Assessing Adaptive Capacity of Pioneer Valley Farmers

Angelica Carey

University of Massachusetts Amherst

Follow this and additional works at: https://scholarworks.umass.edu/masters_theses_2

Part of the Agricultural and Resource Economics Commons, Environmental Studies Commons, and the Urban Studies and Planning Commons

Recommended Citation


This Open Access Thesis is brought to you for free and open access by the Dissertations and Theses at ScholarWorks@UMass Amherst. It has been accepted for inclusion in Masters Theses by an authorized administrator of ScholarWorks@UMass Amherst. For more information, please contact scholarworks@library.umass.edu.
ASSESSING ADAPTIVE CAPACITY OF PIONEER VALLEY FARMERS

A Thesis Presented

By

ANGELICA LEE CAREY

Submitted to the Graduate School of the University of Massachusetts Amherst in partial fulfillment of the requirements for the degree of

MASTER OF REGIONAL PLANNING

February 2018

Department of Regional Planning
ASSESSING ADAPTIVE CAPACITY OF PIONEER VALLEY FARMERS

A Thesis Presented

By

ANGELICA LEE CAREY

Approved as to style and content by:

_________________________________________________
Elisabeth Hamin, Chair

_________________________________________________
Henry Renski, Member

_________________________________________________
Scott Jackson, Member

_____________________________________________
Robert Ryan, Department Head
Department of Regional Planning
ACKNOWLEDGMENTS

I would like to give my sincere thanks to the farmers that donated their time for this research and encouraged me that this work was not only interesting, but necessary. Further, I thank my committee and Chair, along with other professors throughout the LARP department for their guidance throughout this process. I am grateful for my dearest friend Lara, who has always pushed me to show my truest potential as a scholar and provided so much support throughout my graduate career. I would like to thank Brian who has provided an ear to listen to my ideas and finally, I thank my mom who has always reminded me of my past accomplishments to propel me forward in my work.
This thesis explores Pioneer Valley farmers and their agricultural practices, knowledge and resources as they relate to climate change. Adaptive capacity is used throughout scientific literature, and often includes numerous components; for this thesis the measurement of farmers’ adaptive capacity would be assessed according to only three components: knowledge, past experiences and use of resources. Climate change and its impacts on agriculture have been studied but what is unclear is how prepared farmers are to deal with these impacts. Through literature review, survey development and recorded interviews, data was then analyzed both for quantitative and qualitative results to understand farmer's adaptive capacity. Most Pioneer Valley farmers realized changes to their farming practices over 5 to 10 years but were not in consensus of the cause and if this could just be due to climate change. Despite belief in climate change, most were willing to accept assistance to climate change adaptation, even if not knowing what these adaptation strategies would include. As a pilot study, numerous considerations have been included for future work on this topic to reduce assumptions and improve results accuracy. The study was too small to translate to the greater Pioneer Valley for results, but the method is important and applicable in future research and should be examined further to maintain the integrity of the agriculture sector.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF INTERVIEWS</td>
<td>viii</td>
</tr>
<tr>
<td>KEY TERMS</td>
<td>ix</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>The Pioneer Valley and the Imprint of Agriculture</td>
<td>4</td>
</tr>
<tr>
<td>Climate Change Issues and Agriculture in the Northeast and Massachusetts</td>
<td>5</td>
</tr>
<tr>
<td>Purpose</td>
<td>7</td>
</tr>
<tr>
<td>Goals</td>
<td>7</td>
</tr>
<tr>
<td>Research Questions</td>
<td>8</td>
</tr>
<tr>
<td>II. LITERATURE REVIEW</td>
<td>11</td>
</tr>
<tr>
<td>Projections of Climate Impacts</td>
<td>13</td>
</tr>
<tr>
<td>The use of Resilience in Climate Change</td>
<td>17</td>
</tr>
<tr>
<td>Spatial Landscape Planning</td>
<td>21</td>
</tr>
<tr>
<td>Farmers’ Perceptions on Climate Change Adaptation and the Role of Extension</td>
<td>23</td>
</tr>
<tr>
<td>Local Community Resilience through Civic Engagement</td>
<td>29</td>
</tr>
</tbody>
</table>
III. RESEARCH METHODOLOGY .................................................................33

Sample Selection ..........................................................................................33
Survey Coding .................................................................................................35
Profiles and Index ...........................................................................................37
Summary Index .................................................................................................38
Findings ...........................................................................................................40
Limitations .......................................................................................................41

IV. RESULTS: SURVEY QUESTIONS AND RESPONSES .........................44

Quantitative Results .......................................................................................44
Qualitative Results .........................................................................................47
Combined Knowledge and Belief in Climate Change ........................................49
Farming Issues ...............................................................................................51
Preparation and Farmers’ Actions .................................................................55
Support and Resources .................................................................................57

V. RESULTS: FARMER PROFILES ...............................................................59

Interview 1: Hampden County ........................................................................60
Interview 2: Hampshire County .....................................................................64
Interview 3: Hampshire County .....................................................................68
Interview 4: Franklin County ..........................................................................74
VIII. 2080 SUMMER TEMPERATURE MODELED ........................................ 136

IX. CURRENT SEASONAL CHANGES ........................................................... 137

X. 2080 SEASONAL CHANGES .................................................................. 138

XI. RESOURCES ......................................................................................... 139

BIBLIOGRAPHY .......................................................................................... 142
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Changes in Climate from 2011 Massachusetts Climate Action Report</td>
<td>7</td>
</tr>
<tr>
<td>2. Survey Sample Distribution</td>
<td>35</td>
</tr>
<tr>
<td>3. Survey Questions and Appropriate Component of Adaptive Capacity</td>
<td>37</td>
</tr>
<tr>
<td>4. Forced Choice Survey Questions and Responses (4 Options)</td>
<td>44</td>
</tr>
<tr>
<td>5. Forced Choice Survey Questions and Responses (5 options)</td>
<td>46</td>
</tr>
<tr>
<td>6. Combined Knowledge and Belief of Climate Change</td>
<td>49</td>
</tr>
<tr>
<td>7. Farming Issues presented by Most References to Least</td>
<td>51</td>
</tr>
<tr>
<td>8. Occurrences of Preparation mentioned amongst Farmers</td>
<td>55</td>
</tr>
<tr>
<td>9. Support and Resources for Farmers</td>
<td>58</td>
</tr>
<tr>
<td>10. Adaptive Capacity Index</td>
<td>115</td>
</tr>
<tr>
<td>Figure</td>
<td>Page</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>1. Breakdown of Adaptive Capacity Components</td>
<td>40</td>
</tr>
<tr>
<td>2. Hierarchy of Node Categories</td>
<td>49</td>
</tr>
<tr>
<td>3. Actions Taken by Farmers</td>
<td>56</td>
</tr>
<tr>
<td>4. Nodes within Adaptive Capacity</td>
<td>132</td>
</tr>
</tbody>
</table>
# LIST OF INTERVIEWS

<table>
<thead>
<tr>
<th>Interview</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hampden County</td>
<td>60</td>
</tr>
<tr>
<td>2. Hampshire County</td>
<td>64</td>
</tr>
<tr>
<td>3. Hampshrie County</td>
<td>68</td>
</tr>
<tr>
<td>4. Franklin County</td>
<td>74</td>
</tr>
<tr>
<td>5. Franklin County</td>
<td>79</td>
</tr>
<tr>
<td>6. Hampshire County</td>
<td>84</td>
</tr>
<tr>
<td>7. Hampden County</td>
<td>90</td>
</tr>
<tr>
<td>8. Hampden County</td>
<td>94</td>
</tr>
<tr>
<td>9. Hampshire County</td>
<td>99</td>
</tr>
<tr>
<td>10. Franklin County</td>
<td>106</td>
</tr>
</tbody>
</table>
KEY TERMS

Adaptation: Defined by the Intergovernmental Panel on Climate Change (2014) “The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.”

Adaptive Capacity: “The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” defined by IPCC (2014).

Climate change adaptation: Defined by the National Research Council (NRC; 2010) as “adjustments in the natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects” (p. 19).

Climate Change: Defined by United States Global Change Research Program (USGCRP) and the definition used for the survey. Changes in average weather conditions that persist over multiple decades or longer. Climate change encompasses both increases and decreases in temperature, as well as shifts in precipitation, changing risk of certain types of severe weather events, and changes to other features of the climate system.

Climate Change: As defined by the Intergovernmental Panel on Climate Change (2014) to provide a more detailed scientific understanding. Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the
Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: “a change of climate which is attributed directly or in directly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.” The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.

**Vulnerability**: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (IPCC, 2014).

**Impacts**: Effects on natural and human systems. In this report, the term impacts is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time-period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts (IPCC, 2014).

**Risk**: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard (see Figure SPM.1). In this report, the term risk is used primarily to refer to the risks of climate-change impacts (IPCC, 2014).
**Resilience**: “The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation” (IPCC, 2014).
CHAPTER I
INTRODUCTION

Weather experienced over generations is a place’s climate, but as the climate becomes so irregular that natural and built environments cannot cope into the extended future, this is the premise of climate change. Adaptation is a central pillar of farming and has been since its beginnings. Farmers rely on the weather, which can change even from hour to hour, and thus must decide if minor alterations they make based on the forecast could have major effects on their crop outcomes. Farmers also provide examples of resiliency overtime, after trialing new or permanent changes to their techniques due to consistent changes in weather. If farmers are not prepared for changes in specific weather events such as extreme flooding caused by more frequent and severe storms, drought, and shifts in seasonal patterns, this could lead to major losses in crops and livelihood. By investigating farmers’ knowledge and ability to adapt to seasonal and yearly weather changes over time, this can help to measure their adaptive capacity for a sustained changing climate. If farmers are continuing their same techniques over time despite their experienced changes in weather, then the assumption is that these farmers will have less adaptive capacity for future weather variability.

Adaptive capacity is a term used often in climate change; Crimmins et al. define as “it is the ability of communities, institutions, or people to adjust to potential hazards, to take advantage of opportunities, or to respond to consequences” (2016). Walker and Salt say that farmers need “to have the capacity to ask the appropriate questions. And [they] need the capacity to implement change” (2006, p. 114). “The capacity of the actors in a system to manage the system’s resilience is known as adaptability (also referred to as adaptive capacity)” (Walker & Salt, p.119). This will be measured for farmers’ past ability to adapt to
incremental year-to-year changes in weather. Typically, adaptive capacity includes many factors such as individual knowledge/education, social capital, economic sources, political intervention, infrastructure, etc. Because it would be difficult to assess all layers of adaptive capacity, this thesis will focus on only a few components.

My thesis will define adaptive capacity for family farmers in the Pioneer Valley by assessing their knowledge and experience of climate issues directly impacting their farms and preparation. According to the 2012 U.S. Department of Agriculture Census, “80% of Massachusetts farms are family owned.” Sizes of family farms are determined by the amount of economic value from sales including government payments; small farms must sell less than $350,000 and mid-size farms are between $350,000 to 999,999 (Hoppe, 2014, p. 4). A focus on family farms is imperative for the Pioneer Valley because almost all farms fall into this category. This research is important because it asks farmers their knowledge and belief of climate change as defined by United States Global Change Research Program, and if they are prepared to adapt in the future. The method of surveying is direct and like methods used in polling. It asks the beliefs of participants to predict their behaviors and support, such as for voting. Most climate change research studies are indirect by asking the public about their knowledge on select aspects of climate change and then inferring their beliefs on climate change existence and its causes (Arbuckle, Morton, & Hobbs, 2013).

