Investigating Small-Scale Farmers' Perceptions of Climate Change in Northwestern Pennsylvania: Implications for Agricultural Sustainability

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Abstract
Pennsylvania has experienced significant temperature increases and precipitation changes since the early 1900s, with projections indicating further warming and increased rainfall by 2050. Projected impacts such as an increase in intense precipitation events and rising temperatures will cause crop damage and an overall decrease in farm production in crops and livestock. In the state of Pennsylvania, agriculture is crucial to the economic and cultural landscape. Farmers in this region are disproportionately impacted by climate change, yet their perspectives often remain understudied. By conducting a focus group of four small-scale farmers from Crawford County, this study highlights the nuanced insights into farmers' risk perceptions, adaptation strategies, and willingness to engage in climate change efforts. These findings highlight the complex relationship between climate change impacts, local food production, and farmers' perceptions while providing insights and strategies for promoting sustainability within food systems. Future research should explore the viability of farmers' proposed solutions for addressing climate issues, examine the long-term effects of changing weather patterns on ecosystem biodiversity, evaluate the effectiveness of small-scale farmers' adaptation strategies, and continue exploring climate perceptions within underrepresented communities.

Introduction

According to the Intergovernmental Panel on Climate Change (IPCC), anthropogenic effects of climate change have already impacted ecosystems globally, creating negative implications for the security of our global food systems (Bezner et al. 2022). Yet only 72% of Americans believe climate change impacts their local community, and 16% of Americans perceive little or no impact that global warming will impose on their local community (Yale Climate Opinion Maps, 2023). In 2021, only half of Americans believed that human activity has contributed to global warming, and the other half believed that anthropogenic activities are not the cause of climate change (Funk et al. 2021). Moving into the near future, climate change will pose new problems for US agriculture because it is hard for farmers to adapt to unpredictable weather changes. Globally, farmers are disproportionately affected by climate change, making them a vulnerable group to changing climate patterns. This will have a direct impact on our food systems and increase food insecurities globally (Bezner et al. 2022).

In the United States, adaptation to climate change will be necessary for approximately half of the nation's production of high-value specialty crops, including fruits and vegetables. This is because a significant portion of the country's high-value specialty crops, such as fruits and vegetables, are grown in regions that are susceptible to the impacts of climate change. This will be especially challenging since the demand for these crops is projected to increase (Frisvold et al. 2013). Changes projected to occur in various regions of the United States may include “more frequent episodes of increases in temperatures, less frequent episodes of extremely cold temperatures” (Ishtiaque, 2023) and “changes in temperature, level, and type of precipitation, and the timing of mountain snowmelt and runoff into lower elevations agricultural regions” (Frisvold et al. 2013). These new and unexpected weather conditions can lead to lower yields and potentially decreased productivity and profitability for farmers. Climate researchers firmly believe that climate change will exacerbate the issues of food insecurity globally, especially in areas already suffering from hunger and undernutrition (Wheeler and von Braun, 2013). Wheeler and von Braun (2013) suggest that food insecurity issues, such as access to adequate nutritious foods especially those provided by domestic production and imports, will be impacted. Other studies such as one produced by Ishtiaque (2023) have suggested various adaptation strategies or modifications to current adaptation strategies to address the potential challenges associated with climate change such as:

1. Changes in planting and harvesting practices.
    a. Suggestions included planting earlier or planting seeds deeper to retain moisture and allow crops to mature sooner and harvesting earlier to avoid the dry and warm conditions impacting productivity and crop loss.
2. Tactics to conserve moisture and combat drought.
    a. Encouraging tactics such as rainwater harvesting, substituting water-intensive crops for drought-resistant crops, and conservation tilling.
3. Microclimate modification
    a. Encouraging implementation of riparian buffer zones, to reduce erosion, high tunnels, or "shelterbelt systems", to reduce wind speed.
4. Irrigation scheduling
    a. Reduce the cost of high-efficiency irrigation systems
    b. Collaboration between farmers and soil scientists to identify best practices and schedules for irrigation.
5. Government crop insurance programs
    a. Modify commodity or crop insurance programs to be more flexible
    b. Allow farmers to choose from a variety of crops to insure and ensure insured farmers will not be penalized for potentially choosing between subsidized and more stress-resistant varieties of crops.

However, some of these suggestions were provided assuming that severe warming will be accompanied by a decrease in summer precipitation (Easterling, 1996). With a significant portion of the U.S. agricultural sector at risk from unpredictable weather patterns, adaptation measures are becoming more essential. However, in order to effectively adapt to climate change and maintain the resilience of our food systems in the face of changing environmental conditions, cooperative efforts, well-informed policies, and innovative agricultural methods are needed (Amaru & Chhetri, 2013).

Climate Change in the Commonwealth of Pennsylvania

Agriculture is an important livelihood for many small-scale farmers who provide for themselves and their communities. The Pennsylvania Department of Environmental Protection has highlighted the many ways climate change will exacerbate current agricultural issues and

introduce new problems as well. Pennsylvania has experienced significant temperature increases and precipitation changes since the early 1900s, with projections indicating further warming and increased rainfall by 2050. Crawford County, specifically, faces rising temperatures, more heavy rainfall events, and heightened flood risks (City of Meadville, 2022). Projected impacts such as an increase in intense precipitation events and rising temperatures will cause crop damage and an overall decrease in farm production in crops and livestock (PA DEP, n.d.). In the state of Pennsylvania, agriculture is crucial to the economic and cultural landscape. In fact, the Commonwealth of Pennsylvania "is recognized as a national and global leader in the agriculture and food industry." (Team Pennsylvania, 2018). This is because Pennsylvania is a leading producer of dairy and livestock products, the top 5 agricultural commodities in 2022 were dairy products such as milk, chicken eggs, broilers, corn, and cattle (USDA, 2023b). According to the Census of Agriculture of Pennsylvania in 2017, there were around 53,157 farms with an average farm size of 137 acres (USDA, 2023b). Of those farms, more than half, 62.5%, are only 1 to 99 acres in size. The USDA classifies small-scale farms as those with 231 acres or less, and that produce less than $250,000 of agricultural products annually (USDA, 2023b). The primary agricultural products grown by small-scale farmers in Pennsylvania are 30.5% oilseed and grains, 8.3% vegetables and melons, 5.6% fruit and tree nuts, 9.8% floriculture, 0.6% tobacco, 45.6% hay, 25.6% beef, 45% dairy cattle and milk, 1.5% hogs and pigs, 4.6% poultry and eggs, 6.1% sheep and goats, and lastly, 16.9% aquaculture (Kelsey et al. 2021). Small-scale farms that produce $100,000 or more in revenue in Pennsylvania play a crucial role in agricultural production, with a majority of the state's farm output coming from a relatively small number of these farms; specifically, the 11,348 farms with $100,000 or more in annual sales accounted for 92.4% of such sales statewide (Kelsey et al. 2021). In 2017 the USDA reported that in Crawford County, 88 - 94% of farms sold less than $250,000 of agricultural products (Kelsey et al. 2021). In Crawford County, agricultural product sales, totaling $107,270, included a variety of crops, such as grains, oilseeds, dry beans, dry peas, vegetables, melons, potatoes, sweet potatoes, fruits, tree nuts, berries, nursery, greenhouse, floriculture, sod, cultivated Christmas trees, short rotation woody crops, and other crops and hay (USDA, 2017).

Demographics	Study population	National Average
Median Age	43 years	39 years
Median Household Income	$54,497	$74,755
Education (Bachelor's degree or higher)	22.3%	35.7%
Employment rate (Full-time)	55.3%	60.3%
Employment in the agriculture, forestry, fishing, hunting, and mining sectors	4.4%	1.6%
Climate Change Perceptions		
Believe climate change is happening	66%	72%
Worried about climate impacts	58%	65%
Believe elected officials should do more to address CC	53%	59%

Table 1: Demographics and Climate Opinions of Crawford County, Pennsylvania

Note: Demographic data was sourced from the 2020 US Census Bureau report and climate perceptions from the 2023 Yale Climate Opinion Maps. Since all study participants reside in Crawford County, the study population reflects data specific to Crawford County.

Table 1 shows data gathered from both the United States and Crawford County, PA on demographics like age, household income, education levels, and employment rates; and on climate change perceptions specifically, what percentage of residents believe climate change is happening, are worried about climate impacts, and believe elected officials do more to address climate change. These statistics on climate change opinions are all less than the national average, demonstrating that many people in this area have mixed opinions on climate change. Studies have shown that climate opinions can predict support for adaptation or mitigation strategies; for example, Dietz et al. (2007) found that "individuals with stronger beliefs about the consequences of climate change to people and other species had greater support for climate change mitigation policies".

