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Public Perception about Agricultural Pollution

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Public Perception about Agricultural Pollution in Mississippi

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ABSTRACT

Proliferation of chemical use in agriculture has led to increased public scrutiny and concern over potential environmental impacts. Consequently, attempts are being made to tighten the regulation of agricultural chemicals. As a driver of policy, public perception of agricultural pollution is important. At the same time, the development of precision application technology holds the promise of reducing agricultural pollution by using chemicals more efficiently. Thus, a survey of Mississippi residents was conducted to begin to assess public concerns and to gauge support for a program to encourage the adoption of precision application technology. Our survey uncovered interesting patterns in perceptions and suggested that there is general support for a program to encourage adoption of new technologies.

Keywords: nonpoint pollution, precision agriculture, public perception, surveys

Public Perception about Agricultural Pollution in Mississippi

INTRODUCTION

Use of agricultural chemicals has increased dramatically over the past 50 years. Over time, public awareness and concern over the use of these chemicals has increased as well. Scientific developments and public pressure have led to use of more "environmentally friendly" chemicals. However, public attention to chemical use and the impacts of chemicals on water quality, biodiversity, and human health continue to be intense. Since public concerns shape policy decisions, it is important to have information about the attitudes that shape public perception. Such information can be used to identify important issues and help design education programs. A primary objective of this study is to begin to assess public awareness and concern about agricultural pollution.

There is a growing body of literature relating to agricultural pollution (e.g., Abler and Shortle; Bosch, Cook, and Fuglie; Cabe and Herriges; Ervin; Franco, Schad, and Cady; Lichtenberg and Lessley; Napier and Brown; Pease and Bosch; Ribaudo and Horan). It is generally recognized that significant mitigation of pollution from point sources (pollution originating from a discrete, identifiable source) has been achieved since the implementation of the 1972 Clean Water Act. However, nonpoint pollution (NPP) of waterways – or pollution originating from runoff of chemicals and nutrients into bodies of water – is still a major problem. In fact, in 1996, the United States Environmental Protection Agency (USEPA) found that more than a third of all surveyed streams, lakes, rivers, and estuaries are not fully supporting of their designated uses (USEPA). NPP is believed to be the major reason for these deficiencies (USEPA; USDA), and agriculture is generally recognized as the largest contributor to NPP (USEPA).

Since NPP is a primary contributor to water quality problems, it is important to develop ways to decrease agricultural pollution in order to meet the goals of federal clean water standards. However, because of the large number of parties contributing to the problem, it is difficult to implement and monitor reduction programs. Thus far, education has been the primary method used to encourage reduction of agriculture-related NPP (Ribaudo and Horan). Education can be effective by encouraging altruistic behavior in agricultural producers. However, altruism is limited when a program is perceived as having negative impacts on profitability.

New techniques such as variable rate technology (VRT) and site-specific management (SSM) have shown some promise in reducing runoff of agricultural chemicals, thereby decreasing NPP (Khanna and Zilberman; Oriade et al.; Schnitkey and Hopkins). Precision application technology relies on the use of site-specific prescriptions to utilize chemicals more effectively. However, the effects of VRT and SSM on profitability are mixed. Relatively high investment/fixed costs for equipment used in VRT and SSM could result in negligible or negative impacts on profits, so that producers will have little incentive to adopt the new technology.

The broad consuming public would be the primary beneficiary of improved water quality brought on by a reduction in NPP, with benefits accruing in the form of improved recreation activity, enhanced aesthetics, and decreases in the cost of providing safe drinking water supplies. As such, there may be some support for a program that reduces NPP. In the case at hand, we assume that the public may show support through a willingness to pay (WTP) for subsidies that promote adoption of VRT and SSM practices. Such WTP would reflect a public desire to assist farmers in offsetting some of the high fixed costs of adoption in order to reduce agricultural NPP. A secondary objective of this analysis is to assess the general willingness of the public to support programs to encourage the adoption of VRT and SSM practices. Although the ultimate goal is to derive "willingness-to-pay" estimates, that analysis is not presented here. Rather, the objective is to present the general support for such programs along with the general perceptions and attitudes of the public toward agricultural pollution.