A challenge with predicting climate change impacts for the region is that much of the climate projections are created for the global or state levels. Down scaling can often be hard to access even at state levels due to costs and technical skill, and even those results may still not be as finely-detailed as needed for a city or county level (Brown et al., 2015). This presents challenges for those at the town or regional level who likely do not have access to smaller-scale projections, which can influence their decision-making. Utilizing the recent
Climate Action Tool, a project released by Scott Jackson of the University of Massachusetts Amherst, finer-grained climate data can be made available to important stakeholders such as agricultural Extension faculty and private or nonprofit organizations that support farmers. However, there is not a designated plan to advertise this tool, which leaves these stakeholders at a disadvantage since they are expected to find this information on their own and then relay it amongst farmers. Lack of knowledge on climate change and its impacts is a necessary component in adaptation and mitigation, along with past experiences with weather changes and accessing resources. Because the relationship between UMass Extension and farmers is unclear, it is hard to determine the level of knowledge that farmers have on climate change and if they had accessed information and/or resources provided by Extension or other organizations. Of the total 2,181 farms in the Pioneer Valley, my hypothesis is that most will lack at least one element of adaptive capacity to effectively implement climate mitigation and adaption proposals (Commonwealth of Massachusetts, 2017). The results may be transferrable for other agricultural Extensions at public universities across the United States, which will reveal where Extension can improve their support to farmers but also continue their current efforts.

This thesis does not aim to ask farmers about climate change over the course of periodic changes such as 30 to 50-year projections, but is rather based on their ability to make changes over the last five to 10 years and how that may translate into future behavior based on their knowledge of climate change and past experiences with changes in weather. According to predictions for the Northeast region, climate change ultimately increases variability amongst weather such as rain episodes, drought, and seasonal temperatures. My underlying assumption is that farmers who were more likely to respond to short-term weather changes by altering farming methods are likelier to adapt in the future. The greater
the knowledge and responsiveness of farmers to changes in weather, the greater their value of adaptive capacity. Resources available to farmers and the degree they are accessed is also pivotal to farmer’s ability to adapt over time to a changing climate. These will also be considered in the study to determine adaptive capacity of farmers for the region and their individual farms. An increase in adaptive capacity of farmers should lead to a likelihood of a more resilient Pioneer Valley as climate change is experienced.

**The Pioneer Valley and the Imprint of Agriculture**

The Pioneer Valley is a region in Massachusetts that has 14% of its land dedicated to agriculture in some form through berries, orchards, vegetables, livestock, dairy and/or grains, and comprises about 7.4% of the Pioneer Valley’s local sales (Pioneer Valley Planning Commission, 2014, p. 151). According to the Massachusetts Department of Agricultural Resources (MDAR), the Valley has been a region with more farmland when compared to the rest of the state with all three counties spanning 173,358 acres compared to the next region (Worcester County only following at 101,808 acres). Farmlands are a significant attribute of the Valley, represented by the numerous farmers’ markets, land-use policies that protect farmland, and nonprofits such as Communities in Sustaining Agriculture (CISA) that promote local food and farmer support. There is a livelihood that encompasses economy, policy and culture which cannot be separated from the local agriculture. Agriculture is a necessary attribute that must be conserved and sustained as the world begins to experience shifts in weather patterns and climate in order to secure fresh, local foods from the communal scale to the global scale. The Pioneer Valley Planning Commission advises in their Climate Action and Clean Energy Plan, “Climate change impacts related to agriculture in the Pioneer Valley will be complex. Approximately one-third of Massachusetts’ farmland is in the region. Therefore, any change to agriculture production capabilities will have effects

4
throughout the Northeast” (2014, p. 150). The next section will explore the effects that climate impacts will have on the Northeast as a region, which will serve as climate predictions for the Pioneer Valley Region.

**Climate Change Issues and Agriculture in the Northeast and Massachusetts**

Tobin et al. (2015) states “The climate of the Northeast is changing. Weather station data show that between 1895 and 2011, temperatures of the region increased by almost 2°F (0.16°F per decade), precipitation increased by approximately 5 inches, or more than 10 percent (0.4 inches per decade), and growing seasons lengthened by more than a week”. While some may consider these changes potential opportunities, without adaptation, these changes can also present challenges for farmers. Horton et al. say (2014) that farmers in the Northeast region of the United States have already been experiencing crop damage from extreme precipitation, with heavy rains increasing the most than any other region of the country, leading to delayed planting and harvesting dates and ultimately changing yields. This is just one of the multiple major impacts that a changing regional climate can have on the agriculture industry. Other predictions include compromised water quality and distribution, increased soil erosion and decreased productivity of crops. (McCarl, 2010)

Much of the data that are available now for climate projections and impacts are at the national and regional scales. Technology and costs are some factors that limit data to be made available at smaller geographical levels, which could provide projections at a finer grain. The primary source for my projections is the Climate Action Tool, as many of the projections for the state of Massachusetts were calculated by an individual team from the Environmental Conservation department at the University of Massachusetts Amherst. This tool presents the state’s current climate along with predictions for low and high emissions scenarios for 2050 and 2080 and the impacts on different environmental facets. This tool is
mainly known amongst the environmental sciences academia at the University. By using the Climate Action Tool’s projections in my research and promoting it amongst the agricultural community, my hope is that it can be a resource that makes climate change impacts more accessible to groups other than scientists.

Climate issues in the Pioneer Valley are mainly the same as predicted for across the Northeast region and state, besides coastal flooding and sea-level rise threat which do not apply due to the geography. Table 1 is from the Massachusetts Climate Action Report that shows predictions of climate impacts for years 2050 and 2100. Temperatures and precipitation rates are due to increase across the state, with higher chances of storms but less snowfall during winters. Further, the table shows the increase in growing days over the next century due to the earlier start time of warmer temperatures in the spring, and lasting longer through summer into fall. This means changes to seasonal start and end times, along with variability in frosts and thaws.
Table 1: Changes in Climate from 2011 Massachusetts Climate Action Report

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual temperature (°C/°F)</td>
<td>8/46</td>
<td>2 to 3/4 to 5</td>
<td>3 to 5/5 to 10**</td>
</tr>
<tr>
<td>Winter temperature (°C/°F)</td>
<td>5/25</td>
<td>1 to 3/2 to 5</td>
<td>2 to 5/4 to 10**</td>
</tr>
<tr>
<td>Summer temperature (°C/°F)</td>
<td>20/68</td>
<td>2 to 3/4 to 5</td>
<td>2 to 6/4 to 10**</td>
</tr>
<tr>
<td>Over 90 °F (32.2 °C) temperature (days/yr)</td>
<td>5 to 20</td>
<td>–</td>
<td>30 to 60</td>
</tr>
<tr>
<td>Over 100 °F (37.7 °C) temperature (days/yr)</td>
<td>0 to 2</td>
<td>–</td>
<td>3 to 28</td>
</tr>
<tr>
<td>Ocean pH</td>
<td>7 to 8</td>
<td>–</td>
<td>-0.1 to -0.3*</td>
</tr>
<tr>
<td>Annual sea surface temperature (°C*F)</td>
<td>22/32F</td>
<td>2/3 (in 2030);</td>
<td>4/8</td>
</tr>
<tr>
<td>Annual precipitation</td>
<td>103 cm/41 in.</td>
<td>5% to 8%</td>
<td>7% to 16%**</td>
</tr>
<tr>
<td>Winter precipitation</td>
<td>21 cm/8 in.</td>
<td>6% to 16%</td>
<td>12% to 30%**</td>
</tr>
<tr>
<td>Summer precipitation</td>
<td>28 cm/11 in.</td>
<td>-1% to 3%</td>
<td>-1% to 0%**</td>
</tr>
<tr>
<td>Streamflow timing of spring peak flow</td>
<td>85</td>
<td>-5 to -8</td>
<td>-11 to -13**</td>
</tr>
<tr>
<td>(number of calendar days following January 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Droughts lasting 1-3 months* (#/50 yrs)</td>
<td>13</td>
<td>5 to 7</td>
<td>3 to 10**</td>
</tr>
<tr>
<td>Snow days (number of days/month)</td>
<td>5</td>
<td>&lt;2</td>
<td>&lt;2 to -4**</td>
</tr>
<tr>
<td>Length of growing season (days/year)</td>
<td>184</td>
<td>12 to 27</td>
<td>29 to 43</td>
</tr>
</tbody>
</table>

Table 1: Changes in Massachusetts’ Climate

Sources: 1-Hayhoe et al., 2006; 2-Frumhoff et al., 2007; 3-IPCC, 2007; 4-MWRA, unpublished; 5-Nixon et al., 2004
Note: All numbers have been rounded to the nearest whole number. Unless otherwise indicated, the predictions for the year listed as 2050 are for the period between 2035-2064. * Global data; **Predictions for period between 2070-2099

Purpose

The purpose of this thesis is to understand what factors may or may not be useful in preparing farmers for the future under the assumption that climate change will continue for the region. This research will develop a Farmer Capacity Index to measure the current adaptive capacity of farmers to adapt to changes in weather. The index will show what vulnerabilities are more prevalent within each county, and combined with farmers’ responses to certain vulnerabilities and their ability to use resources, can extenuate the adaptive capacity in a numerical value for each county.

Goals

- Utilize the Climate Action Tool to reveal the Pioneer Valley’s most critical climate issues and present visual data to supplement farmer’s interviews.
• Explore the weather issues that farmers have dealt with in past and present farming experiences, that may or may not be due to climate change.

• Design a survey that asks questions related to adaptation strategies to changes in weather (or climate over time) to see where farmers have excelled on their own.

• Compare amongst farmers their awareness of climate change and preparation through best practices, resources and support (and if they utilize these).

• Present results to Extension faculty and regional planning agencies to show where resources are needed (as stated by farmers) and where current aid from these organizations is still very necessary.

• Create an index that rates adaptive capacity amongst each farm and for the Pioneer Valley, based on farmer’s adaptive capacity.