Literature Review

There is evidence to support the claim that not all Americans are concerned with climate change's negative effects and not all Americans are convinced about the need to address climate change. However, recent research has shown that the number of climate opinion studies has been

increasing in the United States. Studies regarding climate opinion tend to measure risk assessment, perceptions of climate change and causes, changes in management practices, and support for adaptive or mitigative policies. Schattman et al. (2016) helped close the gap in research regarding farmers' perceptions of climate change in the Northeastern United States. Their study, conducted in Vermont after major Tropical Storm Irene, assessed how Vermont farmers perceive climate-related risks such as farm features, land tenure, erosion, increased pests, market volatility, financial stability, and floods. They found that personal experiences with climate change risks can motivate support for adaptation practices, but that these experiences alone will not be sufficient to motivate citizens to support climate adaptation policies. Instead, they emphasize the need for open communication between farmers and stakeholders– such as local governments, conservation agencies, and federal government institutions like the USDA– to address climate change adaptation and participatory climate forecasting models (Schattman et al. 2016). Participatory climate forecasting models are useful tools because they are community-based and can inform policies from community perspectives and they even empower communities to be more involved in climate change monitoring and policies.

A larger study conducted in 2013 on the United States Agricultural Producers Perceptions of Climate Change found that 15-20% of large-scale producers in four states strongly disagreed with the scientific consensus that climate change is occurring (Rejesus et al., 2013). The four states surveyed in this study were Mississippi, North Carolina, Texas, and Wisconsin. Half of Mississippi and Texas agricultural producers had negative responses towards the scientific consensus on climate change and did not believe that human activity is responsible for climate change (Rejesus et al., 2013). Arbuckle Jr. et al. (2013a) conducted studies with large-scale farmers in the Midwestern United States on climate change beliefs, levels of concern, and attitudes toward adaptation and mitigation strategies. The sample for this study was organized by watershed stratification, the 12 states covered in this study were Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin. Generally, he found that about 8% of farmers believed that “climate change is occurring and is caused mostly by human activities”, 33% of farmers believed that climate change is occurring but that it is caused “more or less equally by natural changes in the environment and human activities”, and lastly, 25% of farmers believed that climate change is occurring but that it is caused “mostly by natural changes in the environment” (Arbuckle et al. 2013a). This is also consistent with evidence

from his Iowa research (Arbuckle et al. 2013b). In two studies looking at Midwestern states Arbuckle et al. (2013a) found that beliefs about climate change and its causes matter because they can influence levels of support for adaptive actions. Their study found that higher concern about the impacts of climate change was a positive predictor for farmers' support for adaptive and mitigation actions and that those who believed that anthropogenic factors cause climate change also indicated a positive predictor for adaptive policies (Arbuckle et al. 2013b). Even though many Iowa farmers believe that climate change is occurring, they disagreed that mitigation actions mandated by government policy, such as reducing greenhouse gas emissions, should be pursued (Arbuckle et al. 2013b). However many Midwestern farmers, especially those in the Corn Belt, expressed concerns about predicted climate change impacts including drought, extreme heat, and extreme precipitation events.

Although Pennsylvania is not considered the Midwestern United States, Northwestern Pennsylvania is interesting because it will not experience the exact same climate impacts as the Northeast or the Northwest. For instance, the Corn Belt is comprised of 11 states— Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin" (Loy et al. 2013), and according to the Corn Belt map produced by the USDA (Loy et al. 2013), Crawford County is included in the Western Lake Erie region.. The 2013 study on Corn Belt states conducted by Loy et al. (2013) found that 7.8% of all participants – large-scale farmers -- believed that climate change is occurring and is caused mostly by human activities, and 7.1% of participants from the Western Lake Erie region believed that climate change is occurring and is caused mostly by human activities. The majority of participants, 33.1%, believed that climate change is occurring but that it is caused more or less equally by natural changes and human activities; 33.9% of participants in the Western Lake Erie region agreed with this sentiment (Loy et al., 2013). However, it is significant that 30.9% of all participants believe that there is not sufficient evidence to declare climate change is occurring, and 30.5% of participants from Western Lake Erie also agreed with this sentiment.

Project Description

Northwestern Pennsylvania is a unique area of study because it is underrepresented in climate perception research and also because the effects of climate change will vary across the state. The purpose of this project is to investigate the experiences and perceptions of farmers in Northwestern Pennsylvania regarding climate change. This is an important area for research

because farmers are disproportionately impacted by climate change and are responsible for much of the produce required for nutritional diets and food security in the United States. This research assessed the public perceptions of climate change among small-scale northwestern Pennsylvania farmers via a focus group consisting of 4 small-scale farmers in which questions were asked about the experiences and perceptions of small-scale farm owners in Northwestern Pennsylvania on issues related to climate change and its impacts on local farms. Learning about the perspectives of these farmers can help to reveal opportunities for educational outreach on climate issues among this population, while also revealing opportunities to support small-scale farmers as climate impacts continue to shift and worsen in the coming years. This knowledge will contribute to assessments of where vulnerable populations and vulnerabilities in our food systems exist, as well as how local and federal governments can work with growers to combat and overcome these difficulties. This project will also explore how the US government or local stakeholders can better support farmers as they are forced to cope with climate change consequences. Many scholars have suggested the use of interview data to better understand the perceptions of climate change in various countries and states and the trends in changes in public opinion. Public opinions on climate change are more complex than many might expect, they are culturally and dynamically shaped over time. By looking at the effect the occupation of farming and the experiences associated with climate change have on the relationship between perceived impacts with climate change beliefs this project will contribute to the increasing need for literature in the climate change field of study. In this study, I will address the following research questions:

1. What are the farmers' perceptions on the issue of climate change in Northwestern Pennsylvania?
2. What is the relationship between climate change impacts on small-scale growers and local food production, and how do these impacts influence agricultural worker perceptions?
3. How does the awareness and willingness of Northwestern Pennsylvania farmers to participate in adaptation efforts relate to their perceptions of climate change impacts?

Methods

Data Collection

In December of 2023, a focus group was conducted in the Meadville Public Library to assess the perceptions of climate change and responses to climate change among small-scale Northwestern

Pennsylvania farmers. Focus groups incorporate the aspect of the focused individual interview and group discussion (Stoll-Kleeman et al., 2000). Although they are widely used for marketing they are also beneficial for assessing mass public opinion on certain topics such as climate change (Stoll-Kleeman et al., 2000). Richard Krueger, an expert on focus groups, describes the purpose of focus groups as "to better understand how people feel or think about an issue, idea, product, or service" (Krueger & Casey, 2015). Focus groups can be useful to inform policies, especially in this study where a focus group is being used to learn about farmers' perspectives on climate change and learn the best ways to support farmers through mitigative or adaptive policies. Since the target audience is the impacted group, it is best to hear and learn from their experiences to better inform policy suggestions. The benefits of using a focus group are that they can enable authentic discussions, and allow for further analysis through elaborative follow-up questions, between people who potentially share personal experiences and beliefs (Olausson, 2011). Typically, climate opinion studies are assessed via surveys or individual interviews. This study is different from the average studies because it utilizes a focus group rather than the alternative methods. According to Ulrika Olausson (2011), who conducted a focus group in Sweden on climate change and the role of the media, a focus group can be more beneficial than a survey or an individual interview because it incorporates the aspects of an individual interview with a group discussion. The purpose of this focus group was to gather information on what were the perceptions and risk perceptions surrounding climate change and how farmers are responding to climate change through adaptation and mitigation strategies. Since Olausson (2011) and other researchers suggest avoiding oversized groups, this focus group was comprised of only 4 small-scale farmers from Northwestern Pennsylvania farms. The focus group session lasted 1 hour and 30 minutes. Discussion and responses during this focus group were recorded via handwritten notes and an audio recorder. Audio recordings were later transcribed verbatim. Participants were not compensated for their participation.