METHODS AND RESULTS

Public perception was gauged using a telephone survey of a random sample of 828 Mississippi residents. The questionnaire was designed to elicit information on attitudes, awareness, and concern about various government programs, agricultural production practices, and nonpoint pollution. In addition, respondents were asked if they would support a tax to encourage the use of precision application technology to reduce agricultural NPP. The survey was administered by trained enumerators at the Telephone Survey Center at the Mississippi State University Social Sciences Research Center. Discussion of results of a few of the most relevant questions and comparisons are summarized in the following pages.

Importance of National Goals to Protect the Environment

One of the primary questions in the survey relates to how the public perceives the importance of the environment in general. Respondents were asked, "How important do you feel is a national goal of protecting the environment?" Responses were first classified into five groups: "Farms" (respondent lived on a farm), "Nonfarm Open Country" (respondent did not live in a community but did not live on a farm), "Rural Communities" (communities with a population less than 10,000), "Urban Communities" (communities with a population greater than 10,000), and "Not Reported" (responses that did not report their type of residence). Table 1 shows the importance ascribed to a national goal of protecting the environment by respondent residence. As expected, most respondents believe that protecting the environment is important, and there appears to be no definitive pattern across residence types. Results of chi-square (CS) and likelihood ratio chi-square (LR) tests confirm that there is no difference in environmental attitudes between agricultural producers and their neighbors.

Examination of the responses to this question was also performed on the basis of age (Table 2). In general, the importance ascribed to the national goal of protecting the environment appears to decrease with age, although this difference is not statistically significant as measured by the CS and LR tests. The younger age group has a longer planning horizon and grew up in an age of enhanced environmental awareness. That is, the environment has been a topic of focus for much of their lives. Thus, we would have expected to see more pronounced differences among the age groups. Comparison on the basis of education (Table 3) reveals that those with a high school diploma or less were more likely to believe a national goal of protecting the environment was very important (although the percentages for the combination of somewhat and very important are similar). Based on statistical tests, the difference among education groups is significant at the 0.01 level. What is striking in this result is that the group with the lowest education level is the one that most strongly agrees with a goal of protecting the environment. Finally, respondents were asked if they had contributed to an environmental organization in the last 12 months. Approximately 69% of those contributing to environmental organizations believe that a national goal to protect the environment is very important compared to 55% for those who did not contribute to an environmental organization; CS and LR tests suggest that there is a significant difference between these groups (data not presented in a table).

Table 1. Attitudes toward the importance of a national goal to reduce pollution and protect the environment by respondent residence.[1]

Response	Farms n=71	Nonfarm open country n=211	Rural communities n=262	Urban communities n=259	Not reported n=25
Very important	63	55	64	57	56
Somewhat important	31	43	31	40	32
Not important	4	2	5	2	12
Don't know	1	1	1	1	0

Chi-Square(21) 22.92, p=0.35. Likelihood Ratio Chi-Square(21) 19.03, p=0.58.

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Table 2. Attitudes toward the importance of a national goal to reduce pollution and protect the environment by age of respondent.[1]

Response	18-30 years n=159	30-55 years n=406	55 and older n=263
Very important	62	59	57
Somewhat important	34	38	37
Not important	4	2	5
Don't know	0	0	2

Chi-Square(6) 8.53, p=0.20. Likelihood Ratio Chi-Square(6) 9.25, p=0.16.

