0.294*	-0.342**
	(0.172)	(0.160)	(0.152)
inc51to75	-0.458***	-0.386**	-0.326**
	(0.174)	(0.157)	(0.150)
expuser	0.235*	0.0824	0.0517
	(0.139)	(0.126)	(0.119)
usemanure	0.137	0.146	0.0698
	(0.139)	(0.127)	(0.121)
customapp	-0.00561	-0.0500	-0.0240
	(0.144)	(0.132)	(0.123)
conservation	-0.309	-0.0431	0.0928
	(0.201)	(0.184)	(0.173)
notill	-0.128	0.136	0.213
	(0.191)	(0.177)	(0.163)
pennsylvania	-0.188	-0.180	-0.148
	(0.206)	(0.186)	(0.174)
maryland	-0.184	-0.125	-0.0188
	(0.151)	(0.139)	(0.131)
virginia	-0.0349	-0.0125	0.198
	(0.214)	(0.197)	(0.185)
lessthanhs	0.0145	-0.675***	-0.900***
	(0.284)	(0.246)	(0.241)
somecollege	0.181	-0.149	-0.0275
	(0.180)	(0.165)	(0.158)
assoctech	0.181	-0.0155	-0.149
	(0.205)	(0.188)	(0.177)
bs	0.151	-0.127	-0.170
	(0.168)	(0.156)	(0.148)

Table B-7. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	-0.0137	-0.439*	-0.496**
	(0.242)	(0.223)	(0.210)
Constant	2.400***	2.393***	2.402***
	(0.248)	(0.231)	(0.217)
Observations	147	149	148
R-squared	0.203	0.231	0.300

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-8. Differences in impacts on the importance of compliance with government regulations in the decision to implement a practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	-0.261*	-0.224	-0.420***
	(0.139)	(0.135)	(0.141)
prlandlease	0.0121	0.0573	0.177
	(0.181)	(0.176)	(0.182)
smallfarm	0.132	-0.213	-0.0445
	(0.155)	(0.153)	(0.156)
largefarm	0.0334	-0.0229	0.0703
	(0.181)	(0.171)	(0.178)
lessthan25	-0.400**	-0.172	-0.0426
	(0.185)	(0.183)	(0.187)
inc25to50	-0.412**	-0.299*	-0.352**
	(0.169)	(0.165)	(0.171)
inc51to75	-0.353**	-0.188	-0.0368
	(0.170)	(0.162)	(0.169)
expuser	0.260*	0.128	0.0706
	(0.137)	(0.130)	(0.135)
usemanure	0.0765	0.0366	0.0883
	(0.136)	(0.132)	(0.137)
customapp	-0.0482	0.0825	5.03e-06
	(0.141)	(0.136)	(0.139)
conservation	-0.0552	0.0308	-0.00428
	(0.197)	(0.190)	(0.195)
notill	-0.0314	0.170	0.177
	(0.188)	(0.183)	(0.184)
pennsylvania	-0.351*	-0.137	-0.288
	(0.202)	(0.192)	(0.197)
maryland	-0.307**	-0.154	-0.235
	(0.147)	(0.143)	(0.148)
virginia	0.229	-0.111	0.0788
	(0.210)	(0.204)	(0.210)
lessthanhs	-0.121	-0.635**	-0.578**
	(0.278)	(0.255)	(0.272)
somecollege	-0.264	-0.299*	0.0419
	(0.177)	(0.170)	(0.179)
assoctech	-0.345*	-0.154	-0.0803
	(0.201)	(0.194)	(0.200)
bs	0.0679	-0.169	-0.192
	(0.165)	(0.161)	(0.167)

Table B-8. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	-0.717***	-0.473**	-0.544**
	(0.237)	(0.231)	(0.238)
Constant	2.617***	2.445***	2.382***
	(0.243)	(0.239)	(0.245)
Observations	147	149	148
R-squared	0.296	0.259	0.290

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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Table B-9. Differences in impacts on finding information about the practice limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	-0.386*	-0.599***	0.151
	(0.218)	(0.225)	(0.239)
prlandlease	0.244	-0.0801	0.292
	(0.282)	(0.291)	(0.305)
smallfarm	0.314	0.420	0.593**
	(0.243)	(0.256)	(0.266)
largefarm	-0.122	0.0583	0.315
	(0.282)	(0.290)	(0.301)
lessthan25	-0.646**	-0.0456	-0.307
	(0.287)	(0.300)	(0.316)
inc25to50	-0.492*	0.0148	-0.265
	(0.265)	(0.275)	(0.292)
inc51to75	-0.172	0.0460	-0.164
	(0.264)	(0.276)	(0.286)
expuser	-0.149	-0.147	-0.278
	(0.210)	(0.221)	(0.228)
usemanure	0.0971	-0.0843	0.194
	(0.210)	(0.221)	(0.230)
customapp	0.0628	-0.224	-0.120
	(0.220)	(0.230)	(0.237)
conservation	-0.551*	-0.317	-0.108
	(0.302)	(0.315)	(0.328)
notill	-0.124	-0.0169	0.370
	(0.287)	(0.301)	(0.310)
pennsylvania	0.179	-0.148	0.504
	(0.317)	(0.322)	(0.334)
maryland	-0.393*	-0.103	0.122
	(0.229)	(0.241)	(0.249)
virginia	0.191	0.696**	0.482
	(0.329)	(0.344)	(0.357)
lessthanhs	-0.933**	-0.175	-0.937**
	(0.426)	(0.420)	(0.464)
somecollege	-0.103	0.348	0.202
	(0.278)	(0.288)	(0.305)

Table B-9. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
assoctech	-0.512	-0.641**	-0.337
	(0.309)	(0.323)	(0.334)
bs	0.174	0.471*	0.262
	(0.261)	(0.271)	(0.281)
gradprof	0.137	-0.152	-0.0433
	(0.365)	(0.380)	(0.406)
Constant	3.846***	3.114***	2.751***
	(0.378)	(0.395)	(0.413)
Observations	152	153	150
R-squared	0.184	0.230	0.163

