

## **Pennsylvania Agricultural Producers' Observations of Changing Environmental Conditions: Implications for Research and Extension**

### **Abstract**

To understand environmental conditions Pennsylvania agricultural producers had observed in the past and what their environmental concerns were for the future, we conducted a statewide survey. We used Spearman rank order correlations to show differences between past observations and future concerns regarding environmental conditions and found a disconnect between what respondents previously had observed and their anticipations for the future. Additionally, we used chi-square analysis to determine whether perspectives on environmental conditions were related to producer demographic characteristics. Two demographic variables were significant: generation of farmer and political affiliation. Our findings can assist Extension professionals in developing programs tailored to target audiences' environmental perceptions and demographics.

**Keywords:** [climate change](#), [Pennsylvania farmers](#), [changing environmental conditions](#)

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## **Introduction and Need**

In the northeastern region of the United States, agriculture is being affected by climate change, as evidenced by increases in storm variations, precipitation, and temperature (Romero-Lankao et al., 2014). Climate change adaptation and mitigation strategies for agriculture exist; however, agricultural producers are reluctant to adopt these new technologies (Arbuckle et al., 2014). Understanding how northeastern agricultural producers have observed the environmental conditions they experience daily can inform climate change programming outreach for this target audience.

From an extensive literature review, consisting of over 70 articles on studies conducted across the country and focused on farmer perceptions of climate change, researchers determined that only four empirical studies had been conducted in the Northeast (Chatrchyan et al., 2017). Although climate change is felt globally, it is

interpreted locally, creating a need to better understand regional, state, and individual perspectives.

Accordingly, we explored Pennsylvania farmers' perceptions of environmental conditions and ways in which researchers and Extension professionals can work with producers to manage impacts experienced from changing environmental conditions.

The conceptual framework we used in our study stemmed from Wheaton and MacIver's (1999) adaptation cycle. We applied the adaptation cycle, consisting of five key questions for addressing the process of adaptation, to better understand the specifics of adaptation in response to climate change. The five key questions are as follows: Who adapts? What do they adapt to and why? How do they adapt? How well do they adapt? What impacts result? We focused on the question *Who, or what system, adapts?* by exploring relevant characteristics of agricultural producers in Pennsylvania.

## Purpose and Objectives

Our study stemmed from a larger one that more comprehensively examined Pennsylvania agricultural producers' perspectives on climate change. The purpose of our study, specifically, was to examine the environmental conditions agricultural producers perceive. Two objectives guided the study: (a) Determine Pennsylvania agricultural producers' perceptions about whether they had observed certain environmental conditions (e.g., drought) during the preceding 10 years relative to the broader context of the preceding 20 years and whether they were concerned about those same environmental conditions as they looked toward the coming 10 years, and (b) determine whether Pennsylvania agricultural producers' perceptions of environmental conditions are related to their demographic characteristics.

## Methodology

The population for our study was statewide Pennsylvania agricultural producers ( $N = 59,309$ ). On the basis of our sampling list of available Pennsylvania agricultural producers, we had a target population of 3,860 producers. Using Krejcie and Morgan's (1970) sampling procedures, we determined that we would use a sample size of 357 producers, reflecting a 5% sampling error. To compensate for sampling limitations, we oversampled, surveying a total of 500 producers.

We developed a six-section survey instrument that was reviewed by a panel of experts; we field and pilot tested the instrument to ensure validity and reliability. The items on the survey involved the use of nominal, ordinal, and ratio scales. Five mailings occurred over an 8-week period (Dillman, Smyth, & Christian, 2014). In total, 260 surveys (52.1%) were returned, with 252 surveys (50.5%) usable for analysis. Early respondents, late respondents, and nonrespondents (contacted through phone calls) were compared relative to key questions on the survey. No significant differences were found among the groups; thus, we determined that the results were generalizable to the target population (Miller & Smith, 1983; Radhakrishna & Doamekpor, 2008).

Participants were asked two questions regarding certain environmental conditions: one about their observations of the environmental conditions during the preceding 10 years relative to the broader context of the preceding 20 years and another about their concerns about the occurrence of the environmental conditions in the coming 10 years. For both questions, the same 14 known environmental conditions for the area were listed, and producers responded by indicating "yes," "no," or "unsure" for each condition. For the purpose of identifying characteristics of the agricultural producers and their farms, the instrument included

demographic questions on eight topics: age, gender, ownership or rental of portions of farmland, generation of farmer, political affiliation, retirement plans, level of education, and annual net income. We conducted descriptive and nonparametric statistical analyses to summarize the data.

## Results

### Demographic Profile

Producers' average age was 59 years old, with a range of 22 to 90 years. The overwhelming majority of respondents (95%) were male. A majority of the respondents (67.5%) indicated that they owned and rented portions of their land and were the primary operators. Over half of the respondents (51.6%) were at least fourth-generation farmers. With regard to political affiliation, the majority of respondents (67.8%) identified with the Republican Party. Concerning retirement plans, 53.0% indicated that they were not planning to retire in the subsequent 5 years. Over half of the respondents (54.4%) had a high-school-level education, and another 40.8% had education through undergraduate or professional degrees. As for income level, over half of the respondents (58.6%) had an annual net income of \$74,999 or less.