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Table 3. Attitudes toward the importance of a national goal to reduce pollution and protect the environment by education of respondent.[1]

Response	High school diploma or less n=406	Some college to a bachelor's degree n=330	Some graduate work to professional degree n=69
Very important	63	55	58
Somewhat important	32	42	42
Not important	4	3	0
Don't know	1	0	0

Chi-Square(6) 16.72, p=0.01. Likelihood Ratio Chi-Square(6) 21.38, p=0.002

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

The Role of Technology in Reducing Pollution

A second issue of importance is how people feel about the effectiveness of technology in solving current environmental problems. Respondents were asked if they believed that "technology could be used to achieve a cleaner environment while promoting an increasingly good standard of living." The results by type of residence are shown in Table 4. Again, the majority of respondents agreed with this proposition, suggesting that the majority of the public is confident that technology can be used to mitigate pollution without adversely affecting their standard of living. However, those living on farms appear to be less confident in the positive benefits of technology. Based on the ratios of percentages who agree with the statement, people living in nonfarm, rural communities, and urban communities are 1.05 (79/75), 1.06 (80/75), and 1.09 (82/75) times more likely to agree that technology can be beneficial as compared to those living on farms. Although not substantially different, the apparent lower confidence in technology expressed by farmers is somewhat interesting. This could be a reflection of past negative experiences with technology, or it could simply reflect a general skepticism about the benefits of technology relative to the remainder of the population.

Difference among age groups is significant on the basis of the CS and LR tests. The younger age group was 1.15 times more likely to agree with the proposition relative to the oldest age group, while the middle age group was 1.01 times more likely to agree (Table 5). This appears to indicate a much stronger perception by the younger age group that technology can be used to mitigate problems. This result likely reflects the fact that individuals in the younger age group were born during the most recent technological boom and have become accustomed to (and possibly take for granted) the role of technology in problem solving. In addition, older people may have had more experience with failed technologies in the past.

Again, the results on this question were statistically significant at the 0.01 level with respect to education. Respondents with greater than a bachelor's degree were much more likely to believe that technology could be used to reduce pollution (Table 6). In fact, those with a high school diploma or less were 1.17 times less likely,

and those with some college to a bachelor's degree were 1.12 times less likely to agree with the proposition as compared to those with a postgraduate education. Although the majority of people in all categories agreed with the proposition, these results suggest that the level of education affects the perception about the effectiveness of technology. Finally, those who contributed to environmental organizations were 1.11 times more likely to believe that technology could be used to reduce pollution, although the statistical tests are inconclusive with respect to significance of the result (i.e., CS is insignificant, but LR test is significant at 90% level).

Table 4. Perception that technology can be used to reduce pollution while maintaining current standard of living by type of residence for respondent.[1]

Response	Farms n=71	Nonfarm open country n=211	Rural communities n=262	Urban communities n=259	Not reported n=25
Agree	75	79	80	82	84
Neutral	14	10	9	10	8
Disagree	1	5	6	3	8
Don't know	10	5	5	5	0

Chi-Square(21) 28.68, p=0.12. Likelihood Ratio Chi-Square(21) 32.58, p=0.05

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Table 5. Perception that technology can be used to reduce pollution while maintaining current standard of living by age of respondent.[1]

Response	18-30 years n=159	30-55 years n=406	55 and older n=263
Agree	87	79	78
Neutral	9	11	9
Disagree	3	6	3
Don't know	1	4	10

Chi-Square(6) 26.90, p=0.002. Likelihood Ratio Chi-Square(21) 28.11, p<0.00001.

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Table 6. Perception that technology can be used to reduce pollution while maintaining current standard of living by education of respondent.[1]

Response	High school diploma or less n=406	Some college to a bachelor's degree n=330	Some graduate work to professional degree n=69
Agree	78	81	91
Neutral	10	11	6
Disagree	6	4	1
Don't know	7	4	1

Chi-Square(6) 10.88, p=0.09. Likelihood Ratio Chi-Square(6) 12.19, p=0.06.

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Belief that Agriculture is a Source of Pollution

An important question is whether the public is aware of the scientific consensus (USEPA and USDA) that agriculture is the primary source of nonpoint pollution. Respondents were also asked if they believed that "some current agricultural practices resulted in nonpoint pollution" (Table 7). Interestingly, those living on farms were more likely to respond "yes" to this question, although the differences are not statistically significant. Nonfarm and rural communities were 1.22 and 1.17 times less likely to respond "yes" as compared to those living on farms, respectively. This seems to suggest that agricultural producers are, on average, more cognizant of the potential impacts of their practices than their nonfarm neighbors, which may be a result of the extensive educational programs that have been conducted on the subject (Ribaudo and Horan).