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-10. Differences in impacts on having enough time to learn about the practice limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	-0.0676	-0.499**	0.0935
	(0.208)	(0.242)	(0.232)
prlandlease	0.189	-0.229	-0.0532
	(0.270)	(0.313)	(0.297)
smallfarm	0.427*	0.364	0.202
	(0.232)	(0.275)	(0.258)
largefarm	0.0929	0.0755	0.303
	(0.270)	(0.312)	(0.293)
lessthan25	-0.542*	-0.0352	-0.163
	(0.275)	(0.322)	(0.307)
inc25to50	-0.431*	0.123	0.0816
	(0.253)	(0.296)	(0.284)
inc51to75	-0.240	-0.210	-0.155
	(0.252)	(0.297)	(0.278)
expuser	-0.239	0.0122	-0.216
	(0.201)	(0.237)	(0.222)
usemanure	0.377*	-0.0710	0.274
	(0.201)	(0.238)	(0.224)
customapp	-0.142	-0.330	0.0276
	(0.210)	(0.248)	(0.230)
conservation	-0.361	-0.166	-0.210
	(0.289)	(0.338)	(0.319)
notill	-0.0482	0.0594	0.0974
	(0.275)	(0.323)	(0.302)
pennsylvania	0.00789	-0.211	0.628*
	(0.303)	(0.347)	(0.325)
maryland	-0.376*	-0.184	0.201
	(0.219)	(0.259)	(0.243)
virginia	0.430	0.680*	0.195
	(0.315)	(0.370)	(0.347)
lessthanhs	-0.754*	0.261	-0.440
	(0.408)	(0.451)	(0.452)
somecollege	0.225	0.545*	0.167
	(0.266)	(0.310)	(0.297)
assoctech	-0.489	-0.572	-0.305
	(0.296)	(0.348)	(0.325)
bs	0.610**	0.456	0.129
	(0.250)	(0.291)	(0.274)

Table B-10. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.216	-0.289	0.319
	(0.349)	(0.408)	(0.395)
Constant	3.610***	3.338***	3.164***
	(0.361)	(0.425)	(0.402)
Observations	152	153	150
R-squared	0.206	0.187	0.116

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-11. Differences in impacts on getting a return on investment from the practice limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	0.202	-0.164	-0.127
	(0.185)	(0.251)	(0.215)
prlandlease	0.400	-0.447	0.132
	(0.241)	(0.326)	(0.275)
smallfarm	0.360*	0.0713	-0.324
	(0.207)	(0.286)	(0.239)
largefarm	-0.0538	0.119	-0.0922
	(0.241)	(0.323)	(0.271)
lessthan25	-0.685***	-0.127	0.0544
	(0.246)	(0.335)	(0.285)
inc25to50	-0.244	0.218	0.399
	(0.224)	(0.310)	(0.263)
inc51to75	-0.392*	-0.299	-0.247
	(0.226)	(0.304)	(0.257)
expuser	0.142	-0.0592	-0.135
	(0.179)	(0.243)	(0.206)
usemanure	0.129	0.0791	-0.0281
	(0.179)	(0.245)	(0.207)
customapp	-0.426**	-0.0948	-0.0823
	(0.187)	(0.255)	(0.214)
conservation	-0.0743	0.0168	-0.0638
	(0.258)	(0.351)	(0.296)
notill	0.236	0.0125	0.127
	(0.246)	(0.335)	(0.280)
pennsylvania	-0.297	-0.194	-0.154
	(0.271)	(0.360)	(0.301)
maryland	-0.0169	0.380	0.162
	(0.195)	(0.267)	(0.225)
virginia	-0.233	0.296	0.0681
	(0.282)	(0.396)	(0.322)
lessthanhs	-0.698*	-1.129**	-0.163
	(0.365)	(0.468)	(0.419)
somecollege	0.0183	0.0843	0.0104
	(0.238)	(0.321)	(0.275)
assoctech	-0.0291	-0.863**	0.171
	(0.264)	(0.360)	(0.301)
bs	0.101	-0.0784	-0.295
	(0.223)	(0.305)	(0.253)

Table B-11. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.0337	-0.190	0.0602
	(0.304)	(0.424)	(0.366)
Constant	4.068***	4.003***	4.317***
	(0.323)	(0.439)	(0.372)
Observations	153	153	150
R-squared	0.169	0.150	0.095

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-12. Differences in impacts on cost of the practice limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	0.168	-0.107	0.0274
	(0.200)	(0.230)	(0.199)
prlandlease	0.167	0.000255	0.245
	(0.261)	(0.299)	(0.254)
smallfarm	0.140	0.188	0.136
	(0.223)	(0.263)	(0.221)
largefarm	-0.0747	0.101	0.196
	(0.264)	(0.297)	(0.251)
lessthan25	-0.224	-0.0599	0.00702
	(0.265)	(0.308)	(0.263)
inc25to50	0.0227	0.00567	0.350
	(0.243)	(0.284)	(0.243)
inc51to75	0.00290	-0.0236	-0.0953
	(0.244)	(0.284)	(0.238)
expuser	-0.153	-0.165	-0.227
	(0.196)	(0.224)	(0.190)
usemanure	0.249	0.205	-0.00172
	(0.194)	(0.225)	(0.192)
customapp	-0.260	-0.0155	-0.0876
	(0.202)	(0.234)	(0.197)
conservation	-0.271	-0.260	0.127
	(0.279)	(0.322)	(0.273)
notill	0.161	-0.128	0.133
	(0.266)	(0.307)	(0.258)
pennsylvania	-0.200	-0.125	-0.0217
	(0.292)	(0.330)	(0.278)
maryland	0.0917	-0.0664	0.0336
	(0.212)	(0.247)	(0.208)
virginia	-0.272	-0.0268	0.00372
	(0.306)	(0.364)	(0.297)
lessthanhs	-0.664*	-0.691	0.0411
	(0.394)	(0.429)	(0.387)
somecollege	0.246	0.502*	0.290
	(0.257)	(0.295)	(0.254)
assoctech	-0.0331	-0.721**	0.212
	(0.286)	(0.331)	(0.278)
bs	0.300	0.0187	-0.147
	(0.241)	(0.280)	(0.234)

Table B-12. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.0954	0.0529	-0.0175
	(0.328)	(0.389)	(0.338)
Constant	4.156***	3.977***	4.003***
	(0.349)	(0.403)	(0.344)
Observations	152	152	150
R-squared	0.114	0.102	0.076