### Objective One: Pennsylvania Agricultural Producers' Perceptions of and Concerns about Environmental Conditions

As shown in Table 1, respondents indicated distinct differences regarding their observations of environmental conditions during the preceding 10 years and their concerns about future environmental conditions. Regarding environmental conditions observed during the preceding 10 years relative to the broader context of the preceding 20 years, the most frequently observed conditions, as indicated by percentages of responses, were *warmer winter temperatures*, *abnormal precipitation events*, and *late frosts*. However, respondents' selections of conditions that concerned them relative to the future were not reflective of their past observations. The top three conditions respondents were concerned about for the future were *drought*, *abnormal precipitation events*, and *increased pests*. The condition *abnormal precipitation events* did carry over, but the two other top conditions producers were concerned about relative to the future ranked 7th and 8th as conditions they had observed in the past. These results indicate a lack of alignment between what producers had observed in the past and what their concerns were for the future.

**Table 1.**

Order of Agricultural Producers' Observations of Past Environmental Conditions and Concerns About Future Environmental Conditions

<b>Environmental condition</b>	<b>Past-10-years observations (rank)</b>	<b>Future-10-years concerns (rank)</b>
Warmer winter temperatures	1	6
Abnormal precipitation events	2	2
Late frosts	3	11
Warmer summer temperatures	4	7
Excessive winds	5	5

Longer growing season	6	14
Drought	7	1
Increased pests	8	3
Increased diseases	9	4
Increased parasites	10	8
Increased flooding	11	9
Colder summer temperatures	12	12
Colder winter temperatures	13	13
Early frosts	14	9

*Note.* Ranking order was determined according to frequency of response rates of producers.

We calculated Spearman rank order correlation (Mendenhall & Ramey, 1973) to determine the agreement between producers' past observations and their concerns about the future. Although lack of alignment in rankings existed, no significant disagreement was noted. The obtained value of  $r_s = .452$  was similar to the critical value of  $r_s = .457$  at the .05 level.

## Objective Two: Associations Between Pennsylvania Agricultural Producers' Perceptions of or Concerns About Environmental Conditions and Select Demographic Characteristics

We used chi-square analysis to explore associations between respondents' demographic characteristics and their past observations of environmental conditions (see Table 2). Of the eight demographic variables studied, only two—"generation of farmer" and "political affiliation"—were significantly correlated with environmental conditions producers perceived they had observed during the preceding 10 years. The demographic variable "generation of farmer" was assessed through four response options: *first generation*, *second generation*, *third generation*, and *fourth generation or higher*. When we analyzed this variable with regard to association with respondents' perceptions of environmental conditions, we found that the response *fourth generation or higher* was significant. The demographic variable "political affiliation" was assessed through four response options: *Democrat*, *Republican*, *other*, or *not applicable*. When we analyzed this variable with regard to association with respondents' perceptions of environmental conditions, we found that the response *Republican* was significant. These significant relationships indicate that there are associations between one's generation as a farmer and perceptions of environmental conditions and one's political affiliation and perceptions of environmental conditions, specifically concerning producers who are at least fourth-generation farmers and those who affiliate with the Republican Party. In particular, the variable "generation of farmer" was related to six of the 14 environmental conditions producers had observed in the past, and "political affiliation" was related to seven of the 14 conditions.

To assess how fourth-generation farmers and Republicans compared to their peers, we performed an analysis to identify correlations between first- through third-generation farmers and fourth-generation farmers and between non-Republicans and Republicans. While directionality was not a primary concern, the most notable

differences in rank order were that *warmer summer temperatures* ranked as the 3rd highest condition observed in the past for first- through third-generation farmers but ranked 7th highest for fourth-generation farmers. As for political affiliation, *warmer summer temperatures* ranked as the 3rd highest condition observed in the past for non-Republicans but ranked 6th highest for Republicans.

**Table 2.**

Chi-Square Significance for Observed Past Environmental Conditions

Environmental condition <sup>a</sup>	Generation of farmer <sup>b</sup>	Political affiliation <sup>c</sup>
	$\chi^2$	$\chi^2$
Warmer winter temperatures	14.04*	8.26*
Abnormal precipitation events	9.62*	5.67
Late frosts	9.10*	2.34
Warmer summer temperatures	12.34*	7.21*
Excessive winds	2.14	6.44*
Longer growing season	12.03*	1.15
Drought	5.03	2.10
Increased pests	5.91	9.86*
Increased diseases	4.81	12.12*
Increased parasites	9.89*	9.88*
Increased flooding	3.01	8.81*
Colder summer temperatures	1.94	0.04
Colder winter temperatures	2.64	3.44
Early frosts	4.40	0.27

<sup>a</sup>Order based on ranking of observed past environmental conditions. <sup>b</sup>Respondents selected from *first generation*, *second generation*, *third generation*, or *fourth generation or higher*. <sup>c</sup>Respondents selected from *Democrat*, *Republican*, *other*, or *not applicable*.