I used the World Wildlife Fund Climate Crowd survey questions for the questionnaire that guided the focus group. The WWF survey was chosen because it focuses on changes in forests, freshwater, climate change, wildlife, food, and biodiversity which impact farmers' growing seasons, management practices, and adaptations to these changes. The questions relate to climate change impacts, perceptions of climate change, and community responses to changes in climate. These open-ended questions serve as a tool to enable authentic discussions with farmers, and, in

the context of a focus group, allow farmers to relate to one another on similar or different experiences with climate change. Despite this survey being designed for individual interviews, it works well for a focus group because the questions are open-ended and they build off of each other, which allowed me to to provide more detailed responses through elaborative follow-up questions. In addition to the stock questions on the WWF survey, four questions were gathered from another study on climate opinions (Capstick et al. 2015). to explore other themes that can contribute to the analysis and that wouldn't have been covered in the original questionnaire such as risk perceptions and perceptions regarding community supported agriculture systems. These additional questions allow for an additional examination of the perceived impacts of climate change, and the perceived risks associated with climate change among study participants. Risk perceptions, and the factors that shape them, are important to understand because they influence how people perceive climate change risks, and offer insight into the support they have for mitigative and adaptive actions.

Participants

All four of the participants were small-scale farmers located in Crawford County, Pennsylvania. Focus group participants were solicited through three mechanisms. The first was a general recruitment message that was sent to the emails of small-scale local farmers associated with the Northwestern Pennsylvania Growers Co-Operative. This strategy did not generate any participants. The second recruitment strategy involved in-person contact with small-scale farmers attending a potluck held at Fat Hawk Farms in November 2023, which is a member of PASA Sustainable Agriculture. Participants were recruited at this event. This strategy recruited two participants. To learn about small-scale farming practices, outreach and recruitment strategies were broadened to include solicitation to farms associated with local market houses. The last recruitment process involved snowball sampling, where one participant who was interested in participating in the study was used to recruit other farmers to participate in the project as well. This participant reached out to five farms they knew from farmers markets and through other personal connections; of those five contacted farms only two farmers were able to participate.

Analysis of Interview Data

The audio of the focus group discussion was recorded with two audio recorders. Recordings were manually transcribed using a digital software program called NVIVO for qualitative data analysis.

Responses were analyzed following the guidelines from Braun and Clarke (2006) and Maguire and Delahunt (2017) and by utilizing applied ground theory, this means that codes were generated by the research as opposed to using preconceived codes from previous studies. The coding process was done first by hand by reading and highlighting physical copies of the transcript to identify any patterns in participants' responses and the second round of coding was completed using NVIVO, a qualitative data analysis software. Participants' responses were coded based on explicitly answering questions, emotional responses, and meaningful phrases. In order to derive meaning from the transcript, codes were assigned based on what key concepts, patterns, or potential themes emerged from participants' responses. These codes symbolize the interpretation of the researcher and were generated by the researcher to better understand participants' perceptions of the impacts of climate change they may be experiencing on their farms or have heard from mutual farmer relationships and if current programs–enacted by their local, state, and federal governments– are sufficiently supporting them to adapt to climate change. In the second phase of coding, the initial round of codes were assigned and grouped together to broader categories based upon connections between different codes. This was then followed by thematic analysis, I looked for similarities, differences, and relationships between codes and categories, and then I grouped them into themes that captured the nature of the data. These categories and codes were then connected to form four thematic maps on NVIVO. Thematic maps were an important tool for forming connections between codes and generating overarching themes that capture the core of the responses from study participants.

Results

Table 2 summarizes the codes, categories, and themes generated from the analysis of participant's responses. Farmers talked about perceived changes in climate, such as changes in seasonal crops, drought, flooding, frost or snowmelt, hotter temperatures, precipitation, and wildfires. These were coded to "Seasonal Changes" (See **Table 2**). The most significant and relevant climate changes farmers were recognizing were changes in precipitation. Changes in precipitation are notable because climate forecasts project that regions of Pennsylvania, including Crawford County, will experience more precipitation with the coming changes (Pennsylvania Department of Environmental Protection, n.d.). Farmers will need to continue to adapt to these changes, and

study participants acknowledged how they are already adapting to changing precipitation patterns. For instance, Farmer 2 shared their perception of the importance of noticing these changes in precipitation early on.

> Farmer 2: “I think with the rainfall, it's more important to focus on, like when the rain is falling and not falling, like we're not getting it in the early spring, when plants needed the most, and we're getting it later on when things are trying to grow so...”

Farmers demonstrated their understanding of how climate change will affect their livelihoods by acknowledging how they are adapting their farming practices and which of these practices were successful. Many of the adaptations that the participating farmers mentioned are typically associated with regenerative agriculture practices. The most notable adaptation to these changes was pest management. This response from Farmer 3 was cross-referenced in both “Adaptations” and in “Pests” because it refers to both adaptations in their farming practices, specifically practices of pest management, to climate related weather changes and specific pests/insects on their farm.

> Farmer 3: “I guess one of my methods of pest management is trying to build basically diverse robust food webs. I wouldn't say it's a failure, but it's not like I can ditch row covers, you know, anything like that. But for example, I basically try to have a crop, or some plant species near my garden that has aphids on it throughout the summer, which sounds kind of weird, but that means, like timing golden rod in the earliest in the spring, to faba beans, to chamomile. And then by late summer, there's just so many different crops. And the idea is that there's a steady food supply for predatory insects.”

Codes derived from expressive emotional responses based on context and language were coded into “Emotional Response”.. This response from Farmer 2 demonstrates multiple emotions such as uncertainty and concern that were cross-referenced in the “Emotional Response” code.

> Farmer 2: “<u>But I've been thinking a lot about, changing</u>, like we've talked about climate, like the zones, and I've been thinking about more warmer climate crops. <u>But it's still very unpredictable</u> with the way the springs are and the length of our growing season. <u>So I'm very hesitant</u> to make a deep dive into warmer climate crops.”

Table 2 Categories, codes, subcodes, and category descriptions are compiled based on the participant's responses.

Category	Code	Sub Codes	Category Description
Adaptations	Farming Practices	Composting	Small-scale farmers are adapting to changes in pest populations and in weather patterns by composting, planting more diversity, increasing tilling, and rainwater catching by creating food webs, intercropping, and trap cropping.
		Planting Diversity	
		Rainwater catching	
		Tilling	
	Pest Management		
Changes in Biodiversity	Amphibians		Changes in weather patterns are causing changes in the biodiversity of amphibians, plants, insects, birds, etc. These changes are causing a decline in populations and displacement of native species due to habitat fragmentation.
	Birds		
	Insects		
	Plants		
Emotional Response	Concerned		Different emotional responses, displayed during the discussion, were assessed based on tone and infliction of participants' responses. Some were questions asked to one another, thanking one another, and expressing varying levels of concern, hope, and certainty.
	Curious		
	Gratitude		
	Hopeful		
	Hopeless		
	Pleasant		
	Not Concerned		
	Reminiscing		
	Sympathy		
	Uncertain		

Category	Code	Sub Code	Category Description
Pests	Invasives		Changes in weather patterns are affecting pest populations, increasing invasive pests, decreasing native predators and prey, decreasing native species, etc.
	Pest Management		
Risk Perception	Health Impacts		Different levels of concern were expressed based on the perception of risks and solutions associated with climate change such as health impacts (air quality from wildfires, diseases, heat/cold illnesses), global warming/climate change, community-supported agriculture, and government programs and government relationships with farmers. Levels of concern were measured through a scale of least worried to very worried.
	Climate Change		
	Global Warming		
	Community Supported Agriculture		
	Government	Crop Insurance	
		Food Stamps	
Seasonal Changes	Crops		Changes in weather patterns are causing changes in seasonal patterns such as changes in precipitation, rising temperatures, varying frost days and lack of snow melt, increased flooding and increased drought, impacts on seasonal crops, and an increase in wildfires.
	Drought		
	Flooding		
	Frost/Snowmelt		
	Hotter Temperatures		
	Precipitation		
	Wildfires		

Category	Code	Sub Codes	Category Description
Solutions - Oriented	Allegheny College	Farmer Relationships	Various solutions were proposed by both the facilitator and participants to support farmers during changes in our climate better. Some possible solutions were community-supported agriculture like food hubs that would address food insecurity, educational initiatives through Allegheny College, prioritizing farmers equally as renewable energy, infrastructure changes in public transportation, and supporting organic farming. "Government" was highly emphasized here in correlation with government programs (crop insurance, SNAPS/Food Stamps), and government relationships with farmers and energy corporations.
	Community Supported Agriculture	Addresses Food Inaccessibility	
		Farmer Relationships	
		Food Hubs	
	Education	Lack of awareness	
	Infrastructure	CATA	
		Lack of accessibility	
		Public Transportation	
	Organic Farming	Certifications	
		Sustainable	
	Renewable Energy	Brown Fields	
		Solar Investments	

The “Solutions-Oriented” category which was comprised of the codes “Allegheny College”, “Education”, “Infrastructure”, “Organic Farming”, “Renewable Energy”, and “Community-Supported Agriculture” all of which helped to understand how to better support farmers and address programs that are lacking in support.