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-13. Differences in impacts on difficulty implementing the practice because of timing and weather limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	0.0280	-0.110	-0.298
	(0.201)	(0.185)	(0.229)
prlandlease	0.485*	0.425*	-0.0990
	(0.263)	(0.240)	(0.293)
smallfarm	0.331	0.360*	0.426*
	(0.225)	(0.211)	(0.255)
largefarm	-0.0304	0.229	0.495*
	(0.262)	(0.239)	(0.289)
lessthan25	-0.586**	-0.0669	-0.111
	(0.268)	(0.247)	(0.303)
inc25to50	-0.282	0.253	-0.109
	(0.244)	(0.228)	(0.280)
inc51to75	-0.123	0.192	0.172
	(0.246)	(0.227)	(0.274)
expuser	0.00357	-0.0930	0.0135
	(0.195)	(0.181)	(0.219)
usemanure	0.221	-0.178	0.153
	(0.195)	(0.183)	(0.221)
customapp	-0.144	0.0977	-0.266
	(0.204)	(0.189)	(0.228)
conservation	-0.340	-0.249	-0.174
	(0.281)	(0.259)	(0.315)
notill	-0.0259	-0.336	-0.0675
	(0.267)	(0.247)	(0.298)
pennsylvania	0.289	0.121	-2.51e-05
	(0.295)	(0.265)	(0.321)
maryland	0.291	0.247	0.282
	(0.213)	(0.198)	(0.240)
virginia	-0.116	-0.354	0.0374
	(0.307)	(0.292)	(0.343)
lessthanhs	-0.879**	0.199	-0.791*
	(0.397)	(0.345)	(0.446)
somecollege	0.211	0.615**	0.540*
	(0.259)	(0.237)	(0.293)
assoctech	-0.384	-0.515*	-0.474
	(0.288)	(0.266)	(0.321)
bs	0.438*	0.135	0.0546
	(0.243)	(0.225)	(0.270)

Table B-13. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.163	0.465	0.00951
	(0.331)	(0.313)	(0.390)
Constant	3.713***	3.719***	3.707***
	(0.352)	(0.325)	(0.397)
Observations	153	152	150
R-squared	0.183	0.215	0.131

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-14. Differences in impacts on having the right equipment to implement the practice limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	-0.0832	-0.195	0.0852
	(0.174)	(0.201)	(0.187)
prlandlease	0.210	-0.0824	0.0252
	(0.227)	(0.260)	(0.239)
smallfarm	0.242	0.383*	-0.0849
	(0.195)	(0.228)	(0.207)
largefarm	-0.0396	0.272	0.220
	(0.227)	(0.259)	(0.236)
lessthan25	-0.233	0.00585	0.126
	(0.231)	(0.268)	(0.246)
inc25to50	-0.0951	0.153	-0.119
	(0.211)	(0.246)	(0.227)
inc51to75	0.0466	0.178	0.103
	(0.213)	(0.244)	(0.223)
expuser	-0.117	-0.267	-0.224
	(0.169)	(0.195)	(0.179)
usemanure	0.103	0.0541	-0.0234
	(0.169)	(0.196)	(0.180)
customapp	-0.338*	-0.140	-0.248
	(0.176)	(0.204)	(0.185)
conservation	-0.718***	-0.152	0.133
	(0.243)	(0.281)	(0.256)
notill	-0.360	-0.107	0.222
	(0.231)	(0.268)	(0.242)
pennsylvania	-0.574**	-0.191	-0.0600
	(0.255)	(0.288)	(0.261)
maryland	-0.0999	0.240	0.145
	(0.184)	(0.214)	(0.195)
virginia	-0.0352	-0.0907	0.138
	(0.265)	(0.308)	(0.279)
lessthanhs	-0.358	-0.232	0.378
	(0.343)	(0.375)	(0.355)
somecollege	0.215	0.619**	0.304
	(0.224)	(0.257)	(0.239)
assoctech	-0.873***	-0.824***	-0.188
	(0.249)	(0.289)	(0.261)
bs	0.360*	0.250	0.512**
	(0.210)	(0.241)	(0.220)

Table B-14. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.00705	-0.0670	0.162
	(0.286)	(0.339)	(0.317)
Constant	5.023***	4.088***	4.263***
	(0.304)	(0.352)	(0.323)
Observations	153	154	151
R-squared	0.239	0.195	0.122

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-15. Differences in impacts on having the right technology to implement the practice limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	-0.158	-0.358	0.0611
	(0.193)	(0.220)	(0.206)
prlandlease	0.200	-0.209	-0.0504
	(0.250)	(0.285)	(0.264)
smallfarm	0.428**	0.480*	-0.0540
	(0.215)	(0.250)	(0.229)
largefarm	0.149	0.357	0.366
	(0.250)	(0.284)	(0.260)
lessthan25	-0.283	-0.124	0.00968
	(0.255)	(0.293)	(0.273)
inc25to50	-0.151	0.475*	-0.122
	(0.235)	(0.269)	(0.252)
inc51to75	0.121	0.104	-0.0787
	(0.234)	(0.267)	(0.247)
expuser	-0.205	-0.401*	-0.255
	(0.187)	(0.213)	(0.197)
usemanure	0.0777	0.279	-0.0152
	(0.186)	(0.214)	(0.199)
customapp	-0.284	-0.0673	-0.275
	(0.195)	(0.223)	(0.205)
conservation	-0.419	-0.495	0.102
	(0.268)	(0.308)	(0.283)
notill	-0.0957	-0.00476	0.309
	(0.255)	(0.294)	(0.268)
pennsylvania	-0.311	-0.170	0.108
	(0.281)	(0.316)	(0.288)
maryland	-0.327	0.333	0.122
	(0.204)	(0.235)	(0.215)
virginia	-0.000797	-0.0644	0.220
	(0.292)	(0.337)	(0.308)
lessthanhs	-0.651*	-0.647	-0.170
	(0.378)	(0.411)	(0.401)
somecollege	0.384	0.789***	0.284
	(0.247)	(0.281)	(0.263)
assoctech	-0.697**	-0.713**	-0.0474
	(0.275)	(0.316)	(0.288)
bs	0.531**	0.368	0.497**
	(0.231)	(0.264)	(0.243)

Table B-15. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.288	0.0515	0.283
	(0.324)	(0.371)	(0.350)
Constant	4.571***	3.680***	4.164***
	(0.335)	(0.385)	(0.357)
Observations	152	154	150
R-squared	0.200	0.257	0.105