\* $p < .05$ .

We also used chi-square analysis to explore associations between respondents' demographic characteristics and their concerns about future environmental conditions (see Table 3). Of the eight demographic variables examined, only "political affiliation" was significantly correlated with producers' concerns about environmental conditions relative to the coming 10 years. As indicated previously, study participants consistently selected the response option *Republican*, indicating that it is Republican Party affiliation that is associated with the concerns about future environmental conditions. Specifically, "political affiliation" was related to seven of the 14 environmental conditions.

To assess how Republicans compared to their peers, we performed an analysis to identify correlations

between non-Republicans and Republicans. There were no major differences (rank order differences of more than two placements) between non-Republicans and Republicans with regard to concerns about future environmental conditions.

**Table 3.**

Chi-Square Significance for Concerns about Future Environmental Conditions

<b>Environmental condition<sup>a</sup></b>	<b>Political affiliation<sup>b</sup></b>
	<b>χ<sup>2</sup></b>
Drought	3.07
Abnormal precipitation events	7.17*
Increased pests	4.87
Increased diseases	7.03*
Excessive winds	3.01
Warmer winter temp	12.53*
Warmer summer temp	9.27*
Increased parasites	12.26*
Increased flooding	6.97*
Early frosts	1.46
Late frosts	7.27*
Colder summer temp	2.26
Colder winter temp	1.56
Longer growing season	2.43

<sup>a</sup>Order based on ranking of concerns about future environmental conditions. <sup>b</sup>Respondents selected from *Democrat, Republican, other, or not applicable*.

\**p* < .05.

## Conclusions

The results of our study illustrate some similarities between environmental conditions producers had observed in the past and their concerns about the future. One example is that the condition *abnormal precipitation events* was ranked 2nd highest relative to both past observations and concerns about the future. However, there also were discrepancies in participants' responses. Although many producers indicated having observed *warmer winter temperatures* and *late frosts* during the 10 years preceding the study, there did not seem to be a high concern about these conditions relative to the coming 10 years, with the conditions ranking 6th and 11th, respectively, in that regard. Interestingly, the top concerns relative to the coming 10 years were *drought* and *increased pests*. Previous literature has suggested that both of these conditions are products of warmer winters, with increases in pests occurring as a result of decreases in snowpack, which

allow pests to linger (Horton et al., 2014). These results indicate a potential producer disconnect between felt environmental conditions and the cause of those conditions.

As the second objective was to determine associations between perceptions of environmental conditions and select demographic characteristics, it is notable that the average age of our study's respondents was 59 years, which is in alignment with the national average (U.S. Department of Agriculture, 2012); therefore, asking respondents to think about the preceding 10 years relative to the broader context of the preceding 20 years was appropriate. Specifically considering the variable "generation of farmer," there was a high response rate to the answer option *fourth generation or higher*, indicating that many respondents were part of a long-standing tradition of farming as a family career choice. Due to this variable's being significant in relation to observation of past environmental conditions, it stands that there is a connection between the tradition of being a producer and the types of environmental concerns of a producer. This response is supported by Wheeler, Zuo, and Bjornlund (2013), who tested for a "tradition" factor with farmers in Australia. They found that belief in climate change was associated with having a less traditional motivation for farming, which is supportive of our findings regarding the role of one's generation as a farmer.

For the variable "political affiliation," the majority of respondents (67.8%) indicated affiliation with the Republican Party. This political affiliation, when considered along with respondents' past observations and concerns about the future, could be indicative of ways the producers respond to farm politics. For example, perhaps Republican respondents had a greater concern regarding certain future environmental conditions due to government management of impacts of the conditions.

## **Recommendations for the Profession**

Our study provides insight into the environmental conditions Pennsylvania agricultural producers have observed and their concerns about future environmental conditions. The findings can assist outreach educators in conducting climate change outreach regarding the best ways to engage agricultural producers when conversing about climate change adaptations. This can be done through being mindful of the generational roles and political affiliations of producers. Taking proactive steps, such as understanding whether producers are multigenerational farmers, knowing their viewpoint on climate change, and determining their political affiliation, will go a long way toward addressing the impact of observed changes in environmental conditions. For example, when talking with producers who are third- or fourth-generation farmers, conversing about environmental changes as seen with temperature or precipitation is likely to be better received than having a direct conversation about climate change, as this conversation is not one previous farming generations have likely participated in.

On the basis of our findings, we make the following observations and recommendations:

1. Research faculty and Extension program staff involved in climate change efforts should understand the roles that generational farming and politics play in their target audiences' receptivity to conversations about changes in environmental conditions. This understanding could aid in the development of climate change programs and decision-support tools that have a greater chance of being accepted and incorporated by producers.
2. Given the evidence of the effects of climate change on farms in Pennsylvania and throughout the Northeast, our findings should be used to better understand the top future environmental conditions and

the best adaptation methods for producers to manage those conditions. Additionally, our research methodology can be used to understand the individual needs of farming communities. Such proactive effort may serve as a springboard for future research and Extension programming efforts.

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