Thematic Maps

Thematic Maps demonstrate the connections between codes, and determining the meaning behind these connections created an understanding of the relationship between the perspectives of the interviewed small-scale farmers and climate change impacts in Northwestern Pennsylvania. By following the guidelines from Braun and Clarke (2006) and Maguire and Delahunt (2017), four thematic maps were created to develop an overarching theme: "Small-scale farmers' adaptive strategies and policy needs in response to climate change impacts". **Figure 1** depicts the first thematic map " Changes in weather patterns are causing changes in biodiversity" based on the connections between the codes associated with the categories of "Seasonal Changes" and "Changes in Biodiversity". This theme highlights the impact of climate change on the natural environment, specifically how shifting weather patterns are affecting biodiversity. This first map helps to address the first research question:

1. What are the farmers' perceptions on the issue of climate change in Northwestern Pennsylvania?

All farmers perceived seasonal changes as changes in precipitation, increase in temperatures, increased flooding, variations of frost timing and lack of snowmelt, increase in drought due to lack of precipitation and increased temperatures, and changes in the seasonal timing of certain crops. They attributed these changes to their perceived changes in populations of local biodiversity specifically in plant, insect, amphibian, and bird species. According to participants, "Changes in precipitation" was the most significant change in their region. Farmers are concerned that changes in precipitation have been oversimplified as simply involving too much rain or not enough rain. This means that farmers are noticing that the impacts of changes in precipitation are connected to changes in the timing of their seasons, especially shoulder seasons– fall and spring. Because of this, seasonal crops are being displaced and impacted by the lack of rainfall in the early spring and the increase in rainfall, especially stronger storms, during the fall. Two farmers noticed a decrease in frogs on their properties and they attributed these population changes to a lack of rain in the Spring.

> Farmer 2: “We've noticed a lot less vernal pools in the springtime or they're not lasting as long as they once were. Like I said, I've only been there for seven years, so it's a noticeable difference within that seven years.”

These changes in populations of plant and animal biodiversity can be explained by the seasonal changes in weather. This means that native species are increasingly being displaced by habitat fragmentation due to the changing climate conditions. If there is less rain in the Spring one year, this can create habitat fragmentation for migrating amphibians who will breed in vernal ponds in the Spring. Or if there is a drought, this can make forests more susceptible to wildfires which can lead to habitat fragmentation for birds or other woodland critters.

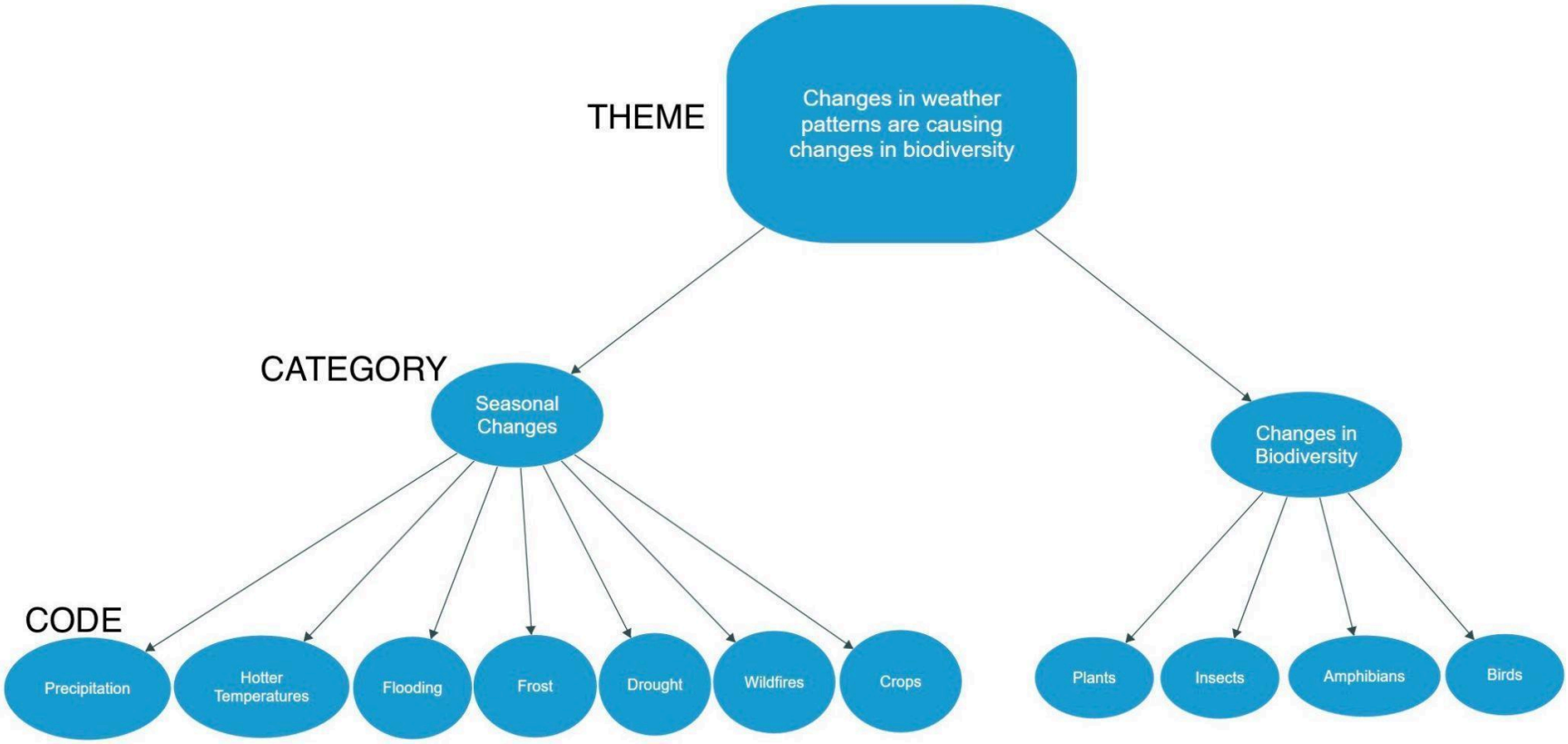


Fig 1. Thematic Map 1: Theme: Changes in weather patterns are causing changes in biodiversity is compiled of the "Seasonal Changes" and "Changes in Biodiversity".