**Research Questions**

The research questions that guided the survey questions and data gathered asks:

What are individual farmers’ adaptive capacity in preparation for climate change? From there, what will adaptive capacity for agriculture in the Pioneer Valley look like, and what support is needed? It is necessary to define adaptive capacity and its relation to climate vulnerabilities in a more direct measure. *Adaptive capacity* for the purposes of this research will include three components that can be considered separately but when combined in total, will equal maximum adaptive capacity. It is ideal that farmers have some level of knowledge as the basis of their adaptive capacity level, as this can help understand their past actions and how much they are aware of resources available or not to them. These three components are:
A. Knowledge of climate change terms/impacts and experience of changes in weather

B. Past actions taken to experienced weather changes

C. Awareness of resources (i.e. grants/subsidies, organizational support, technical advising) and best management practices

Understanding vulnerabilities to specific climate issues of the region is important for emergency preparedness but also for economies that rely on the weather, like agriculture. Knowledge can be considered the base of the adaptive capacity definition. While there are other conditions to be met for action such as access to money or political intervention, knowledge is primary as it is needed to know of these other resources. Implementation of climate adaptation and mitigation relies on more than knowledge by itself, but also requires experience of the issues and resources to then help solve them. Using the Climate Action Tool along with other reports for the Northeast (U.S., IPCC, and PVPC), the following environmental vulnerability issues for the Pioneer Valley have been selected as the primary focus for this project:

1) Precipitation
   a) Drier conditions for extended periods of time (i.e. Drought)
   b) More frequent and severe storm events

2) Temperature
   a) Seasonal changes, including frosts and thaws
   b) Increased periods of intense heat and intense cold

3) Increasing Pests/Diseases
From comparing the vulnerability issues of the Pioneer Valley to farmers’ adaptive capacity (comprised evenly of knowledge, past actions and resource awareness), a summative index can be created that rates individual farmers’ and the Pioneer Valley’s adaptive capacity.
CHAPTER II

LITERATURE REVIEW

The premise of this thesis relies on the general understanding of climate change and how it will impact the Pioneer Valley and its agricultural economy. This literature review focuses on four topics. One is identifying likely climate trends for the Pioneer Valley. The second is the language of climate change, establishing what terms and underlying concepts will be used in the rest of the thesis. Literature that discusses the differences in climate change adaptation terminology (resistance v. resilience) is addressed to help characterize the options open to farmers. The review then turns to considering agriculture, farmers, Extension and other agricultural advising, and how beliefs and communication about climate change influence actions planned and taken by farmers. Using the mapping analysis provided by the Climate Action Tool, it is inferred that land use changes will need to occur to maintain the current land productivity that is dedicated to farming, which shows the importance of spatial landscape mapping in climate change.

Understanding Climate Change and Adaptation for Farming

This literature review will assess climate vulnerabilities directly intersected with agriculture, how farmers are responding to climate change based on perception and scientific understanding and provide examples of civic engagement used as a tool to engage communities in resilience. It is unclear how prepared farmers are for mitigating climate change effects on their lands. While some farmers may be aware of climate change effects, it is unapparent to what extent they are informed on policies that have been made to address climate change. Berry et al. write “Calls for adaptive action have acknowledged that farmers are both among the most vulnerable groups to climate change and the ones on whom the task of adapting to climate change and mitigating agriculture’s contribution to it [reducing
greenhouse gases] largely falls” (2006). Because farmers have a history of resourcefulness due to the nature of their weather reliance, they typically will be quick to modify their methods for better yields.

One of the challenges of this topic is the conceptual difficulty around weather versus climate change. Weather, of course, is a topic of consuming interest for all farmers. Essentially, weather is the short term impacts of the atmosphere on human life, whereas climate change is the daily averages of weather over longer periods of time. “The difference between weather and climate is that weather consists of the short-term (minutes to months) changes in the atmosphere. Most people think of weather in terms of temperature, humidity, precipitation, cloudiness, brightness, visibility, wind, and atmospheric pressure, as in high and low pressure”. Climate is usually what you would expect to see based on past weather trends, whereas weather is the day to day changes that we experience.

The way weather versus climate change is discussed is often determined by who is part of the conversation. Wright-Morton and Rudel (2014) write:

Rural residents and scientists often offer dramatically different perspectives on climate change. Rural residents base their views on memories of past weather and are preoccupied with current weather (such as flooding, drought, shifts in seasonality). Scientists track large-scale global patterns and model scenarios of climate change decades into the future (p.182).

This can present numerous challenges especially in conversing about the struggles of those in rural areas to those considered “experts,” and similarly, conveying the need to plan into the future for rural people. Bryant (2013) asserts that the "natural environment has to be seen as part of human society, its communities and its activities, particularly in rural areas...[and that] "a truly sustainable development perspective today needs to consider how the mobilization and involvement of citizens (including, of course, farmers in rural systems)" (Caldwell, 2015, p. 154). Further, although municipal officials and land use planners are an
integral piece of sustainability, they should not be solely relied upon because they ultimately may not represent all community interests. Issues of municipalities will also differ place to place and so tailoring solutions should be according to the farmers and residents in their own community. When proactively adapting for the future, strategies that reduce vulnerability require a collection of diverse actors are necessary along with considering a multitude of approaches for the future.

**Projections of Climate Impacts**

To accurately place the issues of climate impacts in the Pioneer Valley, it is imperative to become familiar with the scientific data. This is especially important when conversing with others on the topic of climate change including interviewees that may or may not have knowledge of the subject. Later in the literature review I will address farmer’s perceptions and beliefs about climate change and how that impacts their decision-making. Their perceptions are influenced by the amount of knowledge (and what kind) they have been exposed to. This section will mostly present the impacts of climate change in the Pioneer Valley as they will affect hydrology, geology and land use for agriculture.

One of the primary issues of climate change is change in precipitation. For the US Northeast region, the change in total rainfall is not expected to be large (Hatfield & Takle, 2014; Walthall et al., 2012; Massachusetts Wildlife Climate Action Tool, 2017). However, greater volumes of rainfall accumulation are expected to occur more during single storm events, rather than evenly over a season. Thus, it is more likely there will be greater periods of dry spells without precipitation in between these flash wet periods. This will increase the likelihood for drought, plant heat stress and thus changes in outputs of crops (Tobin et al., 2015, pp.7-8). “Drought conditions lasting 1-3 months have occurred in the Northeast U.S. approximately every 2-3 years. Projections of future drought remain uncertain, but our best
understanding suggests short-term droughts of 1-3 months will increase, while long-term drought conditions may not change considerably from historical periods” (Climate Action Tool, 2017). Flooding and erosion can lead to damage to the soils on which agriculture depends. Furthermore, with changes of precipitation amounts and warmer weather trends, pathogens and pests are predicted to shift in their locations and move further North. This can have particularly large effects on farmers that produce one or two crops if they are ill-equipped for management and pest prevention (Tobin et al., 2015, p. 10).

Temperature is expected to increase and also to experience greater variations. Although there has been a persistent trend of warmer winters, there has been a growing issue of inconsistent frost_freeze dates observed over the past 10 years, and this will continue into 2100 (Tobin, 2015, p. 6). The Climate Action Tool states (2017):

The growing season has lengthened in Massachusetts by approximately 10 days since the 1960s. Future climate projections using a high emission scenario show continued lengthening of the frost_free season across New England by at least 19 days by the year 2055, and as much as 1 – 2 months by the end of the century, depending on the emissions scenario.

Winter temperature variability is particularly hard on crops that bloom annually (e.g., grapes, apples, cherries); these may be especially impacted if there is an increase in longer, warmer periods in late winter or early spring (ibid). Winter is predicted to experience the greatest changes in temperature with warming increases as high as 5°F by 2050 (ibid). Because winters are projected to get warmer over time, this has a likelihood of precipitation falling more as rain rather than snow, decreasing snow melt in the spring when growing plants need water reserves. Along with warmer winters, warmer summers with more days of extreme heat events will occur, aiding in extended drought periods during the growing season.

Farmers have a history of assessing changing weather conditions to guide their behavior daily. However, climate change on the rise makes for more uncertain weather
events. With changes in seasonal temperatures, availability and management of water, along with pressures from new weeds/pests/diseases, agriculture will experience more vulnerabilities. Wright and Rudel (2014) argue that people of rural places must recognize and plan for these more detrimental risks in order to adapt both financially and ecologically and increase resilience. Otherwise, their livelihoods may require shifting to accommodate for changes in yields.

In Climate Change and Human Development, Reid (2014) presents international examples of those living in poverty and their experiences that are worsened through climate change. Using articles and evidence from over 40 different scientific organizations worldwide, she articulates that many of the problems arising through climate change are either caused or exacerbated by those of higher income levels since they are likely to use more resources. Those in poverty are further disadvantaged after they experience a natural disaster or loss to their economic capital (food, livestock, crops, housing, etc.). Walker and Salt write that worldwide “humans have already converted nearly a third of the land area- almost 3.8 billion hectares- to agriculture and urban or built-up areas. Most of the remainder is too dry for agriculture” (2006, p.3). This supports Reid when considering the numerous countries that have converted their lands from historical agricultural uses to more monocrop style and only growing certain crops. “A resilient social-ecological system has a greater capacity to avoid unwelcome surprises (regime shifts) in the face of external disturbances, and so has a greater capacity to continue to provide us with the goods and services that support our quality of life” (Walker & Salt, 2006), p. 37).

According to Brown et al. (2015), the authors, increases in precipitation and its variability will significantly change management strategies for corn and other cash crops, likely relying more on increased conservation structures and different crop varieties (p. 183).
This affects all rural Americans, including the Pioneer Valley, as many farmers supplement their vegetable growing income with corn growth into the fall. Further, while farming practices vary throughout the Valley, there are numerous farmers that practice single crop seasons and who rarely alter the seed they use. Getting farmers to understand climate impacts on their practices and their options to adapt (or not) can be a challenge, but was the reason that supported my interview methodology. These issues translate globally but can lead to political and economic manifestations for farmers that they may not have much control over or ability to influence, limiting their capacity to act and make changes for a more resilient future.

Graves, Deen, Frasier and Martin (n.d.) present twelve challenges that will decrease farmlands productivity over the next fifty years that will require overhauls to current agriculture system practices. They discuss complex system synergies as a solution for more resilient farming as opposed to traditional practices that deplete soil structures and crop health. These offerings can be used for recommendations for farmers in the Pioneer Valley if these conventions are not already being practiced. Incentives such as a Single Farm Payment program (which can offer payment to farmers that utilize soil improvement methods) may positively alter the amount of farmers that participate in climate adaptation preparation.

Caldwell et. al (2015) opens their examination of resilience by identifying advanced technologies to support stronger and more sustainable community building:

According to Newman, Beatley, and Boyer (2009), planners can use technologies such as small-scale water, waste and renewable energy systems, biomimicry, green chemistry, and industrial ecology to rethink communities and move toward more localized polycentric, distributed, and eco-efficient approaches that prepare for climate change and the end of cheap oil (Caldwell et al., 2015).

In the book *Planning for Rural Resilience*, Caldwell et al. (2015) identifies three hierarchies of resilience: psychological/personal, community and system. Personal beliefs are
inherently psychological and can be influenced by personal surroundings and experiences, which will ultimately be the base to either support or deny climate change and resiliency strategies. Relying on Magis’ (2007, 2010) literature review of community resilience, Caldwell identifies that collective ideologies and ability to influence and respond to change and/or sustaining communities can ultimately influence to the greater “system” (region or network) that the community belongs in. “Others, (Norris et al. 2008) describe community resilience as a process of linking a network of adaptive capacities to adaptation after a disturbance or adversity. These capacities include economic development, social capital, information and communication, and community competence” (Caldwell, 2015). Farmers ability to adapt, otherwise adaptive capacity, will either increase or decrease their resilience overall. If weather patterns are changing overtime and becoming less predictable, this variable will change the agricultural system. Farmers, crops and farming techniques are other variables to be considered, along with factors such as funding, political will and community knowledge and skills. Rural areas that rely on agriculture for livelihood are increasingly becoming important for study due to the energy intensive processes involved and its direct correlation to carbon output which contributes to climate change. How will these areas and the people that live in them support their working economies if they are ill-prepared to handle the changes? This is where the term resilience is key, which has many definitions according to the field it is used in and who is using the term.