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-16. Differences in impacts on finding services related to the practice limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	-0.222	-0.234	-0.0840
	(0.221)	(0.227)	(0.239)
prlandlease	0.426	-0.584**	-0.102
	(0.287)	(0.293)	(0.306)
smallfarm	0.218	0.0751	-0.383
	(0.247)	(0.257)	(0.266)
largefarm	-0.0219	0.423	-0.148
	(0.287)	(0.293)	(0.302)
lessthan25	-0.340	0.433	0.373
	(0.292)	(0.302)	(0.317)
inc25to50	-0.273	0.303	-0.112
	(0.269)	(0.278)	(0.293)
inc51to75	-0.317	0.302	-0.0452
	(0.268)	(0.275)	(0.286)
expuser	0.285	-0.0401	-0.131
	(0.214)	(0.220)	(0.229)
usemanure	0.574***	0.334	0.292
	(0.213)	(0.221)	(0.231)
customapp	-0.392*	0.145	-0.158
	(0.223)	(0.230)	(0.238)
conservation	-0.576*	-0.754**	-0.00584
	(0.308)	(0.317)	(0.329)
notill	-0.258	-0.483	-0.00128
	(0.292)	(0.303)	(0.311)
pennsylvania	-0.116	0.0700	-0.0530
	(0.322)	(0.325)	(0.335)
maryland	0.193	0.584**	0.0941
	(0.233)	(0.242)	(0.250)
virginia	0.0416	0.522	0.0604
	(0.335)	(0.347)	(0.358)
lessthanhs	-0.510	-0.393	0.336
	(0.434)	(0.423)	(0.466)
somecollege	0.424	0.690**	0.0688
	(0.283)	(0.290)	(0.306)
assoctech	-0.430	-0.961***	-0.365
	(0.315)	(0.326)	(0.335)
bs	0.672**	0.533*	0.416
	(0.265)	(0.272)	(0.282)

Table B-16. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.0531	-0.0960	0.214
	(0.371)	(0.382)	(0.407)
Constant	3.578***	3.088***	3.691***
	(0.384)	(0.397)	(0.414)
Observations	152	154	150
R-squared	0.203	0.272	0.079

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-17. Differences in impacts on believing the practice is better suited for larger operations limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	0.203	-0.341	0.252
	(0.241)	(0.278)	(0.269)
prlandlease	0.342	-0.331	0.299
	(0.315)	(0.362)	(0.345)
smallfarm	0.120	0.715**	0.655**
	(0.270)	(0.317)	(0.299)
largefarm	-0.398	0.587	0.0119
	(0.314)	(0.359)	(0.340)
lessthan25	0.386	-0.0866	0.00164
	(0.320)	(0.372)	(0.356)
inc25to50	0.320	0.429	0.0674
	(0.292)	(0.344)	(0.329)
inc51to75	0.120	-0.00217	0.141
	(0.294)	(0.338)	(0.322)
expuser	-0.924***	-0.556**	-0.937***
	(0.234)	(0.269)	(0.257)
usemanure	0.345	0.00271	0.189
	(0.234)	(0.272)	(0.260)
customapp	-0.0750	0.258	-0.143
	(0.244)	(0.283)	(0.266)
conservation	-0.444	-0.713*	-0.473
	(0.337)	(0.389)	(0.369)
notill	-0.0606	-0.575	-0.328
	(0.320)	(0.372)	(0.351)
pennsylvania	0.00212	0.341	-0.0591
	(0.353)	(0.399)	(0.376)
maryland	0.151	0.333	-0.164
	(0.255)	(0.297)	(0.282)
virginia	-0.467	-0.110	-0.828**
	(0.367)	(0.439)	(0.392)
lessthanhs	-0.226	-0.209	0.387
	(0.475)	(0.519)	(0.503)
somecollege	-0.0595	0.473	0.466
	(0.310)	(0.356)	(0.345)
assoctech	0.255	-0.381	0.0853
	(0.345)	(0.400)	(0.377)
bs	0.179	0.106	0.322
	(0.291)	(0.338)	(0.318)

Table B-17. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.0730	-0.104	0.549
	(0.396)	(0.471)	(0.458)
Constant	3.620***	3.256***	3.628***
	(0.421)	(0.487)	(0.467)
Observations	153	153	151
R-squared	0.230	0.194	0.240

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-18. Differences in impacts on difficulty implementing the practice on leased land limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	-0.304	-0.470*	-0.316
	(0.273)	(0.272)	(0.290)
prlandlease	0.911**	-0.0653	0.126
	(0.361)	(0.357)	(0.377)
smallfarm	0.472	0.0183	0.559*
	(0.310)	(0.311)	(0.325)
largefarm	0.430	0.403	0.652*
	(0.354)	(0.352)	(0.367)
lessthan25	-0.240	0.152	-0.0474
	(0.362)	(0.366)	(0.386)
inc25to50	-0.150	-0.0334	-0.0595
	(0.344)	(0.341)	(0.364)
inc51to75	0.379	-0.0783	-0.112
	(0.335)	(0.331)	(0.348)
expuser	-0.496*	-0.142	-0.695**
	(0.267)	(0.265)	(0.279)
usemanure	0.313	0.128	0.454
	(0.267)	(0.268)	(0.284)
customapp	-0.212	-0.290	-0.291
	(0.279)	(0.279)	(0.291)
conservation	-0.441	-0.529	-0.313
	(0.385)	(0.388)	(0.406)
notill	-0.00929	-0.0743	0.0323
	(0.367)	(0.371)	(0.385)
pennsylvania	-0.323	-0.219	-0.532
	(0.398)	(0.391)	(0.407)
maryland	0.454	0.127	0.316
	(0.292)	(0.293)	(0.306)
virginia	-0.124	0.225	0.0201
	(0.415)	(0.431)	(0.448)
lessthanhs	-0.659	-0.872*	-0.443
	(0.535)	(0.509)	(0.565)
somecollege	0.428	0.255	0.420
	(0.355)	(0.354)	(0.377)
assoctech	0.0557	-0.389	0.317
	(0.389)	(0.392)	(0.407)
bs	-0.0146	0.291	0.210
	(0.330)	(0.332)	(0.347)

Table B-18. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.131	-0.100	0.00172
	(0.459)	(0.462)	(0.496)
Constant	2.776***	3.097***	2.676***
	(0.488)	(0.487)	(0.514)
Observations	148	151	147
R-squared	0.201	0.132	0.161