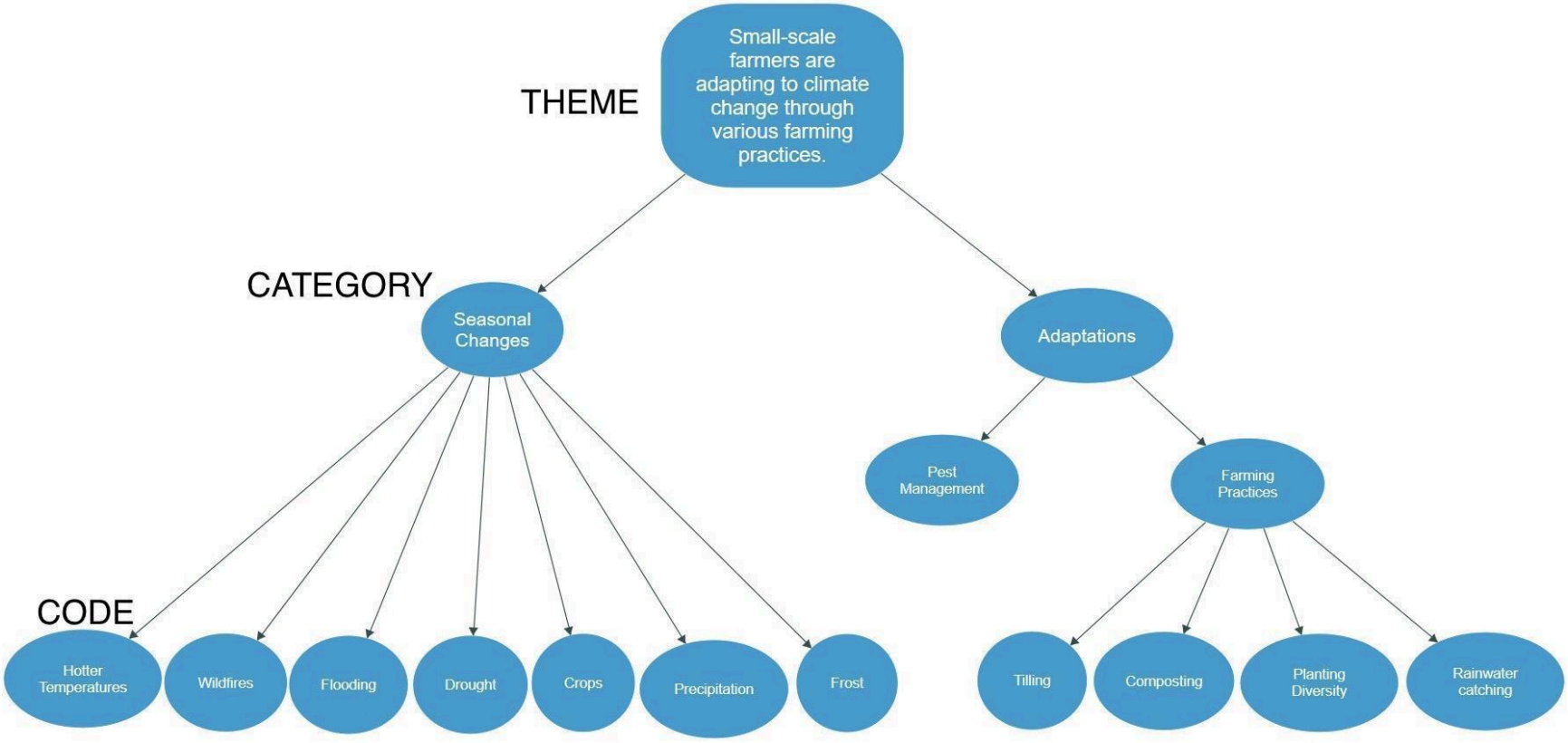


Fig 2. Thematic Map 2: Theme: Theme: Small-scale farmers are adapting to climate changes through various farming practices is compiled of the categories of "Seasonal Changes" and "Adaptations" codes, and associated codes and subcodes.

Figure 2 continues to answer research question 1 and answers research question 3:

1. What are the farmers' perceptions surrounding climate change in Northwestern Pennsylvania?

3. How does the awareness and willingness of Northwestern Pennsylvania farmers to participate in adaptation efforts relate to their perceptions of climate change impact?

Thematic Map 2 in **Fig 2** shows how the "Seasonal Changes" code and the "Adaptations" code were connected to form the theme: "Small-scale farmers are adapting to climate changes through various farming practices". This theme highlights the adaptive responses of small-scale farmers to climate change, demonstrating their efforts to adjust their farming practices to adapt to changing environmental conditions. As stated earlier, the farmers' perceived seasonal changes include changes in precipitation, temperatures, seasonal timing of crops, frost, and increased drought and flooding. Farmers' perceptions of climate change are influencing their adaptation efforts. Because of changes in precipitation, specifically a decrease in rainfall in the early spring when crops need rainfall the most, one farmer shared that they have started to participate in rainwater harvesting. Another example of adaptations to changes in precipitation is changing irrigation practices. Farmer 4 indicated that some adaptations in their farming practices included composting, mulching, and learning more about irrigation. Composting, mulching, and irrigation systems are important to maintain nutrients and moisture in their soil.

> Farmer 4: "We do a lot of mulching now too, with it being so hot. Some plants just like their feet cool so, and sometimes you plan like a cooler one on the other side of one of the Trellis…"

Another notable impact of climate change is changes in pest populations. All farmers in the focus group have noticed changes in both native and invasive species of insects on their farms. Some farmers have started to adapt their farming practices by participating in pest management. Some native species of pests farmers mentioned were pirate bugs, hoverflies, ladybugs, lacewings, and cabbage moths. Some invasive species mentioned were spotted wing drosophila suzukii, emerald ash borer, and Asian praying mantises. Although the Emerald Ash Borer is a non-crop pest it is still important to note because Farmer 3 grows trees for products such as fruits or syrup. As stated earlier Farmer 3 shared one form of pest management they have started to do to try and adapt to the changes in pest populations.

> Farmer 3: “I guess one of my methods of pest management is trying to build basically diverse robust food webs. I wouldn't say it's a failure, but it's not like I can ditch row covers, you know, anything like that. But for example, I basically try to have a crop, or some plant species near my garden that has aphids on it throughout the summer, which sounds kind of weird, but that means, like timing golden rod in the earliest in the spring, to faba beans, to chamomile. And then by late summer, there's just so many different crops. And the idea is that there's a steady food supply for predatory insects.”

However, this farmer is also uncertain about the level of success of this adaptation strategy. If this practice was continued over a span of multiple years, there could be more to say on the levels of success of this pest management strategy. The purpose of this strategy is to reintroduce important predators by providing a stable amount of food (prey) for predators. This way predators will continue to visit these crops and can potentially remove invasive species of pests or unwanted pests.

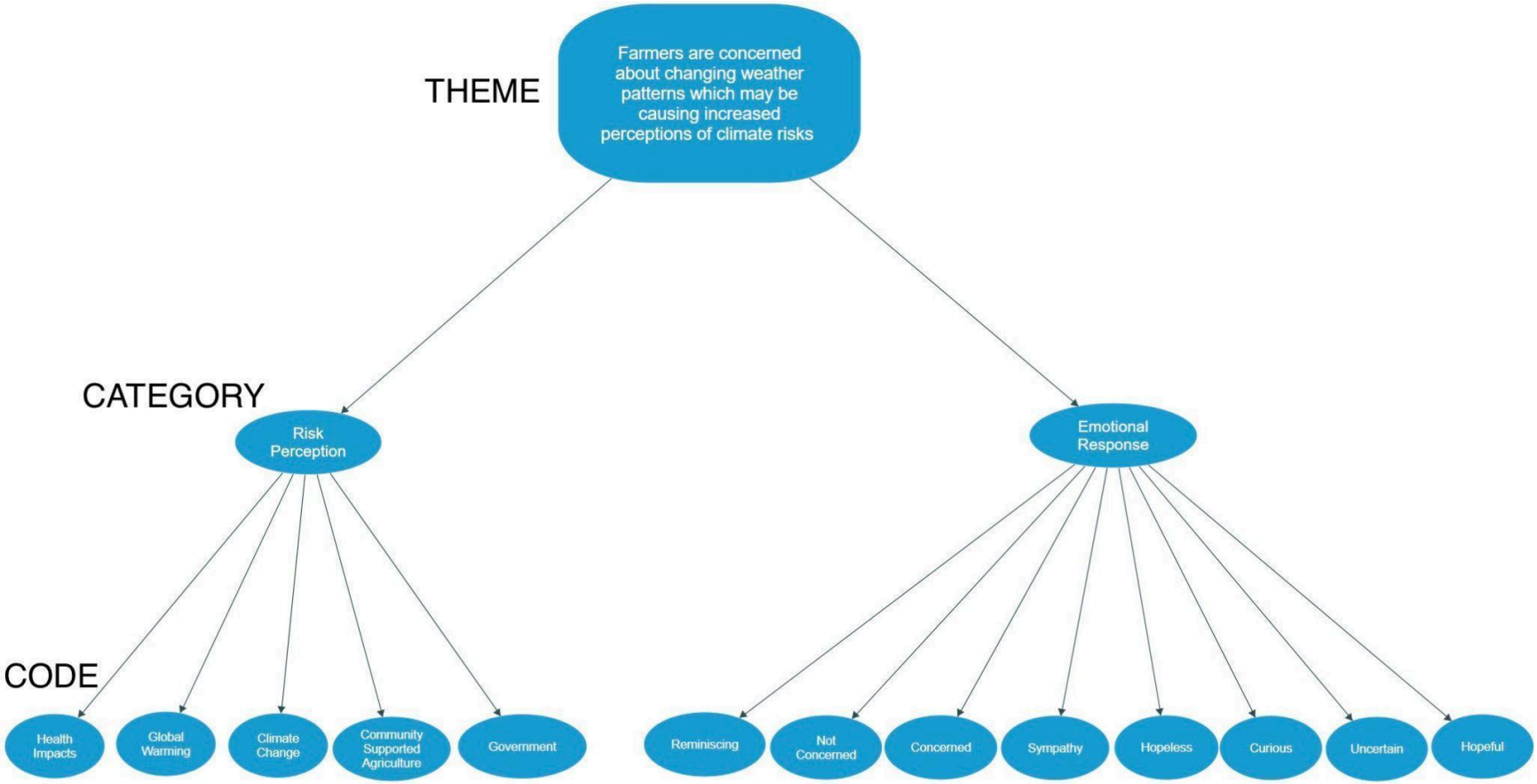


Fig 3. Thematic Map 3: Theme: Farmers are concerned about changing weather patterns which may be causing increased perceptions of climate risks is compiled of the categories of "Risk Perception" and "Emotional Response" codes, along with associated codes and subcodes.