**The use of Resilience in Climate Change**

Terminology in climate change is complex and disputed, so it is important to be precise. The term “resilience” has sparked intellectual controversy as when using it in ecology, it refers to a specific definition: “The capacity to recover following a disturbance” (Nimmo, Mac Nally, Cunningham, Haslem, & Bennett, 2015). The International Panel on
Climate Change’s definition is “The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation” (2014). According to Walker (2006) resilience is the ability of a system to continuously absorb disturbance but retain its basic function and structure. How one responds to the event is the changing lever in the pre-existing farming system (which consists of various vulnerabilities and capacities). The type of changes made in the farming system (and the ability to make that change, i.e. adaptive capacity) will lead to the community resilience as discussed by Caldwell and IPCC.

Over time, the term resilience has been used in ways that confuse its original ecological definition the more that climate change adaptation is discussed amongst various groups. Part of the trouble is that an ecological concept is not directly translatable to social systems. As a result, many authors argue that resilience used on its own is not sufficient, and that the specific components of resilience must be discussed (Fisichelli, Schuurman, & Hoffman, 2016). Those authors ask: “But is this catch-all label useful or is it a maladaptive term that confuses and impedes progress in climate change adaptation?” (p. 3). The authors provide examples of cross-sector efforts in adaptation that relies on commonly understood definitions, but if too vague, allow for misunderstanding in goals and technique (p. 4). For conservation management they advocate for a lexicon that is clear across fields and further, can be parsed into clear and specific management strategies.

One response to these difficulties is to introduce more terms, such as resistance. Resistance refers to “the ability to withstand disturbance” (Walker, 2006). Fisichelli et al. argue that “Resistance strategies seek to prevent climate change impacts to high-value and irreplaceable resources [whereas] resilience strategies for climate change adaptation were
initially described as supporting system recovery.” Using these definitions, resilience strategies cannot be a catch-all solution for adaptation, and resistance efforts are necessary as a way for prevention. This is supported by Wright Morton and Rudel (2014) who say, “Adaptation often begins with efforts to resist and attempts to manage change … [whereas] adaptation strategies focused on resilience try to increase the capacity of the rural community to be more flexible and cope without changing the baseline structure” (p.175-176).

Resistance offers short term responses that may be more economically available and resilience is meant to be considered a longer-term future strategy that may require more investment. Examples of resistance are more infrastructural (building levees near agricultural fields along riverbanks) but resilience would represent “shifting types of agricultural crops grown or diversifying wetter, or drier conditions, but not changing the basic nature of land uses or rural livelihoods” (p. 176).

Hodgson, McDonald, & Hosken argue that resilience cannot be defined by one metric, but actually mutliple metrics that can be compared against each other to make a system more resilient or not (2015). They articulate:

If the metrics of resilience can be measured, then we can compare resilience among systems. For a given exogenous disturbance, we might find that one system is more resilient because it recovers with high ‘elasticity’ and therefore low ‘return time’, while another is more resilient because it is more ‘resistant’ (p. 503).

Resistance and recovery are key factors that must be measured to fully rate a system as resilient or not. This will ensure that a system is not simply identified as resilient, but more what aspects of resilience are met and what others are not. Caldwell (2015) examines resilience as it relates to rural communities and refers to many researchers when defining community resilience and its five community resources as defined by Magis (2007): social, physical/financial, human, political and cultural). Magis (2010) defines community resilience as:
the existence, development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise. Resilient communities intentionally develop personal and collective capacity to respond to and influence change, to sustain and renew the community and to develop new trajectories for the community’s future (p.402).

Magis explains that "Social and physical infrastructure [such as a community space] is important, along with financial resources, collective knowledge, skill, and abilities to anticipate and respond to change, and a diversity of community members actively engaged in strategic community planning" (Caldwell, p. 5). Caldwell argues that there is more need still for planners and local government to work with citizens in making strategic plans for climate change resilience. While the papers provided in the book are related to Canadian climate change, the methods explored and impetus behind the work are still relevant to my research. Further, Caldwell mentions that research on strategies for community resilience is practically negligent for rural communities and that if not planned for, will suffer negative repercussions onto the nations’ food supply. Adopting Magis’ (2010) meaning of community resilience results in smaller communities considering developing approaches which will likely increase adaptive capacity in the Pioneer Valley region. Magis defines community resilience from a sociological perspective, and thus incorporates more than the typical ecologically narrow definition.

Adaptive capacity is “The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” (IPCC, 2014). Having the ability to change to one’s circumstance is dependent on numerous factors. “A community’s vulnerability varies with the magnitude of events, types of events, rates of change, community exposure, sensitivity to events, and adaptive capacity” (Lal, Alavalapati, and Mercer 2011; Howden et al., 2007, p. 181). Due to the geography and different climates throughout the United States, one part of rural America
may experience different challenges than another, and thus their ability and method to adapt will likely differ. Practitioners use a combination of the terms, resistance, resilience and transformation (Millar, Stephenson, & Stephens, 2007).

Before this examination of the literature, I was unaware of the lexicons that were used amongst different scientific fields and how overtime, resilience has become a word that though everyone may think they understand, its definition is complex. It is similar to the word sustainability in that it can incorporate many concepts and values but what those are is dependent on who is using the word and what they are referring to as sustainable. Now, it is clearer to see the many components that make up resilience in the field of ecology and other natural/environmental science fields. It is necessary to use consistent terminology especially across disciplines to make for better planning of recommendations and policies, and enforcement of them. For purposes of this thesis, I am choosing to acknowledge that though there are many components that can comprise resilience, I will use the term in its broader meaning as taken from Magis and Caldwell. The definition of adaptive capacity will mostly come from Walker and Salt. Reviewing the Key Terms section of my thesis, it is a clear comparison between these definitions and those provided by IPCC. For farmers, increasing adaptive capacity through knowledge, assets and experiences reduces vulnerability to unexpected changes in the future, which increases resiliency overtime.

**Spatial Landscape Planning**

In the book *Landscape Planning and Rural Development: Key Issues and Options Towards Integration* (2014), Carlo Rega provides practical and theoretical arguments for how to integrate landscape planning and development policies in rural areas. Providing case study examples from Italy and various rural landscapes, each chapter presents an array of methods used within the European Union to address integration of planning for these landscapes.
This includes current issues between the Rural Development Policy and the Common Agricultural Policy, and offers room for collaboration and borrowing between approaches that lead to recommendations for future strategies. The relevant chapter for my thesis methodology explores GIS visual representation of landscape characteristics and their overlap with Rural Development policies which often only consider landscapes from an economic/production view. Similar to the United States, agriculture is quantified by its level of output and actual land uses and their greater implications are not as high of a priority. Rega’s method offers recommendations to spatially target agri-environmental policies and thus make them more effective at achieving multiple landscape/environment and economic/production goals.

Se’s paper (2007) explores the effects of various green infrastructures on specific climate change issues according to past, present and future conditions. Through a mapping of urban morphology types in Greater Manchester, random point aerial photographs were used to further estimate the surface cover accurately after an initial ArcGIS landcover search, which revealed nine types. “On average 72 percent of Greater Manchester, or 59 percent of the 'urbanized' consists of area, evapotranspiring (i.e. vegetated and water) surfaces” (p. 119). After designing energy exchange and surface runoff models, results showed that dedicating 10% of developed land in high-density residential areas to green space (trees, parks, green roofs, etc.) kept maximum surface temperatures at or below 1961-1990 baseline levels. Further, green roofs were found effective in areas with larger amounts of buildings along with green spaces. Sustainable urban drainage techniques were identified as another infrastructure that could significantly benefit sandy soils in matrices and patches through the urban landscape. One caveat was testing this against the increasing drought predictions, which will have more evaporative results on grasses and can lessen their ability to lower
surface temperatures. This paper presented another model for using spatial modeling to understand how climate impacts the land and then systems that rely on this intersection. Both papers influenced my preference of utilizing maps to present climate impacts on the land over time, and how this would inform future landuse issues of agriculture.

**Farmers’ Perceptions on Climate Change Adaptation and the Role of Extension**

As mentioned in the previous section of the literature review, Caldwell mentioned the three hierarchies of resilience, with the personal being the primary level. This would include the psychological preconceptions along with background knowledge that an individual may have already on resiliency and its application to climate change in particular. This section of the literature review will examine research that has focused on farmers and their perceptions of climate change, adaptation and mitigation, based on their knowledge and personal experiences. Also of interest is the role of Extension Services and Professionals (Extension) distributing information on climate change adaptation, their personal knowledge and beliefs on climate change and how that can influence farmers’ decision-making. For my research interviewing farmers about this subject, it is important to understand the various ideologies and preconceptions that would inform many of the conclusions farmers would present.

Fraisse (2009) says that ‘impacts on agriculture may be “broad and not completely understood,” [but] climate variability and change have the potential to both increase and decrease agricultural yields depending upon location and crop choice’ (Diehl et al., 2015). At the same time, farmer willingness to respond and capacity to act is reliant on one’s social construction of the risks that occur with increasingly variable climate conditions. “The farmer is a critical decision maker if agricultural lands are to be effectively managed to adapt to changing climate conditions” (Arbuckle, Morton, & Hobbs, 2013).
Arbuckle, Morton and Hobbs (2013) analyzed the relationships of U.S. farmer beliefs about climate change and concerns (or lack of) about responses that would mitigate or adapt to climate change, as little research had been completed to see how farmers perceive vulnerability to this issue. (Arbuckle et al., 2013, p. 552). According to Arbuckle et al. (2007), if farmers do not believe climate change to be a threat or that it exists, it is unlikely they will adopt mitigative or adaptive strategies. The research of Arbuckle et al. (2013) involved surveying 1,276 farmers of Iowa to answer two questions: (1) do farmers support adaptation and mitigation actions, and (2) do beliefs and concerns about climate change influence those attitudes. They used data collected from interviewing Iowa farmers to understand their trust of agricultural and environmental interest groups for climate change information and the risks associated with agriculture, support in adaptation and mitigation responses, and belief that climate change exists.

Arbuckle et al. developed two opposing hypotheses and found they were supported: trust in agricultural groups for reliance on information meant less belief (or uncertainty) that climate change was occurring is human-derived and trust in environmental groups would positively impact farmer’s belief that climate change is human-caused and had increased concern. The study also distinguished between individual adaptation responses common amongst Iowan farmers and mitigation efforts that are driven by public action and government intervention. Structural equation modeling was used to assess the multiple variables, which resulted in showing that farmers who believed climate change was occurring and were concerned about resulting risks were more likely to support adaptive responses and also government mitigation policy. These findings are significant in that it poses the intervention methods may need to be prioritized more if farmers are receiving their information from farm press/organizations, which may mean they are less likely to believe in
climate change and thus less likely to perceive risks needing for adaptive action. Support for mitigation was independent of belief in climate change risks and more dependent on climate change occurrence.