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-19. Differences in impacts on having a previous negative experience with the practice limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	0.171	0.00831	-0.183
	(0.263)	(0.256)	(0.269)
prlandlease	0.0738	0.341	0.329
	(0.344)	(0.333)	(0.346)
smallfarm	-0.00799	0.137	0.188
	(0.300)	(0.291)	(0.300)
largefarm	0.449	0.0149	0.117
	(0.339)	(0.330)	(0.347)
lessthan25	-0.473	0.00111	-0.226
	(0.353)	(0.345)	(0.358)
inc25to50	-0.231	0.0519	0.00918
	(0.330)	(0.313)	(0.336)
inc51to75	0.00251	0.207	-0.0759
	(0.322)	(0.310)	(0.322)
expuser	-0.0548	-0.357	-0.164
	(0.255)	(0.253)	(0.259)
usemanure	0.134	0.120	0.0778
	(0.256)	(0.250)	(0.261)
customapp	-0.142	0.148	-0.185
	(0.267)	(0.261)	(0.269)
conservation	0.224	0.0693	-0.164
	(0.374)	(0.363)	(0.371)
notill	0.702*	0.392	0.164
	(0.355)	(0.352)	(0.351)
pennsylvania	0.226	0.350	-0.130
	(0.381)	(0.369)	(0.376)
maryland	-0.0374	0.220	-0.0129
	(0.279)	(0.277)	(0.286)
virginia	-0.447	-0.620	-0.223
	(0.397)	(0.393)	(0.403)
lessthanhs	-0.354	-0.865*	-0.442
	(0.513)	(0.501)	(0.524)
somecollege	0.582*	0.462	0.646*
	(0.334)	(0.332)	(0.350)
assoctech	0.0771	0.124	-0.255
	(0.384)	(0.367)	(0.377)
bs	0.135	0.354	0.0195
	0.171	0.00831	-0.183

Table B-19. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.436	0.456	0.540
	(0.440)	(0.432)	(0.458)
Constant	2.059***	1.765***	2.359***
	(0.482)	(0.449)	(0.466)
Observations	148	152	148
R-squared	0.143	0.116	0.076

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-20. Differences in impacts on farmers preferring to use practices they are more familiar with limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	0.0145	0.0725	0.0616
	(0.236)	(0.245)	(0.226)
prlandlease	0.127	-0.0371	0.248
	(0.306)	(0.317)	(0.290)
smallfarm	0.0652	0.337	0.228
	(0.264)	(0.278)	(0.252)
largefarm	-0.126	0.347	0.0997
	(0.306)	(0.322)	(0.286)
lessthan25	-0.384	0.192	-0.209
	(0.312)	(0.328)	(0.299)
inc25to50	-0.142	-0.159	-0.0833
	(0.288)	(0.306)	(0.277)
inc51to75	0.373	0.321	0.285
	(0.287)	(0.297)	(0.271)
expuser	-0.118	-0.503**	-0.333
	(0.228)	(0.238)	(0.217)
usemanure	-0.161	0.400*	0.389*
	(0.228)	(0.239)	(0.218)
customapp	-0.386	0.00245	-0.0504
	(0.239)	(0.250)	(0.225)
conservation	-0.268	-0.328	-0.393
	(0.328)	(0.344)	(0.311)
notill	-0.0725	-0.0631	-0.284
	(0.312)	(0.327)	(0.294)
pennsylvania	0.0765	0.139	0.00107
	(0.344)	(0.352)	(0.317)
maryland	-0.353	0.172	-0.267
	(0.249)	(0.264)	(0.237)
virginia	-0.130	0.123	0.0842
	(0.358)	(0.375)	(0.338)
lessthanhs	-0.0540	-0.219	0.447
	(0.463)	(0.458)	(0.440)
somecollege	0.282	0.320	-0.0283
	(0.302)	(0.314)	(0.289)
assoctech	-0.0537	-0.473	-0.0771
	(0.336)	(0.352)	(0.317)
bs	0.289	0.346	0.320
	(0.283)	(0.295)	(0.267)

Table B-20. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.701*	0.00610	0.511
	(0.396)	(0.414)	(0.385)
Constant	4.134***	3.014***	3.665***
	(0.410)	(0.429)	(0.392)
Observations	152	153	150
R-squared	0.111	0.123	0.125

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-21. Differences in impacts on farmers believing that new technologies are too difficult to use limiting farmers' use of the practice

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
under60	0.124	-0.159	0.177
	(0.241)	(0.250)	(0.254)
prlandlease	-0.390	-0.0191	-0.160
	(0.315)	(0.323)	(0.325)
smallfarm	0.125	0.462	0.385
	(0.270)	(0.284)	(0.283)
largefarm	0.0423	0.400	0.288
	(0.315)	(0.322)	(0.320)
lessthan25	0.246	0.218	0.141
	(0.321)	(0.333)	(0.336)
inc25to50	0.501*	0.388	0.0185
	(0.293)	(0.306)	(0.310)
inc51to75	0.466	0.511*	0.111
	(0.295)	(0.303)	(0.304)
expuser	-0.351	-0.493**	-0.214
	(0.234)	(0.242)	(0.243)
usemanure	0.131	0.324	0.342
	(0.234)	(0.243)	(0.245)
customapp	0.0879	-0.135	-0.422*
	(0.244)	(0.254)	(0.252)
conservation	0.0152	-0.321	0.453
	(0.337)	(0.350)	(0.349)
notill	0.294	0.0270	0.601*
	(0.321)	(0.333)	(0.330)
pennsylvania	0.357	0.162	0.159
	(0.353)	(0.358)	(0.355)
maryland	0.120	0.156	-0.203
	(0.255)	(0.266)	(0.265)
virginia	0.350	0.0428	-0.354
	(0.368)	(0.382)	(0.380)
lessthanhs	-0.556	-0.131	-0.388
	(0.476)	(0.466)	(0.494)
somecollege	-0.528*	0.217	-0.0792
	(0.310)	(0.319)	(0.325)
assoctech	-0.721**	-0.443	-0.466
	(0.345)	(0.359)	(0.355)
bs	-0.329	0.161	0.122
	(0.292)	(0.300)	(0.299)

Table B-21. Continued.