There is no definitive trend in the responses to this question on the basis of age (Table 8), although statistical tests suggest differences. The differences appear to be related to the fact that the middle age group is 1.12 times more likely to agree with the proposition as compared to the youngest group, and they are 1.16 times more likely to agree than the older age group. In addition, as education level of the respondents increases, there is a significant increasing trend in the belief that agriculture is a source of nonpoint pollution (Table 9). Those with a high school diploma or less are 1.25 times less likely to believe, while those with some college to a bachelor's degree are 1.11 times less likely to believe that agriculture is a source of nonpoint pollution as compared to those with postgraduate education.

Table 7. Perceptions that current agricultural production practices result in nonpoint pollution by type of residence for respondent.[1]

Response	Farms n=71	Nonfarm open country n=211	Rural communities n=262	Urban communities n=259	Not reported n=25
Yes	76	62	65	76	52
No	6	16	12	9	8
Don't know	18	22	23	16	40
Chi-Square(14) 19.16, p=0.16. Likelihood Ratio Chi-Square(14) 20.10, p=0.13.					

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Table 8. Perceptions that current agricultural production practices result in nonpoint pollution by age of respondent.[1]

Response	18-30 years n=159	30-55 years n=406	55 and older n=263
Yes	65	73	63
No	14	11	10
Don't know	21	16	27
Chi-Square(4) 18.43, p=0.001. Likelihood Ratio Chi-Square(4) 17.42, p=0.002.			

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Table 9. Perceptions that current agricultural production practices result in nonpoint pollution by education of respondent.[1]

Response	High school diploma or less n=406	Some college to a bachelor's degree n=330	Some graduate work to professional degree n=69
Yes	64	72	80
No	13	10	9
Don't know	24	18	12

Chi-Square(4) 12.86, p=0.01. Likelihood Ratio Chi-Square(4) 14.66, p=0.005.

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Perceptions that Current Agricultural Practices Reduce Biodiversity

The issue of the effects of pollution on biodiversity is also important. Respondents were asked if they believed that "pollution from agricultural sources causes reductions in biodiversity" (Table 10). There is no definitive pattern in the responses based on residence, a result that is borne out in statistical tests. However, urban residents were about 1.10 times more likely to say "yes" to this question than those living on farms.

It appears that the belief that agricultural practices reduce biodiversity decreases with the age of respondent (Table 11); both the CS and LR tests are significant at the 99% level or higher. The younger and middle age groups were 1.10 and 1.08 times more likely to agree with this statement than the older group. The opposite was true for education level (Table 12). In general, the more education, the more likely one is to believe that current agricultural practices reduce biodiversity.

Table 10. Perceptions that pollution created by agricultural production reduced biodiversity by type of residence of respondent.[1]

Response	Farms n=71	Nonfarm open country n=211	Rural communities n=262	Urban communities n=259	Not reported n=25
Yes	68	70	65	75	68
No	23	20	21	15	8
Don't know	10	10	15	10	24

Chi-Square(14) 19.16, p=0.16. Likelihood Ratio Chi-Square(14) 20.10, p=0.13.

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Table 11. Perceptions that pollution created by agricultural production reduced biodiversity by age of respondent.[1]

Response	18-30 years n=159	30-55 years n=406	55 and older n=263
Yes	72	70	65
No	19	21	16
Don't know	9	9	19

Chi-Square(4) 18.43, p=0.001. Likelihood Ratio Chi-Square(4) 14.42, p=0.002.

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Table 12. Perceptions that pollution created by agricultural production reduced biodiversity by education of respondent.[1]

Response	High school diploma or less n=406	Some college to a bachelor's degree n=330	Some graduate work to professional degree n=69
Yes	66	71	83
No	19	20	14
Don't know	15	10	3
Chi-Square(4) 12.86, p=0.01. Likelihood Ratio Chi-Square(4) 14.66, p=0.005.			