This study showed that farmers’ beliefs about the causation of climate change was not associated with their attitudes toward adaptive action, which shows that adaptive responses can occur without engaging in their beliefs. In other words, if farmers do not believe in the reality or the human-causation of climate change, it does not necessarily translate into how they will respond either through adaptation or mitigation. Instead, support for risk mitigation was independent of belief in climate change risks and more dependent on climate change occurrence. Support was mainly for adaptation against future extreme weather events that could directly impact their farm. These findings are significant in that they demonstrate outreach on risks can be done with both climate change believers and deniers, but the person conveying the information and what sorts of intervention methods used can alter the response.

Haden, Niles, Lubell et al. (2012) hypothesized that past experiences with climate change impacts and farmer’s perceptions of psychological distance between these impacts (both at the local and global scales) would influence behavior. They surveyed 152 farmers in a rural county of California to assess the likelihood of their adoption of mitigation and adaptation responses. Using the Construal Level Theory (CLT), determination of climate effects to be either close or distant influenced the type of strategy likely for adoption by the farmer population surveyed. Mediation models were used to determine independent versus dependent variables that interfered with each other. On average, farmers perceived a decrease in both water availability and summer temperature over the course of their careers, despite there being measured increases in temperature. Over half of the farmers agreed that
climate change was occurring and would negatively impact agriculture globally. Their views were scattered on whether human activities contributed to the cause of climate change.

Bartels, Furman, Diehl et al. (2013) discuss socio-cultural context, political arena, and people’s values/beliefs and how that constructs the conversation around climate change. Stakeholders and their perceptions on climate change can either support or hinder decision-making, and it is imperative that these facets are considered and mediated especially between contrary persons/beliefs. In this paper, a series of workshops were held to discuss risk management with row crop farmers, agricultural extension specialists, researchers, and climate scientists of the Southeastern region of the United States. The exchanges that occurred through this network allowed for coproduction and sharing of knowledge, technology and methods, which showed that perspectives vary amongst professionals and thus greater engagement strategies should be utilized for optimum best practices. This paper supported my choice of method by utilizing story-telling from farmers, specialists and translators to see how agriculture had changed over several generations, along with asking future-oriented questions yielded to specific climate situations (as well as factors restraining adaptation). Perceptions on climate change were shared, along with different technologies and strategies used to successfully transition with changes experienced in agriculture. Over half of those surveyed in each stakeholder group noticed changes to weather or climate since living in the Southeast region, mostly in precipitation or temperature. A striking result from this paper is that although most members from each stakeholder group believed in climate change, the producers (farmers) were less likely to adopt adaptation technologies than either the specialists or translators were likely to recommend these technologies.

Turning to the role of Extension and other farm advisors, Diehl et al. (2015) explored how training extension professionals on climate science and its relevance to the
field of agriculture can adequately provide education and guidance to farmers that may or
may not be equipped for planning for climate change. Results from 50 interviews with
agricultural extension professionals and growers indicated that better training on adaptation
strategies, topic-specific knowledge and forecasting, and more accessibility to trainings, can
help extension professionals in their support to farmers. Farmers that have scientific based
adaptation strategies from professionals are likely to have greater success against climate-
related stressors. Diehl et al. (2015) also advocate for greater exchanges between different
stakeholders, including extension, so that there is a reduced “one-way information transfer”
to farmers, but more collaboration of ideas.

Due to changes in weather extremes and storm conditions over time throughout the
Midwest, some researchers have called for a stronger presence of agricultural extension
outreach in order to improve future preparation responses by farmers. Over time the
funding for federal and state extension programs has decreased, putting strain on the once
strong relationships held with farmers. This, combined with farm specialization and
increasing sizes, has led many farmers to seek help from private agencies, retailers and
Certified Crop Advisors (CCAs) according to Prokopy et al. (2015). Based on an online
survey response of 1,600 agricultural advisors and 239 extension educators from various
Midwestern states, Prokopy et al. (2015) were able to show that advisors trusted Extension
first followed by scientists for climate change information. Three quarters of surveyed
Extension believe that there is sufficient information to determine if climate change is
actually occurring, and over half believe that it is partially human-caused. Agricultural
retailers and CCAs expressed higher confidence in their skill and knowledge to help farmers
approach planning for “weather-related threats” and variability. 41% of Extension were
uncertain of their technical skills and knowledge and another 25% disagreed. “Over 40 % of
the educators believe there is too much uncertainty about climate change to justify advising others to change their practices” (p. 7). This negatively impacts the information that can be given and the responses to climate change, especially if Extension are not confident in their information and how to present it to farmers or advisors. Despite Extension’ less confidence to convey scientific information to farmers, over 70% agree/strongly agree that they should “help farmers to prepare for the impacts of increased weather variability” and over 75% agree/strongly agree in the necessity “for farmers to adapt to climate change to ensure the long-term success of U.S. agriculture” (p. 7). Prokopy et al. recommend that high quality information must be given to agricultural retailers and CCAs (potentially from extension) so that advising to farmers can be accurate and strategically directed for future-oriented changes.

Taken together, the literature discussed above provides significant support to understanding that how knowledge is presented impacts one’s psychological response when confronted with opportunities for change in current behaviors. This applies to farmers and Extension professionals that both are influenced by the type of information they receive and how it is shared, which can inform how likely or not they are to believe climate change is an issue worth learning new information and techniques for. Perceived risk of impact can contribute to beliefs about climate change and likelihood to take future action. Learning new practices and information can definitely increase knowledge but may this knowledge may or may not be shared accurately and widely depending on personal beliefs, which is especially relevant in the relationship between private advisors/Extension and farmers. Looking forward it is advisable that climate science be a topic that is disseminated through intermediaries in regards to mitigation and adaptation, so that Extension is not relied upon for the only source of aid to farmers.
Local Community Resilience through Civic Engagement

In this section I present examples from both the United States and Canada of initiatives either at the individual or government level that provide interventions in climate change and agriculture. My intention in this paper is to not present farmers of the Pioneer Valley as helpless or unaware, as they are simply working with the materials, knowledge and support they have available. These next papers are meant to provide inspiration and even tactical development that may spark initiation amongst farmers or other group throughout the Valley that have a stake in this issue.

Krannich, Gentry, Luloff and Robertson (2014) discuss the history of rural communities and their dependence on resources for economic stability, but also shed light on the issues that arise as resource dependencies change. The authors describe that new technologies, changing demand for resources globally, along with societal preferences and supply availability, make it more likely that economies that rely solely on resource development will experience problems in the future. Although this chapter is referring to rural areas that depend only on resource-driven industry such as corn and single-crop grain towns throughout the Midwest and South, the lesson is that even for a smaller geography as the Pioneer Valley, any change within the agricultural system will have multiple impacts and be noticed. Farmers in the Valley rely on resources for their economic stability so changes to weather and climate will affect yields, which eventually impact sales (Wright-Morton & Rudel, 2014).

Hamin, Gurran and Emlinger (2014) examine 14 coastal communities in Massachusetts and their local adaptation approaches along with any barriers they face when planning for adaptation. Through 18 interviews with planners, the researchers were able to understand different constraints that prevented various communities from initiating climate
change adaptation methods or significantly narrowed adoption options. The researchers discovered that none of the communities had an adaptation plan, with only three preparing to complete one in the future. Only one fifth of the communities were addressing climate change currently while others expressed intention to include it in future planning efforts. The top four barriers to incorporating adaptation planning, in order, were identified as: conflicting values and beliefs, lack of resources, lack of local and state leadership, and lack of information. Also identified were the various levels of government and actors that are present within each of the barriers identified, and how this furthers the difficulty for planners to address adaptation in their communities.

Much of the community efforts were focused on dealing with current hazards rather than future climate change issues. Although this paper is discussing the challenges that planners are faced with when it comes to adaptation and mitigation for climate change, it translates into other aspects of government. If town planners are struggling to incorporate these components into current or future strategic initiatives, I infer that it is an even greater struggle for small town farmers to advocate for climate change adaptation in town policies or projects. Many farmers may take their own initiatives on their personal farms. Without systematic and broader efforts to plan at the town/regional level for climate change and its impacts on agriculture, farmers and those that aid to farmers (ie. Extension and planners) can only have so much impact.

Kraehling and Caldwell (2015) present case studies of environmental stewardship of properties as a method of productively resisting current climate impacts through the Environmental Farm Plan (EFP) and the Canada-Ontario Farm Stewardship Program. In the EFP, farmers host workshops to discuss strengths and concerns of their farms, and decide on timely actions that usually use best management practices. Significant
improvements in soil, water and health quality were discovered. Through these guiding
groups, significant impacts on implementation by farmers and non-farmers alike were noted.
Guiding groups made recommendations to build adaptive and resilient capacity included
specific indicators and benchmarks that could improve farmers practices but also future state
of their lands as they anticipate climate change. Ferguson (n.d.) discusses two Canadian
nonprofits, Everdale and FarmStart, that provide education for farmers in creating more
sustainable practices. Through their work they found that training farmers to be stewards of
the ecological environment as part of their entrepreneurial start can help promote farming
practices that are proactive to climate change issues.

Wagenet and Pfeffer (2007) outline the historical evolution of public engagement
with the U.S. Environmental Protection Agency, specifically public involvement in water
policy issues. This article utilizes two case study examples from New York to assess the
agency's watershed management effectiveness with community participation, according to
EPA guidelines. The research question is as follows: "Does the organization of stakeholder
engagement within a framework from the U.S. EPA encourage more democratic
environmental planning?" Theories of environmental planning are compared which lead to
the EPA's framework for stakeholder engagement. Ten informal private interviews were
held with various stakeholders of the two communities to gain insight on regulatory and
legal interactions between citizens and the agency under EPA guidelines. Finally, the
researchers compared the EPA guidelines according to approaches utilized for specific
regulatory actions by each agency, which revealed that overall, policymakers need to bring
citizens into the scientific and regulatory process in a way that is more open and democratic.
Taking this lesson and applying it specifically to the key stakeholder group, farmers, it is
necessary to include them in any political or economical process that relies on agriculture.
Farmers are highly capable at utilizing materials and practices they have at their disposal with slight alterations as a way to resist current weather-related issues. Overtime, they should be regarded as a key “expert” necessary at the stakeholder table when considering adaptation and mitigation efforts for future climate planning initiatives.

In summary, this literature shows that relying on government initiation for assistance and programming is not the only course of action that can be followed. Many of these farmers’ stories display acts of resilience in that they were responding to experienced and predicted threats but also wanted to prevent damage to their farms in the future, thus proactively resisting climate change impacts. Increasing agency amongst farmers is an important component to resilience work, as those that work in agriculture deal with many federal and state regulations that can sometimes stifle ingenuity. Interviews with farmers will reveal whether existing regulation is interfering with adaptation in farming practices and farmers’ views of their relationship with government.
CHAPTER III

RESEARCH METHODOLOGY

The primary question this thesis seeks to answer is:

What are individual farmers’ adaptive capacity in preparation for climate change?

To accomplish this, I chose to use a mixed methods approach. A survey was administered to a sample of farms, as further explained below. Survey results were coded, and then used in two ways: to compare all farmers’ responses to specific questions and to create profiles of individual farms to provide a more nuanced understanding of their particular situation and reasoning around the thesis issues. In effect, the questions were intended to answer for each farmer what they did or did not know/act upon, and their reasoning why. Each profile is then synthesized into an Adaptive Capacity Index, also further explained below. This allows comparison across farms in the region. Results are then presented as an analysis of survey questions across all farms, analysis of individual farms via their profiles, and cross-case analysis via the Adaptive Capacity Index.