VARIABLES	(1) In-season N modeling	(2) Split N	(3) VRT
gradprof	0.211	0.0153	0.237
	(0.396)	(0.421)	(0.432)
Constant	3.028***	2.574***	2.882***
	(0.422)	(0.437)	(0.439)
Observations	153	154	150
R-squared	0.159	0.143	0.118

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Regression Results Tables: Sources of Information

Table B-22. Differences in impacts on the influence of various sources of information

VARIABLES	Family	Other farmers	Personal experience	University researchers	County extension	Private foundations	Farm Journals
under60	0.0412	0.317	0.245	-0.139	-0.0136	0.114	0.120
	(0.283)	(0.245)	(0.222)	(0.231)	(0.239)	(0.228)	(0.210)
prlandlease	-0.169	0.269	0.474	0.370	0.0921	-0.134	0.0873
	(0.367)	(0.318)	(0.288)	(0.300)	(0.310)	(0.295)	(0.272)
smallfarm	-0.338	0.198	-0.123	0.225	-0.127	-0.447*	-0.0359
	(0.316)	(0.275)	(0.249)	(0.259)	(0.268)	(0.255)	(0.235)
largefarm	0.693*	0.0405	-0.136	-0.457	-0.269	-0.0768	-0.588**
	(0.369)	(0.320)	(0.290)	(0.302)	(0.312)	(0.297)	(0.274)
lessthan25	0.0153	-0.0880	-0.443	-0.657**	0.0524	-0.262	-0.619**
	(0.374)	(0.324)	(0.294)	(0.306)	(0.316)	(0.301)	(0.278)
inc25to50	0.245	-0.0447	0.00445	-0.261	0.0232	-0.735***	-0.143
	(0.341)	(0.295)	(0.268)	(0.278)	(0.288)	(0.275)	(0.253)
inc51to75	0.154	-0.396	-0.146	-0.102	0.389	-0.0568	-0.143
	(0.347)	(0.301)	(0.273)	(0.284)	(0.294)	(0.280)	(0.258)
expuser	-0.234	0.212	0.0443	0.280	0.271	0.346	0.100
	(0.277)	(0.240)	(0.218)	(0.226)	(0.234)	(0.223)	(0.206)
usemanure	0.148	0.0212	0.225	0.0752	0.0841	0.351	-0.266
	(0.276)	(0.240)	(0.217)	(0.226)	(0.234)	(0.223)	(0.205)
customapp	0.131	0.00631	-0.231	-0.347	-0.0892	-0.0959	-0.0448
	(0.284)	(0.246)	(0.224)	(0.232)	(0.240)	(0.229)	(0.211)
conservation	0.192	-0.114	0.393	0.0210	-0.0396	0.118	-0.0776
	(0.395)	(0.343)	(0.311)	(0.323)	(0.334)	(0.318)	(0.293)
notill	0.616	0.0665	0.571*	0.109	-0.0516	0.421	0.0600
	(0.376)	(0.326)	(0.296)	(0.307)	(0.318)	(0.303)	(0.279)

Table B-22. Continued.

VARIABLES	Family	Other farmers	Personal experience	University researchers	County extension	Private foundations	Farm Journals
pennsylvania	0.319	0.289	-0.421	-0.410	-0.0979	0.328	0.146
	(0.396)	(0.344)	(0.312)	(0.324)	(0.335)	(0.319)	(0.294)
maryland	-0.165	-0.0682	-0.321	-0.553**	-0.231	-0.386	-0.181
	(0.299)	(0.259)	(0.235)	(0.244)	(0.253)	(0.241)	(0.222)
virginia	0.479	0.0733	-0.297	0.210	0.615	0.583	-0.0860
	(0.440)	(0.382)	(0.346)	(0.360)	(0.372)	(0.355)	(0.327)
lessthanhs	0.569	0.191	0.0579	-0.630	-0.518	-0.0185	0.0915
	(0.519)	(0.450)	(0.408)	(0.424)	(0.439)	(0.418)	(0.385)
somecollege	0.204	0.473	0.492*	0.603**	0.397	-0.0997	0.0991
	(0.366)	(0.318)	(0.288)	(0.299)	(0.310)	(0.295)	(0.272)
assoctech	0.304	0.202	-0.147	-0.0306	0.212	0.115	0.00518
	(0.414)	(0.359)	(0.326)	(0.339)	(0.351)	(0.334)	(0.308)
bs	-0.269	0.171	0.327	0.330	0.588**	0.364	0.0560
	(0.344)	(0.298)	(0.271)	(0.281)	(0.291)	(0.277)	(0.255)
gradprof	0.222	1.047**	0.859**	0.839**	0.534	-0.0601	0.617*
	(0.463)	(0.402)	(0.365)	(0.379)	(0.392)	(0.374)	(0.344)
Constant	2.108***	2.581***	3.451***	3.416***	3.159***	2.259***	3.395***
	(0.500)	(0.434)	(0.393)	(0.409)	(0.423)	(0.403)	(0.371)
Observations	152	152	152	152	152	152	152
R-squared	0.162	0.135	0.224	0.190	0.150	0.259	0.113

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table B-22. Continued.

VARIABLES	State Dept. of Agriculture	NRCS	County Conservation District	Crop Consultant Company	Independent Crop Consultant	Commodity boards
under60	-0.495**	-0.552**	-0.653***	-0.161	0.0935	0.00704
	(0.230)	(0.232)	(0.238)	(0.237)	(0.241)	(0.208)
prlandlease	0.224	-0.0123	0.291	0.0852	0.0886	-0.181
	(0.299)	(0.301)	(0.311)	(0.309)	(0.313)	(0.270)
smallfarm	0.0182	0.220	0.334	-0.252	-0.736***	-0.222
	(0.258)	(0.260)	(0.269)	(0.267)	(0.272)	(0.233)
largefarm	-0.196	0.0248	-0.0577	-0.238	-0.194	-0.134
	(0.301)	(0.303)	(0.311)	(0.311)	(0.315)	(0.272)
lessthan25	-0.153	-0.655**	-0.675**	-0.372	-0.261	0.0603
	(0.305)	(0.307)	(0.315)	(0.314)	(0.320)	(0.276)
inc25to50	-0.205	-0.707**	-0.683**	-0.110	-0.248	-0.152
	(0.278)	(0.280)	(0.292)	(0.287)	(0.293)	(0.251)
inc51to75	0.548*	-0.217	0.0956	0.0879	0.00858	0.322
	(0.283)	(0.285)	(0.292)	(0.298)	(0.296)	(0.256)
expuser	0.109	0.0180	0.252	-0.0254	-0.0709	0.424**
	(0.226)	(0.228)	(0.234)	(0.233)	(0.239)	(0.204)
usemanure	0.278	0.568**	0.445*	0.302	0.613**	0.0465
	(0.225)	(0.227)	(0.235)	(0.233)	(0.237)	(0.204)
customapp	0.150	0.226	-0.0195	0.119	0.151	-0.134
	(0.232)	(0.234)	(0.240)	(0.238)	(0.243)	(0.210)
conservation	0.0366	-0.519	-0.431	-0.120	-0.0856	0.412
	(0.322)	(0.325)	(0.333)	(0.332)	(0.337)	(0.291)
notill	-0.0375	-0.0826	0.203	-0.0971	0.115	0.596**
	(0.306)	(0.309)	(0.317)	(0.317)	(0.320)	(0.277)
pennsylvania	0.125	0.173	0.188	-0.364	-0.124	0.0988
	(0.323)	(0.325)	(0.334)	(0.334)	(0.338)	(0.292)

Table B-22. Continued.