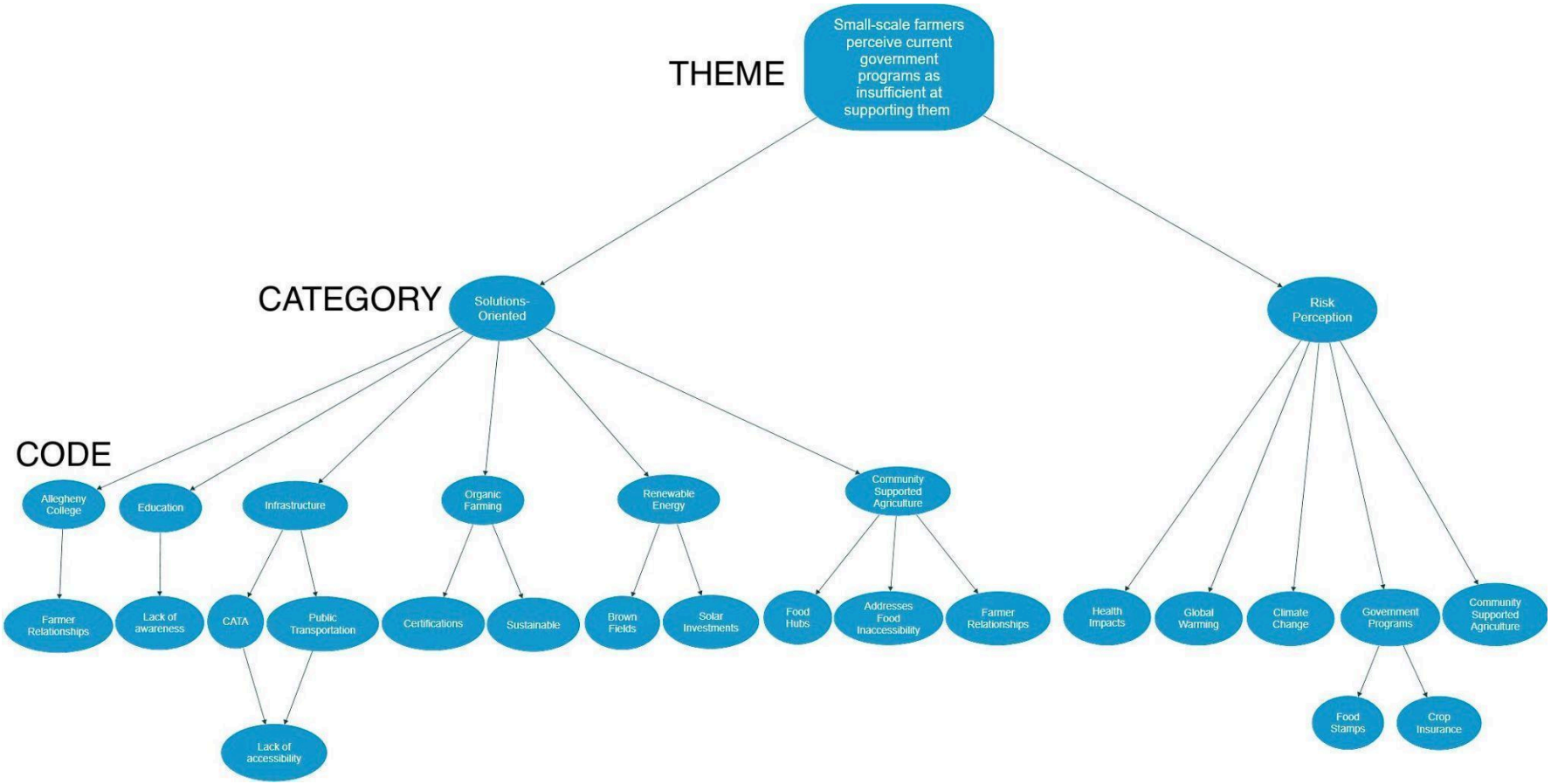


Fig 4. Thematic Map 4: Theme: Small-scale farmers perceive current government programs as insufficient at supporting them is compiled of the categories "Solutions-Oriented" and "Risk Perception" codes, and associated codes and subcodes.

Figures 3 and 4 answer research question 1 and research question 2:

1. What are the farmers' perceptions surrounding climate change in Northwestern Pennsylvania?
2. What is the relationship between climate change impacts on small-scale growers and local food production, and how do these impacts influence agricultural worker perceptions?

Thematic Map 3 in **Fig 3** shows how the "Risk Perception" code and the "Emotional Response" code were connected to form the theme: "Farmers are concerned about changing weather patterns which may be causing increased perceptions of climate risks". This theme reflects the levels of growing awareness and concerns among farmers regarding the risks posed by climate change to their livelihoods and agricultural sustainability. Levels of concern surrounding risks related to health, safety, and livelihood, were measured by asking participants to place themselves on a scale of least worried to very worried. Farmers perceived these risks to be harmful to their health and well-being, and potentially harmful to their economic livelihoods. Risks associated with health impacts were related to climate issues, such as the harmful air quality many Northern American states experienced after the Canadian wildfires in the summer of 2023. Northwestern Pennsylvania experienced poor air quality due to the smoke produced by the Canadian wildfires. The poor air quality made it to breathe outdoors and made it difficult for farmers in the region to work outdoors. The category of "Risk perception" was generated through the codes "Health Impacts", "Global Warming", "Climate Change", "Government Programs", and "Community-Supported Agriculture". The codes "Government programs" and "Community-supported agriculture" were included in this category because farmers perceived how challenges with programs such as crop insurance or SNAPS/food stamps often leave small-scale farmers without government assistance and instead, prioritize large-scale farms.

The most important codes from the category "Emotional response" are "Concerned", "Hopeless", "Hopeful", and "Uncertain". These codes were most relevant because they relate to risk perception. Often emotions influence participants' perceptions of risks. While some participants in climate studies will explicitly state that they are worried about climate change, emotional responses can highlight the exact aspect of climate change that they are worried about. For instance, when asked "Do you worry about climate change on a scale from least worried to

very worried?". All the participants responded with "Very Worried". To further the question, when asked "Do you think that climate change threatens your personal livelihood, safety or health, or all of the above?". All farmers responded with all of the above. One farmer elaborated on their response and demonstrated how a feeling of concern influenced their perception of health risks associated with climate change such as wildfires.

> Farmer 4: "Definitely health, because we have smoke from Canada down here. It was so thick just this past summer you could taste it. There were days I had to work in a mask outside"

This explicitly conveys that farmers are very worried that climate change will threaten their health and safety. These concerns can eventually translate to impacts on their livelihood, if farmers cannot go outside to work on their farm this will lead to a decrease in productivity or revenue on their farm. Additionally, another farmer responded to this remark with an emotional response of fear and concern about climate change's impacts on their health and safety.

> Farmer 1: "I remember those skies were orange, it was scary."

Thematic Map 4 in **Fig 4** shows how the "Solutions-Oriented" code and the "Risk Perception" code were connected to form the theme: "Small-scale farmers perceive current government programs as insufficient at supporting them". This theme addresses the challenges faced by small-scale farmers in accessing sufficient support and resources from government programs to effectively respond and adapt to climate change impacts. The category of "Solutions-oriented" was generated through the codes "Allegheny College", "Education", "Infrastructure", "Organic Farming", "Renewable Energy", and "Community-Supported Agriculture". Participants perceived the following ideas as possible solutions that would address specific complex climate-related issues: education initiatives through Allegheny College; and infrastructure changes, such as investments in better public transportation, organic farming, renewable energy, and community-supported agriculture.

Participants identified challenges associated with many of the ideas they perceived could be potential solutions to climate-related issues such as food insecurity, weather changes, fossil fuel consumption, and lack of awareness of climate issues. For instance, for

the “Infrastructure” code, concerns about the lack of accessibility to the current public transportation system in Meadville, known as CATA, were mentioned. For the “Organic Farming” code, concerns about the costs of getting certified as an organic farm were mentioned; but they felt this was still a good solution because it is sustainable and good for the environment and can help mitigate impacts of climate change. For the “Community-Supported Agriculture” (CSA) code, participants felt that CSA systems could help address food inaccessibility and mitigate food insecurity issues exacerbated by climate impacts. They also perceived that food hubs and farmer relationships would be beneficial as a support system for small-scale farmers. For the “Renewable Energy” code, Farmer 2 expressed many concerns about the government prioritizing solar investments and potentially local solar corporations buying current land used by farmers. To address this concern, Farmer 2 mentioned that “brown fields”, land that may be contaminated by prior activities, should be utilized for solar infrastructure in the state of Pennsylvania.