Sample Selection

For this research study, the focus is the Pioneer Valley, which encompasses three counties from furthest North to furthest South: Franklin, Hampshire and Hampden. The Connecticut River spans the entire Pioneer Valley, and thus the furthest North farm, located in Gill, with the furthest South located in Agawam. Each farm selected for the unit of analysis is meant to be assessed as an individual case study profile, eventually to be compiled for the region. I received a list of farms through the Massachusetts Department of Agriculture and conferred the farms with the Communities in Sustaining Agriculture (CISA) database for information accuracy. I obtained the names of farms, the owners, addresses, and means of contact either through phone or email and randomly selected names to call or
email. The list of farms (218) represented one tenth of all farms registered in the Pioneer Valley by the 2012 USDA Census of Agriculture.

In October, an application to the Institutional Review Board was submitted for the first review of survey questions to be used in individual interviews for farmers. These questions were focused on noticed and experienced changes in weather, beliefs in weather changes being linked to climate change, and farmers preparedness through resources accessed and changes made to farming methods. Questions were later added to ask farmers hypothetical situations regarding drought and severe storms and their anticipated responses to those conditions. These were included to frame the mindset of farmers that even if they had adapted to similar conditions in the past, would they adapt and handle those conditions if they continue, i.e. adapting to a changing climate. Once the questions were approved, an invitation to participate in interviews and consent form were emailed to a pool of 28 identified farmers and interviews were scheduled. The questionnaire can be found in Appendix 1 with its invitation to participate.

Franklin County has 99 farms representing 23 towns, of which I surveyed three farms, one each from the towns of South Deerfield, Gill and Whately. Hampshire County’s pool consists of 87 farms representing 17 towns, in which I sampled four farms, two from Amherst and two from Hadley. Hampden County contains 42 farms and represents 17 towns, of which three farms from Agawam and Ludlow were used for interviews. In total, 10 farmers were interviewed between January and March, see Table 2. Interviews were held in person and over the phone, as some farmers could not commit to scheduling a meeting in person. All interviews were recorded using a personal recording device, and were later transcribed and analyzed using the NVivo Software.
Table 2: Survey Sample Distribution

<table>
<thead>
<tr>
<th>County</th>
<th># Farms in Contact List</th>
<th># Towns Represented</th>
<th># Farms Surveyed</th>
<th># Towns Represented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Franklin County</td>
<td>99</td>
<td>23</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hampshire County</td>
<td>87</td>
<td>17</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Hampden County</td>
<td>42</td>
<td>17</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>218</td>
<td>57</td>
<td>10</td>
<td>7</td>
</tr>
</tbody>
</table>

Rate Surveyed: 4.6% / 12.3%

The sample size of farmer selection was limited to the production of vegetables and fruits as those are the types of farming that are typically grown in the soil. Furthermore, while this was not a part of the research design, all the farms interviewed were located no more than nine miles from the Connecticut River. This highlights the importance of the Connecticut River as a source of irrigation for many of the farms closest to the River, but also translates into the soil types and soil health that can aid agricultural production in the Pioneer Valley.

Survey Coding

Using a word frequency search in NVivo, with each interview then scanned for phrases that contained specific words using the text search query, decided the topics selected for analysis. By using the word frequency first, I saw which words were used most often, and could then assess the phrases to create categories. Three primary categories (considered parent nodes in NVivo) were chosen based on the research questions asked:

1. Knowledge of climate change and experienced farming issues from changes in weather patterns
2. Altered actions by farmers (either because of the economy, weather, or variety)
3. Resources utilized by farmers (either for education, financing, or other support)
After the coding process, eight parent nodes had been created, with multiple child nodes that had been carefully aggregated (see Appendix 4). For instance, the parent node ‘Support & Resources’ has multiple child nodes. After careful review of the many issues experienced by weather and knowledge of climate change, along with actions taken to change farming and resources utilized, the interviews were coded for terms that indicated farmer’s personal beliefs in climate change and the weather issues being linked to climate change. Further, a thorough review of sentences indicating ideas and values related to climate change such as adaptation, resilience, future, capacity, preparation, modeling, etc. allowed for a higher order analysis indicating farmer’s level of knowledge and ability to plan for the future, i.e. preparation. These became additional nodes that provided richer data for understanding farmers knowledge and actions, why they have them, and to what degree of strength.

A total of 12 questions were asked to the survey population, which are posted in the Results with tallied responses. Questions were mixed between Likert Scale and open-ended. Two open-ended questions asked farmers to consider hypothetical situations, drought and storms, over an extended period and how they would respond. Each question asked on the survey was used to satisfy different components of adaptive capacity, with two open-ended questions asked for strictly understanding farmers preparation according to their identified knowledge, actions and resources available. A comparison amongst the farms will present each farm’s responses for the forced choice questions, along with quotes that will serve as evidence of my evaluation for adaptive capacity ratings. Table 3 lists the survey questions with the appropriate component of adaptive capacity that they satisfy, and was used to determine nodes in the analysis. Eight questions satisfied Combined Knowledge, seven satisfied Support & Resources and four questions satisfied the Past Actions component.
Table 3: Survey Questions and Appropriate Component of Adaptive Capacity

<table>
<thead>
<tr>
<th>Adaptive Capacity Breakdown &amp; Survey Questions</th>
<th>Adaptive Capacity Components</th>
<th>Nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question</td>
<td>Combined Knowledge</td>
<td>Past Actions</td>
</tr>
<tr>
<td>1. Have you noticed any changes to your farming or crops over the last five to ten years?</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1A. Do you think these are linked to climate change?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Are you aware of (or heard) any climate change issues specific to your country, town or farm?</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3. On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm now?</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>4. On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the future?</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5. Have you changed any of your farming methods in response to climate change, and if so how?</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8. Are you aware of any best practices/recommendations/policies related specifically to climate change?</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8A. If yes, Are you currently following any of those identified best practices/recommendations/policies?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. On a scale from Extremely Unprepared to Extremely Prepared: How prepared do you feel to start following best practices/recommendations/policies (if you knew them)?</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>10. Would you use or do you currently want support in following these best practices/recommendations/policies?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change?</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>11A. If yes, Have you worked with any of these organizations in the past?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Would you be interested working in the future with an organization or institution that supports farmers in preparedness?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Profiles and Index

Each farmer will be analyzed as its own Profile and will be given an Adaptive Capacity score according to the Index breakdown and how questions were answered. Each profile will contain a general description of the farm such as the county location, crop types and size of farm if available. Each component of adaptive capacity will be examined.
according to how the farm profile answered the questions, which will provide three values for three components. Specific quotes will be mentioned to provide context and support for the values designated for each component. The Profile will model the below example:

Interview #

Farm general description and Adaptive Capacity awarded

Combined Knowledge:
  Questions, Answers & Quotes

Past Actions Taken:
  Questions, Answers & Quotes

Support and Resources:
  Questions, Answers & Quotes

**Summary Index**

To effectively rate adaptive capacity for farmers in the Pioneer Valley, I determined that each component of adaptive capacity would satisfy a third of the total Adaptive Capacity Index, see Figure 1. With each component that is met (and to what degree of strength), the value of adaptive capacity will increase, providing a higher Index rating. This will provide a summative value that can rate the greatest level of adaptive capacity if all components are met for the individual farmer, while also presenting where farmers need assistance in increasing their adaptive capacity. The degree of each component met will also be interpreted using the qualitative interview responses, with the adaptive capacity rating explained below:

1. Farmers that have knowledge of climate change and/or have noticed changes in weather will only be considered to have 33% adaptive capacity.
2. Farmers that have altered past farming practices will increase their adaptive capacity when combined with knowledge of climate issues and/or resource utilization.

3. Farmers that utilize resources such as federal or state grants/programs, local organizations’ outreach, and Extension advising will have increased adaptive capacity when combined with knowledge and/or resource utilization.

The assumption is that missing one or more components of adaptive capacity will likely limit one’s ability to appropriately adapt to climate change impacts according to identified climate change vulnerabilities. For forced-choice questions 1, 2, 5-8A, and 10-12, the answers will be rated by a positive point scale according to the response type. An answer of ‘Yes’ will receive 2 points, ‘Maybe/Some’ will receive 1 point, ‘No’ and ‘I don’t know/Not sure’ will receive 0 points. For questions 3 and 4, the response values will range from 4 (Highly Likely) through 0 (Not Likely), and question 9 designating 2 points to ‘Highly Prepared,’ 1 point for ‘Slightly Prepared,’ and 0 points for ‘I don’t Know or Unprepared.’ The numeric value for that question will be placed in the associated component of adaptive capacity. After the 10 responses have been calculated and totaled, a final number for each component of adaptive capacity will remain. Summing the values amongst each component of adaptive capacity will create a total value on the adaptive capacity Index for each farm. Finally, all farms will be averaged to form an Index score to serve as a broad representative of the Pioneer Valley. To understand conceptually how the percentages rate, anything below 64% is considered to be in need of professional climate change advising and support.
Thus, experience or knowledge of the farming issues occurring due to changes in weather is considered the first component of adaptive capacity. If farmers made any changes to their agricultural practices (either because of market or weather related), this is the second component that complements the farmer’s knowledge. Farmers that know of resources or utilized any to aid in their practices and/or yields is the final piece of adaptive capacity. So, a farmer that had only experienced weather variability in weather would presumably have less adaptive capacity than a farmer who had experienced weather variability and then made changes to their farming. This will be determined in the Results when the values are calculated for each question’s response, with quotes providing additional anecdotal information.

Findings

The Results will be divided amongst two chapters: Chapter IV: Survey Questions and Responses and Chapter V: Farmer Profiles. Chapter IV will present the raw numerical data from the survey responses. Using the response data, a value will be created for each component of adaptive capacity dependent on if the response was positive, negative neutral, or not known. These components of adaptive capacity will be supplemented by quotes for
context and justification for my coding. Chapter V will present the ten farms analyzed as ten individual profiles with their own adaptive capacity rates based on the scores within each of the components. Because there are three components to adaptive capacity, each is worth approximately 33.33%, with all three potentially (if met) earning the farm a total summative score of 100% adaptive capacity. By looking at each farm’s responses, distinction can be made amongst values and issues presented from each farm, along with methods for preparation and adaptation. The geography is also varied amongst these 10 farms, so observing them individually allows for the location to be a possible correlation between response types. At the end of Chapter V, the ten farm adaptive capacity values will be averaged to provide the total of all farms’ rating of adaptive capacity. This will allow insight into which aspects of adaptive capacity are already well represented in the Valley, and which aspects appear to need strengthening. The discussion will interpret the results to the literature, theory and practice and their significance to future planning initiatives.