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Concern for the Effects of Different Pollutants

An important determinant of public perception is the level of concern about the effects of pollutants on human health and environmental quality. Responses on the basis type of residence are shown in Table 13. In general, the level of concern appears to be highest among rural community residents, but the only significant results in the table are those for concerns about chemical fertilizers.

Table 13. Levels of concern about the effects of various pollutants on food safety and biodiversity by type of residence of respondent.[1]

Response	Farms n=71	Nonfarm open country n=211	Rural communities n=262	Urban communities n=259	Not reported n=25
Effects of Chemical Fertilizers on Fruits and Vegetables on Human Health					
Very	48	51	63	53	60
Somewhat	30	30	21	27	24
Little	13	12	9	15	16
Not	10	7	6	3	0
Don't know	0	1	0	2	0
Chi-Square(12) 20.95, p=0.05. Likelihood Ratio Chi-Square(12) 21.09, p=0.05.					
Effects of Pesticides on Fruits and Vegetables on Human Health					
Very	61	61	67	64	84
Somewhat	20	25	23	20	8
Little	10	8	5	11	4
Not	7	6	5	4	4
Don't know	3	1	0	1	0
Chi-Square 18.51(15), p=0.24. Likelihood Ratio Chi-Square(15) 21.09, p=0.36.					
Effects of Fertilizers and Pesticides on Biodiversity					
Very	46	43	48	41	56
Somewhat	31	37	30	36	24
Little	10	10	8	14	4
Not	4	4	8	5	8
Don't know	8	6	5	5	8
Chi-Square 14.78(15), p=0.47. Likelihood Ratio Chi-Square(15) 14.61, p=0.48.					

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Public Support for a Tax to Encourage Adoption of Precision Application Technology

To assess public support of subsidies that encourage adoption of variable rate technology (VRT) and site-specific management (SSM) practices, respondents were asked to express their willingness to support a one-time tax. The question was posed as a referendum, and respondents were told that the purpose of the tax was to pay for the equipment necessary for all crop farmers to adopt VRT technology. An approximate value for the tax was calculated by assuming that one sprayer could cover 1,000 acres three times during one year. Thus, the approximate number of sprayers needed to apply chemicals to all acres was calculated as total U.S. crop acres divided by 1,000. This was multiplied by $20,000 per sprayer, the assumed cost to retrofit sprayers to accommodate variable rate equipment (costs provided by GPS, Inc., Greenwood, Mississippi, for GPS equipment, VRT controllers for sprayers, and a computer to interpret prescriptions and control the sprayer). Finally, the estimated total cost was divided by the number of individual tax returns filed in 1997 to arrive at a per-taxpayer cost of $57 to purchase all VRT equipment.

Respondents were randomly asked if they would support a tax of $25, $50, $100, or $150. Respondents were told that the ultimate impacts of the precision application technology were not yet known.

However, based on bioeconomic modeling, reductions in chemical (fertilizer and pesticide) runoff could be reduced by 10-20%. The bioeconomic model used was the Environmental Policy Impact Calculator (EPIC), which simulated the potential impacts of precision application technology on nitrogen and phosphorous runoff from the edge of a field. Due to the uncertainty of the final impacts, these reductions could only be expected to prevent bodies of water from becoming more polluted.

Survey results on the basis of residence are presented in Table 14. Those living on farms were less likely to vote for the tax than were other groups. Although the results are not statistically significant, this result still poses an interesting question. Why would the primary beneficiary of the program be least likely to support it? One potential reason may be the “free-rider” problem. That is, farmers may realize that the public will support such a program, so there is no need for them to lobby in its favor.

In a follow-up question, those who said they would not vote for the program were asked their most likely reason. For farmers, 22% of the respondents said that they believed that precision application technology would not help the environment. However, the most commonly cited (39%) reason was that they already paid too much in taxes. Alternatively, although not asked, farmers may also perceive that this technology would be detrimental to their profits. Current literature suggests that, at best, there is no change in per-acre profits with the use of this technology. Work by Khanna, Epouhe, and Hornbaker suggests that the lack of demonstrated effects of VRT technology on yields, input use, and profitability is the likely cause of current low adoption rates. If producers truly feel this way, and there is no reason to suspect they do not, they might be less likely to support the program (i.e., adopt the technology) even if it were subsidized.