VARIABLES	State Dept. of Agriculture	NRCS	County Conservation District	Crop Consultant Company	Independent Crop Consultant	Commodity boards
maryland	-0.413*	-0.337	-0.533**	-0.435*	-0.676***	-0.496**
	(0.243)	(0.245)	(0.252)	(0.252)	(0.256)	(0.220)
virginia	-0.303	-0.00946	0.00247	-0.311	-0.455	0.0221
	(0.359)	(0.362)	(0.372)	(0.360)	(0.375)	(0.325)
lessthanhs	-0.458	-1.132***	-1.135**	0.848*	0.677	-0.948**
	(0.423)	(0.427)	(0.437)	(0.433)	(0.442)	(0.383)
somecollege	0.378	0.548*	0.415	0.227	0.591*	-0.0697
	(0.299)	(0.301)	(0.309)	(0.309)	(0.312)	(0.270)
assoctech	0.113	0.0451	-0.109	0.182	0.488	0.147
	(0.338)	(0.341)	(0.349)	(0.349)	(0.353)	(0.306)
bs	0.173	0.188	0.278	0.116	0.439	0.224
	(0.280)	(0.283)	(0.291)	(0.290)	(0.296)	(0.254)
gradprof	0.474	0.0446	0.101	0.343	0.965**	0.115
	(0.378)	(0.381)	(0.392)	(0.391)	(0.397)	(0.342)
Constant	2.721***	3.210***	3.081***	3.660***	3.205***	2.131***
	(0.408)	(0.411)	(0.426)	(0.422)	(0.426)	(0.369)
Observations	152	152	151	152	151	152
R-squared	0.144	0.231	0.252	0.114	0.290	0.222

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Regression Results Tables: Types of Information

Table B-23. Differences in impacts on the helpfulness of various types of information

VARIABLES	(1) Case studies	(2) Economic budgets	(3) On-farm trials	(4) Testimonials	(5) University research summaries
under60	0.235	-0.0159	0.186	0.0564	-0.235
	(0.226)	(0.240)	(0.199)	(0.211)	(0.211)
prlandlease	-0.306	-0.202	0.328	-0.349	0.0210
	(0.291)	(0.310)	(0.257)	(0.272)	(0.273)
smallfarm	-0.167	-0.358	-0.0618	0.0565	-0.148
	(0.253)	(0.269)	(0.223)	(0.237)	(0.237)
largefarm	0.0754	-0.280	-0.138	0.253	-0.227
	(0.292)	(0.311)	(0.258)	(0.273)	(0.274)
lessthan25	-0.150	-0.133	-0.430	-0.175	-0.241
	(0.298)	(0.318)	(0.263)	(0.279)	(0.279)
inc25to50	-0.158	0.0505	-0.266	-0.424	-0.345
	(0.275)	(0.292)	(0.242)	(0.257)	(0.257)
inc51to75	0.528*	-0.0544	-0.196	0.0352	-0.0166
	(0.273)	(0.290)	(0.241)	(0.255)	(0.256)
expuser	-0.232	0.120	0.0184	-0.104	-0.155
	(0.221)	(0.235)	(0.195)	(0.207)	(0.207)
usemanure	0.245	0.296	0.0962	0.100	0.383*
	(0.220)	(0.234)	(0.194)	(0.206)	(0.206)
customapp	0.0129	-0.0483	-0.0169	-0.106	-0.157
	(0.224)	(0.239)	(0.198)	(0.210)	(0.210)
conservation	0.484	0.241	0.0212	-0.371	-0.185
	(0.315)	(0.335)	(0.278)	(0.295)	(0.295)
notill	0.224	0.0105	0.133	0.244	-0.0351
	(0.299)	(0.319)	(0.264)	(0.280)	(0.281)
pennsylvania	-0.153	0.145	0.0350	0.254	-0.412
	(0.316)	(0.336)	(0.279)	(0.296)	(0.296)
maryland	-0.274	0.0854	0.0315	-0.432*	-0.680***
	(0.239)	(0.254)	(0.211)	(0.223)	(0.224)
virginia	0.213	0.779**	0.196	0.182	-0.120
	(0.342)	(0.365)	(0.302)	(0.320)	(0.321)
lessthanhs	-0.0743	-0.258	0.591	-0.690*	-0.846**
	(0.420)	(0.447)	(0.371)	(0.393)	(0.393)
somecollege	-0.0562	-0.262	0.279	0.119	-0.0407
	(0.290)	(0.309)	(0.256)	(0.272)	(0.272)
assoctech	0.0194	0.288	0.493*	-0.245	-0.138
	(0.329)	(0.351)	(0.291)	(0.308)	(0.309)

Table B-23. Continued.

VARIABLES	(1) Case studies	(2) Economic budgets	(3) On-farm trials	(4) Testimonials	(5) University research summaries
bs	0.565**	0.798***	0.446*	-0.199	0.161
	(0.273)	(0.291)	(0.241)	(0.256)	(0.256)
gradprof	0.735*	0.719*	0.893***	0.0630	0.476
	(0.378)	(0.403)	(0.334)	(0.354)	(0.354)
Constant	3.062***	3.037***	3.615***	3.848***	4.118***
	(0.397)	(0.423)	(0.350)	(0.371)	(0.372)
Observations	152	152	152	152	152
R-squared	0.191	0.183	0.164	0.181	0.187

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Regression Results Tables: Methods of Communication

Table B-24. Differences in impacts on the helpfulness of various methods of communication