**Limitations**

It is important to identify limitations to the framework of research as due to the lack of funding and time, not all aspects of vulnerability or adaptive capacity have been measured. Adaptive capacity can include numerous components typically like individual and collective knowledge, funding, political intervention, community networks, etc. For this project I chose to focus on one element of adaptive capacity, individual knowledge of farmers (and their responses based on their knowledge), to be a predictor for the likelihood of capacity they would have to adapt to changes they experienced. Furthermore, vulnerabilities can range from environmental, economic, social and more, but this project only looks at the environmental vulnerabilities related to the local weather and patterns of climate, along with vulnerability that farmers have according to their knowledge and use of resources. There is
an underlying assumption that I have made by asking questions about changes in weather to be a predictor for preparedness of the changing climate over time. Climate change predicts more variability of weather in the future. If farmers have taken actions in the past to the weather changes they saw, the assumption is they are more likely to adapt to changes in the future, and with a more variable climate, they will have increased adaptive capacity and resilience.

A limitation for the methodology is the selection of the sampling group for interview of farmers. Originally, farms were selected by picking at random a farm located in a different city. Each county was selected to have a goal of five different farms, i.e. five cities/towns, selected for interview. However, many farmers were unavailable for the interview or simply not able to be reached by email or telephone communication. This meant that farms had to then be selected in municipalities that may have already been used. This was most present in Hampden County where the number of communities represented by farms was the lowest, so communities were used more than once. This created an uneven distribution of towns represented between the counties, but still can represent frequency of issues within those towns and across each county.

Further, the list used to select farms for interviews is not an exhaustive list of the total farms within each county. I was limited by using Communities Involved in Sustaining Agriculture (CISA) and MDAR as the farms in their databases must be self-registered with those programs. There were some farms that were recommended by other farmers that were not on the original list, which were added to the sampling total list. While the original population was only vegetable farmers, many were not available to interview and thus interviews were held with one berry farmer with general experience in family vegetable farming, and one store owner who only stopped farming in the last five years but drew from
past experiences. This may have altered some of the qualitative responses from these two interviews but did not impact the quantitative results from the survey questions. Due to farmer’s limited availability to interview, the survey sample size did not sufficiently represent Pioneer Valley farmers as a whole population. The research method and results can still survey as a pilot study that in the future can changed to account for these limitations.
CHAPTER IV

RESULTS: SURVEY QUESTIONS AND RESPONSES

Quantitative Results

The results from the Survey questions have been totaled and are in the Table 4. For the first group of questions that follow forced answer choices, colors have been designated to show majority values amongst response choices: Red is for responses of 1-3, Yellow is for responses of 4-6 and Green is for responses of 7-10.

Table 4: Forced Choice Survey Questions and Responses (4 Options)

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>Maybe</th>
<th>No</th>
<th>I don't know/Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Have you noticed any changes to your farming or crops over the last five to ten years?</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1A. Do you think these are linked to climate change?</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2. Are you aware of (or heard) any climate change issues specific to your county, town or farm?</td>
<td>1</td>
<td>0</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>5. Have you changed any of your farming methods in response to climate change, and if so how?</td>
<td>8</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>8. Are you aware of any best practices/recommendations/policies related specifically to climate change?</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>8A. If yes, Are you currently following any of those identified best practices/recommendations/policies?</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>10. Would you use or do you currently want support in following these best practices/recommendations/policies?</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>11. Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change?</td>
<td>5</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>11A. If yes, Have you worked with any of these organizations in the past?</td>
<td>6</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>12. Would you be interested working in the future with an organization or institution that supports farmers in preparedness?</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

The majority (80%) of farmers notice changes to their crops over the last five to ten years, and even into 20 years or more. Furthermore, seven of ten farmers believe there is a link between the changes they have seen (which was dependent on weather as a causal assumption) to climate change over time for the Pioneer Valley. Of the survey responses,
90% have not heard of climate change issues specific to their geographic location. When looking at the behavior of farmers, 80% agreed that they have changed their farming practices/methods, with climate change being a motivator (if not the only).

Questions 8 through 12 assess ‘Preparation’ and ‘Support & Resources.’ Most farmers are unaware of specific policies or planning recommendations that target climate change for the agricultural sector. The results are moderately positive when farmers were asked if they would like support in following best practices/recommendations or policies. Half (50%) of the farmers could name specific organizations and other entities in the Pioneer Valley or nation that offer support for preparedness, and had worked with them before. The interesting result came with Question 12, because despite a low rate of awareness for best practices and mixed responses for aid in preparation, almost all farmers agree that they would be interested to work with an organization that provided aid to farmers in climate change preparedness in the future.

Because the scaling method is “forced choice” for the following three questions, the color scheme values have changed with Red representing ‘Not likely,’ Yellow representing ‘Slightly Likely’ or ‘Slightly Prepared,’ and Green coded for choices ‘Moderately Likely’ through ‘Highly Likely.’ ‘Don’t Know’ was left as a neutral option that was not color-coded.
Table 5: Forced Choice Survey Questions and Responses (5 options)

<table>
<thead>
<tr>
<th>Question</th>
<th>Not Likely</th>
<th>Slightly Likely</th>
<th>Moderately Likely</th>
<th>Likely</th>
<th>Highly Likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm <em>now</em>?</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4. On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the <em>future</em>?</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>9. On a scale from Extremely Unprepared to Extremely Prepared: How prepared do you feel to start following best practices/recommendations/policies (if you knew them)?</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

Questions 3 and 4 were modeled the same except one asked to rate climate issues impacting the ability to farm in the present and the following asked the ability to farm in the future. Comparing the results between the two questions, there are more farmers that feel there is little to slight impact of climate change to farming now, but in the future, more agree that it would be a greater likelihood of impact. Question 9 also addressed ‘Preparation’ by having farmers rate their level of preparedness to begin following climate change best.
practices/recommendations/policies if they knew them. Only one farmer did not know, while a third feel slightly prepared and 2/3 feel extremely prepared. The remaining two questions that were open-ended are below and will be included in the Qualitative Results.

6. According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn’t make it through the season)?

7. What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available?

**Qualitative Results**

The results of the qualitative analysis are only meant to indicate where it is more likely that farmers may see challenges with their current agricultural practices and how they may (or may not) have considered climate change to impact their practices into the future. Because of the sampling size, these results should not be considered representative of the Pioneer Valley region, but more as individual case studies that display a finer-grained picture within each municipality the farm is located in. Similar interview responses (both issues and suggestions for change) can potentially lead to collaborative methods of intervention across municipalities and amongst counties and nonprofit or private agencies.

After significant coding of the interviews, queries including hierarchical charts and matrix coding were utilized for deeper analysis. These allowed connections between parent nodes and child nodes, and interpretation of value between them. Quotes were drawn from the referenced interviews to provide varied context of farmer’s opinions, and to help clarify distinctions within one node. When finished with the coding process, eight parent nodes had been created, with multiple child nodes that had been carefully aggregated (see Appendix 4). Seven of the parent nodes were then grouped into four categories (with Farmer Type
excluded): Farming Issues, Preparation & Farmers’ Actions, Combined Knowledge & Belief of Climate Change, and Support & Resources. How these categories were determined is explained below and is represented by Figure 2:

- **Farming Issues**: Issues either noticed or experienced by farmers due to changes in weather. These were treated as their own category to log what farmers had been noticing over the years.

- **Combined Knowledge** included two child nodes: If farmers had an understanding of Weather/Climate Variability and if they had experienced Weather or Climate Changes (over time). Knowledge is not limited to only intellectual but can also include experience. Belief included if farmers believed in climate change science and its impacts on the Earth. Both nodes contribute to a farmer’s feelings towards climate change and how it influences their decision-making and preparation.

- **Preparation**: Farmers that took measures to be prepared for future changes and were considering future yields/sales. This was combined with the parent node Farmers’ Actions, which logged specific actions taken by farmers to prepare for future climate change.

- **Support & Resources**: This was its own node in the analysis from the beginning of the coding. This node logged types of monetary, educational, technical and organizational support that could be used by farmers, and had been used already.
Combined Knowledge and Belief in Climate Change

Table 6 provides a simple summary of the population and their associated knowledge and values related to the topic of climate change. ‘Combined Knowledge’ was broken down into two child nodes: ‘Knowledge of Weather or Climate Variability’ and ‘Experienced Weather or Climate Changes.’ Knowledge can encompass multiple facets of knowing, and being able to recall experienced changes to weather over time is supplemental to understanding scientific information regarding weather or climate change.

Table 6: Combined Knowledge and Belief of Climate Change

<table>
<thead>
<tr>
<th>Combined Knowledge</th>
<th>10</th>
<th>119</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of Weather or Climate Variability</td>
<td>10</td>
<td>62</td>
</tr>
<tr>
<td>Experienced Weather or Climate Changes</td>
<td>10</td>
<td>57</td>
</tr>
<tr>
<td>Belief of climate change</td>
<td>10</td>
<td>50</td>
</tr>
</tbody>
</table>

All but two sources have knowledge of weather/climate variability and experienced changes in weather over the years of farming. The interviewees believe to some degree that climate change is real, but the ambiguity is shown by the comments made. Many are unsure how climate change would affect the Pioneer Valley and if it would have more negative
impacts than positive. Seven of the ten interviewees are confident that the changes they have witnessed in weather in all their years of farming are due to climate change, while the remainder would answer hesitantly and not definitively and were scored as “maybe” or “I don’t know.” Some of these responses included:

“There’s changes in climate and temperature. I’m not sure if it’s new or if it’s from natural occurrences. In all fairness I don’t know if anyone knows for sure.”

“Well, climate comprises your average climate comprises, a range around a mean and you can get anything in there but it seems to me over the last decades, it’s certainly gotten warmer. But it seems as if the rainfall patterns and the storms associated with them, can I attribute that all to climate change no, but I’m very suspicious.”

“As far as telling you there’s a climate change I can’t say, you know, but I know there’s a lot of difference last year. Now once we get this year under, and it’s the same way, then I might change my mind on everything.”

Looking at a cross comparison between Combined Knowledge and Belief of Climate Change, phrases that indicated Combined Knowledge are mentioned more times. This matches Research Question A, assessing knowledge of climate change issues, including Knowledge of weather variability. The research question did not specifically ask if farmers believed in climate change or not, but the analysis shows that beliefs were inadvertently brought up based on the follow-up of Question 1: Do you think that these (changes to farming/crops) are linked to climate change? Some preferred to refer to “expert” opinions in their reasoning, such as “It seems it has been more extreme these past few years, and it seems to be the general thinking that it’s due to climate change. I’m not an expert in meteorology and all that stuff but what they’re (scientists/climatologists) saying seems to make sense.” It is inevitable that beliefs, weak or strong, are included as part of one’s
reasoning to explain part of the changes that farmers have seen over the last five, ten or even 20 years based on the literature from Arbuckle and Bartels et. al.

**Farming Issues**

Table 7 shows the issues that came up amongst farmers the most. It is important to distinguish that though the number of references can be convincing of the greatest issues, looking at the total number of respondents matters. All ten farmers mention the issues of precipitation, drought and irrigation. This was followed by nine farmers that mention dry weather conditions, wetter periods, storms, temperature, and loss of money or yield as other issues of concern.