On the basis of age (Table 15), the younger age group was significantly more likely to support the tax (1.41 times as likely as the oldest age group). Although slightly smaller, the middle age group was 1.29 times more likely to support the tax than the oldest age group. Interestingly, these results cannot be explained by the fact that farmers are older. In fact, 52% of the farmers in this sample fell into the middle age group. Thus, there appears to be some other factor that motivates the difference in willingness to support the tax on the basis of age. By contrast, there does not appear to be any significant trend in response on the basis of education (Table 15).

Table 14. Willingness to support some level of tax to subsidize the adoption of precision application equipment to reduce agricultural nonpoint pollution by type of residence of respondent.[1]

Response	Farms n=71	Nonfarm open country n=211	Rural communities n=262	Urban communities n=259	Not reported n=25
Yes	56	61	65	65	40
No	25	24	24	22	40
Don't know	18	15	11	13	20

Chi-Square(9) 7.08, p=0.63. Likelihood Ratio Chi-Square(9) 7.11, p=0.62.

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Table 15. Willingness to support some level of tax to subsidize the adoption of precision application equipment to reduce agricultural nonpoint pollution by age of respondent.[1]

Response	18-30 years n=159	30-55 years n=406	55 and older n=263
Yes	72	66	51
No	21	22	29
Don't know	6	12	19

Chi-Square(6) 24.46, p=0.001. Likelihood Ratio Chi-Square(6) 28.33, p=0.001.

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

Table 16. Willingness to support some level of tax to subsidize the adoption of precision application equipment to reduce agricultural nonpoint pollution by education of respondent.[1]

Response	High school diploma or less n=406	Some college to a bachelor's degree n=330	Some graduate work to professional degree n=69
Yes	63	64	65
No	23	24	23
Don't know	14	12	12

Chi-Square(6) 1.82, p=0.93. Likelihood Ratio Chi-Square(6) 2.21, p=0.90.

[1]n = number of respondents. Numbers in each column are percentages. Columns may not sum to 100% due to rounding.

DISCUSSION AND CONCLUSIONS

This paper attempts to provide an understanding of public perception regarding agricultural pollution and its relation to technology. In general, there are some interesting differences in perceptions and attitudes between the farm community and their more urbanized counterparts. For example, farmers appear to be more skeptical about the potential benefits of technology in reducing pollution and seem to be more cognizant of the fact that current agricultural practices result in non-point pollution. In addition, farmers were, in general, less likely to support a tax to subsidize the adoption of precision application technology.

Two general preliminary conclusions can be drawn from this survey. First, there appears to be a high degree of awareness and concern for both agricultural pollution and its impacts. This is not surprising given the considerable media attention to the subject and is consistent with the available body of scientific evidence. Second, there appears to be broad-based public support for subsidization of adoption of variable rate technology (VRT) and site-specific management (SSM) practices. This seems to suggest that while the public is both aware of and concerned with agricultural pollution, they would support and be willing to pay for technological solutions to the problem, provided producers are not harmed. Thus, despite the level of concern, we appear to still be operating in an environment that is generally supportive of agriculture.

Two general limitations to this study should be noted. First, the survey was limited to Mississippi residents. Mississippi is primarily a rural state that still relies heavily on agriculture for its income either directly or indirectly. A survey in a more urbanized, industrial state may yield different results. The goal is to extend this research to a national level using the lessons learned in Mississippi to guide modifications to the survey instrument.

One of those lessons relates to the adoption of VRT and SSM practices. That is, agricultural producers in this survey were not asked if they had already adopted VRT and SSM practices. If producers had already adopted these practices, it may influence their willingness to support a program to encourage adoption of the technology. However, agricultural producers comprised only about 10% of the sample, so the likelihood that this affected the overall results is small.

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