VARIABLES	Brochures	Emails	Farm demos	Field days	Farm school
under60	-0.222	0.278	0.107	-0.0342	0.0525
	(0.199)	(0.254)	(0.217)	(0.226)	(0.212)
prlandlease	0.163	0.148	0.395	0.209	0.315
	(0.258)	(0.330)	(0.280)	(0.292)	(0.274)
smallfarm	-0.118	-0.00417	0.188	0.156	-0.0618
	(0.223)	(0.293)	(0.243)	(0.253)	(0.237)
largefarm	-0.227	0.306	0.0206	0.0240	-0.258
	(0.258)	(0.329)	(0.281)	(0.293)	(0.275)
lessthan25	-0.352	0.110	-0.171	-0.200	-0.0254
	(0.263)	(0.346)	(0.286)	(0.298)	(0.280)
inc25to50	0.104	-0.193	-0.183	-0.174	-0.110
	(0.243)	(0.314)	(0.263)	(0.275)	(0.258)
inc51to75	0.291	0.108	-0.147	-0.244	-0.0528
	(0.241)	(0.314)	(0.262)	(0.273)	(0.256)
expuser	-0.00722	0.0845	-0.0699	-0.238	-0.240
	(0.195)	(0.253)	(0.213)	(0.222)	(0.207)
usemanure	-0.0555	0.332	0.480**	0.251	0.334
	(0.195)	(0.253)	(0.211)	(0.221)	(0.207)
customapp	-0.114	-0.0434	-0.381*	-0.241	-0.233
	(0.198)	(0.260)	(0.216)	(0.225)	(0.210)
conservation	-0.327	0.250	-0.0891	-0.0414	-0.130
	(0.278)	(0.359)	(0.303)	(0.316)	(0.295)
notill	-0.432	-0.367	0.142	0.297	0.0564
	(0.265)	(0.344)	(0.288)	(0.301)	(0.282)

Table B-24. Continued.

VARIABLES	Brochures	Emails	Farm demos	Field days	Farm school
pennsylvania	0.420	0.150	-0.332	-0.214	-0.0674
	(0.279)	(0.360)	(0.303)	(0.316)	(0.296)
maryland	-0.0845	-0.453	-0.443*	-0.312	-0.352
	(0.211)	(0.274)	(0.229)	(0.240)	(0.224)
virginia	-0.256	-0.141	-0.339	-0.250	-0.108
	(0.295)	(0.388)	(0.330)	(0.335)	(0.313)
lessthanhs	0.0803	-0.710	0.145	-0.244	-0.414
	(0.360)	(0.479)	(0.398)	(0.403)	(0.382)
somecollege	0.252	-0.0819	0.0294	0.0152	0.305
	(0.257)	(0.328)	(0.279)	(0.292)	(0.273)
assoctech	0.0504	0.423	-0.00912	0.0630	0.253
	(0.292)	(0.373)	(0.317)	(0.331)	(0.310)
bs	-0.0109	0.556*	-0.0969	0.125	-0.0160
	(0.242)	(0.309)	(0.263)	(0.275)	(0.257)
gradprof	0.809**	0.564	-0.00962	-0.000628	0.389
	(0.335)	(0.428)	(0.364)	(0.380)	(0.355)
Constant	3.715***	2.298***	3.851***	3.984***	3.671***
	(0.351)	(0.464)	(0.382)	(0.399)	(0.373)
Observations	153	149	153	154	153
R-squared	0.133	0.206	0.134	0.062	0.113

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B-24. Continued.

VARIABLES	Newsletters	Podcasts	Social media	Website /blog	YouTube
under60	-0.0182	0.298	0.393*	0.384*	0.384
	(0.182)	(0.211)	(0.218)	(0.212)	(0.252)
prlandlease	-0.199	-0.198	-0.0690	-0.202	-0.0255
	(0.235)	(0.273)	(0.283)	(0.275)	(0.327)
smallfarm	-0.0602	-0.118	0.192	0.0697	0.0664
	(0.204)	(0.243)	(0.252)	(0.244)	(0.290)
largefarm	-0.204	0.198	0.162	0.323	0.707**
	(0.236)	(0.272)	(0.283)	(0.274)	(0.331)
lessthan25	-0.664***	0.521*	-0.111	0.249	0.440
	(0.240)	(0.287)	(0.297)	(0.289)	(0.343)
inc25to50	-0.253	0.0550	-0.226	-0.114	-0.0417
	(0.222)	(0.260)	(0.269)	(0.262)	(0.311)
inc51to75	-0.0694	0.0231	-0.300	0.0540	0.346
	(0.220)	(0.260)	(0.270)	(0.262)	(0.311)
expuser	-0.194	-0.211	0.299	-0.0494	-0.223
	(0.178)	(0.210)	(0.217)	(0.211)	(0.254)
usemanure	0.147	0.602***	0.0315	0.249	0.544**
	(0.178)	(0.209)	(0.217)	(0.211)	(0.251)
customapp	-0.286	0.114	0.191	0.356	0.153
	(0.181)	(0.215)	(0.223)	(0.217)	(0.257)
conservation	-0.349	0.118	0.328	0.536*	0.194
	(0.254)	(0.297)	(0.308)	(0.299)	(0.356)
notill	-0.222	0.196	-0.219	0.159	-0.0555
	(0.242)	(0.285)	(0.296)	(0.287)	(0.342)
pennsylvania	0.0134	0.160	0.182	0.0968	-0.0379
	(0.254)	(0.298)	(0.309)	(0.300)	(0.357)

Table B-24. Continued.

VARIABLES	Newsletters	Podcasts	Social media	Website /blog	YouTube
maryland	-0.279	-0.144	-0.370	-0.273	-0.0662
	(0.193)	(0.227)	(0.235)	(0.229)	(0.272)
virginia	-0.277	0.747**	0.449	0.157	-0.211
	(0.269)	(0.321)	(0.333)	(0.324)	(0.387)
lessthanhs	-0.200	-0.885**	-0.242	-0.478	-1.069**
	(0.328)	(0.396)	(0.411)	(0.399)	(0.475)
somecollege	-0.259	-0.0438	0.199	0.379	0.592*
	(0.235)	(0.271)	(0.281)	(0.273)	(0.324)
assoctech	-0.0164	0.256	0.415	0.508	0.897**
	(0.266)	(0.309)	(0.321)	(0.311)	(0.371)
bs	-0.0473	0.170	0.220	0.522**	0.247
	(0.221)	(0.256)	(0.266)	(0.258)	(0.307)
gradprof	0.228	0.0704	0.137	0.407	0.403
	(0.305)	(0.354)	(0.367)	(0.357)	(0.423)
Constant	4.375***	1.232***	1.358***	1.043***	1.445***
	(0.321)	(0.384)	(0.398)	(0.387)	(0.459)
Observations	153	149	149	149	148
R-squared	0.187	0.223	0.211	0.236	0.248

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$