> Farmer 2: “I mean, I think, as far as this energy shift happens, you know, instead of occupying farmland, I think the focus should be on brown field sites, which we absolutely have enough of in this state.

As demonstrated in **Figure 4**, the code “Community-Supported Agriculture” is cross-referenced under the categories “Solutions-Oriented” and “Risk Perception.” This means that participants expressed both a concern and a hopefulness toward community-supported agriculture as a possible “solution” to one of climate change’s many complex issues. Two farmers believed that food hubs help address food inaccessibility and build farmer relationships. All of the farmers expressed their concerns about depending on food hubs because there is less support for small-scale farmers. However, there is an even larger concern among the farmers about the government’s current support for small-scale farmers especially concerns about crop insurance programs. Many other ideas, that participants perceived could be possible solutions to specific climate-related issues, were brought up during this discussion such as renewable energy, infrastructure changes, educational initiatives through Allegheny College, and organic farming. However, some of these ideas were discussed in the sense that they are prioritized more than organic (or regenerative) farming by the government. Although these ideas were presented as

solution-oriented, this does not mean that all of these ideas are feasible or sufficient solutions to addressing climate-related issues.

Discussion

Small-scale farmers' climate perceptions

All of the participating small-scale farmers perceived anthropogenic climate change and global warming as real and were very concerned about the impacts and risks of climate change on their health, safety, and livelihood. According to focus group responses, participants were very likely to support mitigation and adaptation actions. This is consistent with Arbuckle et al. (2013a), who found that more farmers are accepting that climate change is happening. More importantly, Arbuckle et al. (2013a) also found that Midwestern farmers who believed that climate change was caused by anthropogenic activities were more likely to support both mitigation and adaptation actions. This is also consistent with what Safi et al. (2012) found with ranchers and farmers from Nevada, those who believe that climate change is caused by anthropogenic activities were more likely to perceive climate change risks. Similar to this study, Schattman et al. (2016) found that Vermont farmers perceived "pest and disease pressures" as an important ecological risk associated with climate change. As mentioned before, focus group participants expressed heightened concerns about climate change's impacts on biodiversity including insects and pests, health impacts, and weather patterns. This is conclusive of larger trends in climate perception studies, those who are more vulnerable or have experienced direct impacts of climate change are more likely to express heightened concerns and support climate mitigation and adaptation actions.

Small-scale farmers' adaptive farming practices

Climate change will affect agriculture predominantly through changes in temperature and precipitation. These changes will impact crops, livestock, pests/insects, and soil health (Walthall et al. 2012). The potential effects of climate change on crop yields, soil health, crop pollination, and pest management systems could lead to decreased agricultural productivity. The impact of climate change can further exacerbate larger issues such as food insecurity. Although these four small-scale farmers may not contribute much to their local food systems, climate impacts will impact all farmers meaning these impacts

can affect larger farms that do contribute more to food systems. Further action needs to be taken to ensure farmers are adapting to climate change and provide support to do so. Focus group participants' suggested that strengthening government programs for small-scale farmers and reforming existing policies can better address the needs of local agricultural communities. They believe that if the federal government could provide financial incentives for sustainable and adaptive farming practices, more farmers could transition to a sustainable model of farming to mitigate climate impacts. Sustainable models of farming include conservation measures, these measures promote biodiversity on farms by planting cover crops and using organic practices. This can also potentially foster partnerships between farmers and other stakeholders such as conservation organizations who are also interested in mitigating climate impacts and conserving biodiversity.

Farmers' increased perceptions of climate risks

Risk perception refers to the way that individuals or groups perceive the likelihood of potential harm happening to them. It involves how people perceive, understand, and react to risks based on their beliefs, values, and experiences (Encyclopedia of Environmental Health, 2011). In the case of the climate crisis, it is important to understand individuals' or groups' perceptions of risks associated with climate change. Participants expressed heightened concerns about health impacts associated with climate impacts. They perceived that diseases from pests, like Lyme disease from ticks, and smoke from wildfires can make it difficult to perform outdoor work. This implies that farmers believe that climate change impacts will exacerbate health concerns associated with climate change, to address these concerns participants' proposed a form of health care designed for small-scale farmers. This indicates that a universal health care or a health care system for farmers, designed by the government in collaboration with farmers and medical experts, could protect them better from the health impacts of climate change. Furthermore, these health concerns reflect a deeper concern about the indirect effects of climate change on farmers' livelihoods.

Emotions play a significant role in risk perception, specifically emotions such as fear, anxiety, or anger can influence how people perceive and respond to risks. Sometimes this can cause individuals to overestimate or underestimate the severity of the actual threat. People who may be climate deniers may underestimate the severity of climate change, but

those who perceive climate change as occurring may experience heightened levels of climate anxiety (Clayton, 2020). This can even translate to how they interpret certain climate-related issues and potential solutions to specific issues. Importantly, some of the participants experienced a heightened sense of concern about the lack of government involvement in climate legislation. Some farmers expressed feelings of hopelessness as a result of the fact that the government is not doing enough to help alleviate the impacts of climate change. These heightened concerns can affect how individuals will interpret and perceive climate-related issues such as the government's priorities. Clayton (2020) found that behavioral changes can stem from climate anxiety and could potentially even inhibit those affected from taking effective action, this indicates that heightened concerns can translate into feelings of hopelessness and helplessness and even further, impact how those affected interpret climate issues.

Farmers' perceptions of government programs

Participants expressed that they felt that current government programs are insufficient to support and protect their livelihoods. For instance, participants explained how government crop insurance programs do not affect them because they do not grow enough produce and they grow a large variety of produce which falls out of the scope of current crop insurance programs. Another example they shared was the complications associated with federal organic farming certifications and maintaining those certifications. Given participants' concerns about the effectiveness of current government programs, it is becoming more essential to explore additional sources of support for farming communities. Support from the government to support and protect communities from climate change can include but is not limited to

1. Funding for climate resilience projects
    a. Governments allocate funds to support infrastructure projects aimed at increasing resilience to climate change impacts, such as renewable energy infrastructure.
2. Climate adaptation planning
    a. Governments develop and implement community-informed climate adaptation plans that assess risks, vulnerabilities, and potential impacts of climate change on communities.

3. Insurance and risk management programs
    a. Governments may provide insurance programs or financial assistance to help communities recover from climate-related disasters, such as floods, hurricanes, or wildfires.
4. Investment in renewable energy and clean technologies
    a. Governments incentivize or subsidize the implementation of renewable energy sources and clean technologies to reduce greenhouse gas emissions and mitigate the impacts of climate change.
5. Public education and outreach programs
    a. Governments engage in public education and outreach campaigns to raise awareness about climate change impacts and encourage individuals and communities to take adaptive and mitigative action.

(Council on Foreign Relations, 2023)

Some of the criticisms participants shared were toward current government programs that often exclude small-scale farmers because they are not flexible enough. As mentioned earlier, many small-scale farmers don't have crop insurance because they grow a variety of crops and they do not grow enough to make it worth their while. Therefore, participants are advocating for better job security and financial security because government crop insurance models are not flexible enough for small-scale farmers. Another government feature that excludes farmers is a universal minimum wage. Studies from the UK have shown that minimum wages can increase without negatively impacting the job chances of low-paid agricultural workers and in the past, these wage policies have even lifted a considerable number of families out of poverty or at the very least prevented them from falling below the poverty line as a result of wage control (Gowers & Hatton, 1997). Participants recognized that small-scale farmers do not receive a minimum wage nor health care or benefits, and because of this small-scale farmers are dependent on farmer relationships to sell their products and services and often work part-time jobs to pay for their farms. Research shows that "19% of farmers between the ages of 18 and 64 years are uninsured" (Zheng & Zimmer, 2008). By increasing health insurance access to farmers, health insurance coverage policies can potentially "improve farmers' health and boost productivity" (Zheng & Zimmer, 2008). Participants expressed that the lack of applicable

crop insurance programs and health care for small-scale farmers puts them at risk of the impacts of climate change, this means that small-scale farmers will be more vulnerable to climate risks such as heat-related illnesses, pest-related diseases, and repossession of land.

Recommendations

Climate researchers affirm that the impacts of climate change will exacerbate the current food insecurity issues including food accessibility and even introduce new issues in our food systems (Wheeler and von Braun, 2013). At the World Food Summit in 1996, the Food and Agriculture Organization (FAO) defined food security as "when all people, at all times have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life." (Ziervogel & Ericksen, 2010). Climate impacts can displace communities, which can ultimately impact communities' access to food. Food policy development and planning will need to reflect our changing food system. One suggestion from focus group participants was to allow small-scale producers to accept SNAP benefits or food stamps as a form of payment. The rationale behind this was it could provide a reliable source of revenue, expand the producer's customer base to include low-income families, and foster positive relationships between farmers and their local communities; an additional benefit is how it could help alleviate food insecurity issues by providing communities with locally grown nutritious and accessible food (Briggs et al. 2010). If government programs could provide incentives or subsidies for farmers to accept food stamps this could in turn contribute to the well-being of their communities while promoting access to healthy, locally grown foods.

Another recommendation presented by participants was to invest in infrastructure development for better transportation and better access to local food hubs and farmer's markets. According to participants, the Crawford Area Transportation Authority (CATA) has only one bus route that runs past the Market House where many local farmers sell their products. Participants believe that if CATA received local government funding to invest in better transportation infrastructure, residents of Crawford County would have better accessibility to local foods sold by local farmers. One study examined in Los Angeles, CA, and Austin, TX suggested that improving transportation systems can increase access to local foods (Feenstra, 1997). CATA could improve its transportation systems in Crawford County by expanding transportation options, improving the frequency of public

transportation to local food hubs, and increasing accessibility to public transportation throughout Crawford County (City of Meadville, 2022). Other strategies to increase access to locally grown produce included establishing community gardens, encouraging citizens to purchase from farmers' markets or local produce stands, and establishing food policy councils. Food policy councils (FPC) can help implement community-based frameworks aimed at ensuring community food security; this strategy would create more direct relationships between producers and consumers and empower community members (Feenstra, 1997). Increasing food security is a co-benefit of improving transportation systems in Crawford County, although this project is not designed to improve food security directly, there are broader implications that would coincide with these goals.

Another strategy that uses similar methods of local produce stands and farmers' markets is community-supported agriculture (CSA) systems. Community-Supported Agriculture is defined as "a contractual agreement between one or more farms and a group of consumers variously described as 'members', or 'subscribers'." (Cone & Myhre, 2000). CSAs are beneficial because they create direct relationships between farmers and consumers, they require farmers to depend on one another by sharing responsibility for costs and crops. Community-supported agriculture systems are useful because members or consumers of CSA produce can become more connected with their food systems because they will understand where their food comes from and can even develop a relationship with their local farmers (Cone & Myhre, 2000). Similar to a study conducted in Vermont by Schattman et al. (2016), farmers felt that CSAs were beneficial for farmers because they can reduce "market-related risks" associated with climate change. Despite the obstacles farmers may face when starting CSAs, farmers are still hopeful about proposing a new CSA model that is more government-aligned. This means that a new government program designed to support small-scale farmers who earn less than $10,000 can help farmers market their CSAs and create operable models that support very small-scale farm operations. CSAs are increasingly popular among Northeastern farmers because it is a reliable source of income and there is mutual responsibility and support among participating farmers. Additionally, CSAs aim to educate the public about food production costs and environmental benefits, fostering community engagement and support. By

involving members in various aspects of the farm, CSAs strengthen connections between farmers and consumers, fostering a positive relationship (Kelley & Harper, 2014).

Furthermore, this would benefit both farmers and locals because their dollars would remain in the local economy, locals would have better access to nutritional foods, and local people could potentially form relationships with farmers and understand where their food comes from, fostering a sense of community connection and promoting sustainable food systems. By increasing education and outreach programs, U.S. citizens can understand the benefits of local food systems and how climate change will impact farmers and global food systems.

Limitations and Future Research

One limitation of this study is the small sample size, which may limit the ability to apply these findings to a broader population. My sample of participants may not represent the full population of small-scale farmers in Northwestern Pennsylvania. Another limitation of this study is that it did not explore potential interactions between demographics or other social variables that could have influenced the findings. These interactions can impact focus group dynamics and participants' responses which in turn can influence the interpretation of results. For example, individuals from different demographic backgrounds can have varying perspectives on climate change or agricultural practices which can affect participants' willingness to express their opinions. Finally, this study captured climate perceptions of small-scale farmers in 2023, and these perceptions can shift over time. Understanding climate perceptions is important because policymakers and researchers can develop more effective strategies for addressing climate change challenges. Additionally, studying climate perceptions can help identify barriers to action and opportunities for government intervention, identifying barriers is useful to generate more informed climate policies and programs. I suggest conducting this study with a bigger sample size and multiple focus groups. I suggest future climate perception research should track shifts in climate change perceptions over time.

Future research should delve into whether or not the solutions suggested by farmers are viable to address climate issues. Additionally, future research should investigate the long-term effects of changing weather patterns on biodiversity in agricultural ecosystems and evaluate the effectiveness of different adaptation strategies utilized by small-scale farmers in response to climate change. Further investigation should continue to explore the climate perceptions of

underrepresented communities. Furthermore, when generating policies and potential solutions to climate-related issues, communities that are disproportionately affected by climate change should be prioritized and their perspectives should be reflected in these policies. Lastly, exploring the psychological and social factors influencing small-scale farmers' perceptions of climate risks, including political factors and cultural beliefs, to better understand how to effectively communicate and address climate change needs to be higher prioritized among researchers.

Conclusion

Understanding climate perceptions is important because policymakers and researchers can develop more effective strategies for addressing climate change challenges. Additionally, studying climate perceptions can help identify barriers to action and opportunities for government intervention, identifying barriers is useful to generate more informed climate policies and programs. In summary, this study demonstrates that small-scale farmers are very concerned about the impacts of climate change on their livelihoods and their health and safety. To effectively address climate change impacts on small-scale farming communities, a community-based approach is essential. This approach should include adaptive strategies to foster agricultural resilience, collaborative efforts among stakeholders, improved government support mechanisms, and a deeper understanding of community-level perceptions and needs.

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Appendix A: Questions to be posed to Focus Group

These questions were pulled from the World Wildlife Climate Fund and will be used to engage participants in a meaningful discussion about their perceptions and responses to climate change as well as an additional question generated by the researcher. The focus group will begin with these questions below but will hopefully enable a more authentic discussion with participants and will allow participants to share additional context that is important to the discussion.

A. Background Information

A1. What is your role (e.g. farmer, park ranger, village leader, etc.)? (To be asked of each participant)

A2. What is the source of your main livelihood(s) in the community (e.g. farming, livestock, etc.)? (To be asked of each participant)

A3. How many years have you lived in this area? (To be asked of each participant)

B. Changes in Weather and Climate

B1. What are some of the biggest changes you have observed over the last few years?

B2. What are the biggest changes in weather you have observed over the last few years?

C. Impacts and Responses

C1. How have the changes in weather you mentioned impacted your main livelihood? What are the specific impacts?

C2. How have people responded to these impacts? Which of these responses is working well and which isn't? (e.g. changing to a more drought resistant crop, rainwater harvesting, planting in a different location, taking livestock to a different area to access pasture, relying on a different livelihood source such as logging or hunting, etc.)

C3. How have the changes in weather you mentioned affected natural resources used by the community? What are the specific impacts?

C4. How have people responded to these impacts? Which of these responses is working well and which isn't? (e.g. relying on a different source of freshwater, traveling longer distances to find firewood, purchasing food from the market, relying on other species of plants or animals for sustenance, etc.)

C5. Are there any other impacts or responses to the changes in weather you mentioned? (e.g Crop practices, Livestock practices, Fishing/aquaculture practices, Livelihood type, Livelihood location, Water management, Disease/Pest management, Natural resource use, Natural habitat encroachment, Land conversion, Infrastructure development, Energy source, Migration, etc.)

D3. ADDITIONAL QUESTION FROM RESEARCHER (not included in the original WWCF survey):

D1. Are you a member of any farmer cooperative or grower's group?

D2. Do you think that global warming is happening?

D3. Do you think that the world's climate is changing?

If yes to either of the previous two questions:

D4. Do you think it is caused mostly by human activities, or do you think it is caused mostly by natural environmental changes?

D5. Do you think climate change threatens your personal livelihood, safety, or health? (On a scale from least worried to very worried)

D6. Do you worry about climate change? If so, how much do you worry about climate change on a scale from least worried to very worried?

D7. Do you think that the United States (at the local level, state level, and/or federal level) should take steps to reduce the impact of human activities thought to cause global warming/climate change?