**Table 7: Farming Issues presented by Most References to Least**
<table>
<thead>
<tr>
<th>Farming Issues</th>
<th># Respondents</th>
<th># References</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>10</td>
<td>359</td>
<td>100%</td>
</tr>
<tr>
<td>Precipitation</td>
<td>10</td>
<td>131</td>
<td>36%</td>
</tr>
<tr>
<td>*Drought (Extended dry conditions)</td>
<td>10</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>*Dry Weather and Loss of Water Supply</td>
<td>9</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>*Wetter periods/ More Precipitation</td>
<td>9</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>- Wind</td>
<td>6</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>- Flood</td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>~ Erosion</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>*Storms</td>
<td>9</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>*Snow Cover</td>
<td>5</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>*Hail</td>
<td>4</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>9</td>
<td>67</td>
<td>19%</td>
</tr>
<tr>
<td>*Seasonal Swings or Changes in Season Length</td>
<td>7</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>*Frost and Colder temperatures</td>
<td>7</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>*Extreme Heat and Warmer Temperatures</td>
<td>8</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td>10</td>
<td>56</td>
<td>16%</td>
</tr>
<tr>
<td>*Municipal water</td>
<td>6</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Loss of Money or Yield</td>
<td>9</td>
<td>39</td>
<td>11%</td>
</tr>
<tr>
<td>Diseases and Pest</td>
<td>7</td>
<td>32</td>
<td>9%</td>
</tr>
<tr>
<td>Costs and Labor</td>
<td>6</td>
<td>23</td>
<td>6%</td>
</tr>
<tr>
<td>Government Regulation</td>
<td>5</td>
<td>11</td>
<td>3%</td>
</tr>
</tbody>
</table>

*Issues are presented from most references to least*

The node ‘Farming Issues’ includes only ideas that were considered problematic, thus this node deliberately does not aggregate all issues from the child nodes as some “issues” were actually considered positive. For instance, 'Precipitation' has almost the same number of references compared to its parent node 'Farming Issues' because some references to precipitation were not included as a negative issue but rather, positive. Further, ‘Precipitation’ encompasses two domains: limited precipitation which is present by
drought/dry weather and more precipitation by rainier or wetter periods and more storms. Of the farming issues, changes in 'Precipitation' were the most frequently mentioned (36%), and the survey population discussed ‘Dry Conditions’ and ‘Drought’ more than ‘Wetter Conditions’ or ‘Storms.’ When ‘Drought’ and ‘Dry Conditions’ are combined, they represent 45% of the total ‘Precipitation’ discourse, whereas ‘Wetter Conditions’ and ‘Storms’ combined equates to roughly 35%.

Some farmers indicate that it is easier to put water on the field rather than take it off:

“I would rather dry than rotten. Seriously, I could add water, I’ve got wonderful irrigation and I’ve got good sources of water.”

“It’s hard to protect your farm from too much rain. It’s one of the problems where from drought, it’s fine, you just get irrigation. But, it’s much harder to take water off than to put water on. That’s one that’s tricky, we don’t really have a way, that’s kind of a pray situation.”

However, the costs are usually greater with having to put the water on the field during a drought. ‘Temperature’ was referred to 67 times (19% of Total Issues), divided almost in even thirds between ‘Changes in Seasons,’ ‘Increasing Colder Temperatures’ and ‘Warmer Temperatures.’ The farmers indicated they notice changes in the length of the seasons and when seasons start and end. Depending on what is grown, some farmers get more time out of the growing season, but other farmers have experienced less time due to extreme heat or frost that comes earlier than expected such as:

“Yes, there’s been a minor increase in the length of the growing season and the weather has had seemingly a few more extremes. I lost a crop of peaches last winter, it was warm and then went to 19 below.”
“Simultaneously being able to handle a drought year because you don’t know what you’re gonna get. You’re also kind of hedging your bets like on what kind of spring or fall, you know the shorter seasons, you know how warm is it gonna be how cold is it gonna be.”

“I would say that more than half of the days we’ve had this winter and probably last winter as well in these months where we expected it to be solidly below freezing, we’re seeing it above freezing during the day.”

“I’ve seen an increase of the growing season by about a month, considering both the early part of the season, the spring and the fall. Comes on earlier and it stays longer. It seems, I have nothing to quantify it, but it seems as if the weather is getting more variable.”

The seasonal fluctuation also includes variability of temperature within a season, meaning that during the spring when the last frost typically occurs, there are more instances now that another frost happens and damages budding crops. This presents a challenge for farmers that may grow more sensitive crops such as berries and fruit trees.

“You know, apples, peaches, pears, cherries, all those things are going to be really sensitive to dramatic shifts in weather this time of year.”

Irrigation presents the third most mentioned issue that is both dependent on the first two issues (Precipitation and Temperature). Often, passages that were coded for Irrigation were simultaneously coded for either of the other two issues. Also, many of the quotes that were coded as Issues were then followed with Actions that were taken by farmers, and thus were also coded for ‘Farmers’ Actions.’
Preparation and Farmers’ Actions

‘Preparation’ became a node that encompassed terms such as “adaptation,” “predict,” “predictability,” “capacity” and “resilience.” When subjects mentioned these words, the phrase was logged for planning for future action, i.e. preparation. These words were also used as indicators that farmers had knowledge of climate change, since they are present amongst much of the science literature. Simultaneously, the specific action mentioned would be logged under ‘Farmers’ Actions.’ Table 8 shows the number of times that ‘Preparation’ was logged and Figure 4 shows the types of actions mentioned by farmers that they took in response to their experiences with weather.

Table 8: Occurrences of Preparation mentioned amongst Farmers

<table>
<thead>
<tr>
<th>Name</th>
<th>References</th>
<th>Coverage in Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview 9</td>
<td>17</td>
<td>26.61%</td>
</tr>
<tr>
<td>Interview 6</td>
<td>16</td>
<td>20.72%</td>
</tr>
<tr>
<td>Interview 3</td>
<td>15</td>
<td>27.05%</td>
</tr>
<tr>
<td>Interview 7</td>
<td>12</td>
<td>23.31%</td>
</tr>
<tr>
<td>Interview 10</td>
<td>10</td>
<td>20.82%</td>
</tr>
<tr>
<td>Interview 4</td>
<td>9</td>
<td>14.09%</td>
</tr>
<tr>
<td>Interview 8</td>
<td>9</td>
<td>14.77%</td>
</tr>
<tr>
<td>Interview 5</td>
<td>9</td>
<td>16.85%</td>
</tr>
<tr>
<td>Interview 1</td>
<td>6</td>
<td>11.38%</td>
</tr>
<tr>
<td>Interview 2</td>
<td>4</td>
<td>6.30%</td>
</tr>
<tr>
<td>Total</td>
<td>107</td>
<td>--</td>
</tr>
</tbody>
</table>
In Figure 3, ‘General Farmers’ Actions’ includes actions that refer to the frequency of vague or nonspecific actions taken, or when the farmer indicates they would act but had not identified a specific action yet. This node also includes when farmers discuss practices they have already done and will continue to do in the future and the need for taking future action. ‘General Actions’ are coded alongside ‘Preparation,’ as being prepared ultimately would mean taking some anticipatory action in the future had it not already been. The node ‘General Farmers’ (51 references) was not included in the chart as it was a more general topic; the chart is intended to show specific actions that farmers had taken or would anticipate taking in accordance with changes in weather.

The most common action stated (roughly 33%) includes increasing irrigation and changing the irrigation method, all categorized under ‘Irrigation.’ Use of a water source such as a private well or pond to pump water from, or purchasing water from the municipality,
are most frequently mentioned. Often, interviewees consider reverting to municipal water when having to irrigate their farm during a drought and their current source of water is dry. ‘Soil Techniques’ is the second action most cited (19%), which includes ways to keep soils healthy and minimize erosion, including cover crops, no till, and no pesticide use. The topic ‘Costs and Labor’ is mostly a topic focused on future actions taken if the weather continued to vary due to climate change and is approximately 14% of the total actions. This includes raising prices of produce, reducing labor costs, and increased costs associated with buying more equipment, seeds, etc. Some other topics worth mentioning that were analyzed separately from ‘Costs and Labor’ were ‘Equipment,’ ‘Planting Dates,’ ‘Disease Control’ and ‘Seed Variety.’

Support and Resources

In Table 9, frequently cited examples of ‘Support and Resources’ are available, with organizations most identified. This includes nonprofits and other state/federal programs such as CISA, Farm Bureau and the USDA. UMass Extension was given its own category to separate the institution from the nonprofit and governmental organizations that are involved in supporting farmers. ‘Government regulation’ was brought up mostly due to Questions 10 and 11, in which most responses indicate that regulation would only be welcome if it were optional, not mandated.

“If they’re gonna come in and tell us how to do it and they’re the ones in charge of what we have, that’s a no. But if they’re gonna come in and say “Here I have something for you to look at and this is how I can help you do it…these are ways to go about doing it.” That’s a whole different ball game.”

Many farmers welcome support but more in the monetary manner. Otherwise, government was seen more as a force that works counter to farmers’ independent actions.
“It’s not that you might get a bad storm, my grandfather had bad storms. But the disease is the real problem and to make it worse, our government has so many different federal regulations that it’s almost impossible to navigate them all. That’s the real reason. Actually, the federal regulations work counter to what we’re doing.”

Other support was categorized into monetary, usually in the form of federal, state or nonprofit grants. These programs also have many educational resources such as handouts, that are available to farmers in paper and online format, along with workshops and meetings.

Table 9: Support and Resources for Farmers

<table>
<thead>
<tr>
<th>Support and Resources</th>
<th>10</th>
<th>61</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizations</td>
<td>10</td>
<td>31</td>
</tr>
<tr>
<td>Extension</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Government Regulation</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Money or Grant funding</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Education</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Next will be the deeper analysis of each farmer’s response and how it relates to the adaptive capacity components. Questions from the survey were broken down to suffice at least one of the three adaptive capacity components, which translate into points of adaptive capacity awarded to each farmer. Quotes will supply context for how the answer was coded for adaptive capacity satisfaction and eventually, results will show total adaptive capacity for each farmer and the greater Pioneer Valley.
CHAPTER V
RESULTS: FARMER PROFILES

This section will examine each farm at the individual level and rate their adaptive capacity according to the three components. Quotes from the ten interviews will serve as evidence and context for why adaptive capacity points were allocated (or not) for that farmer. A summary of the farmer and the county it belongs in are provided to identify the farm in the Pioneer Valley, while still preserving anonymity. Of the survey questions, Combined Knowledge was the component that received the most points from survey questions; this was not deliberate, but the questions were formed with Combined Knowledge serving as the primary component for adaptive capacity, so it is reasonable to see why more points were allocated to this. It is also important to note that answers to Questions 6 and 7 were not factored into the total points as they were asked more for qualitative information. In order to provide an index for farmers and other stakeholders that is easily interpreted, I decided to translate the scores into ratings below that could be easily understood and provide guidance, which will be used to rate each farm and the Pioneer Valley accordingly. The minimum and maximums rates came directly from the average County Adaptive Capacity scores, to meet the farmers where they are at currently.

Exceptional = Above 80.48
Satisfactory = 80.47 - 64.01
Progressing = 64 – 49.01
Needs Improvement = 49 – 33.01
Unsatisfactory = Below 33
Interview 1

<table>
<thead>
<tr>
<th>Points Awarded from Questions</th>
<th>Combined Knowledge</th>
<th>Past Actions</th>
<th>Use of Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

| Total Points Possible from Questions | 20                  |
| Past Actions | 10 |
| Use of Resources | 14 |

| Adaptive Capacity Percent | 35.00% | 28.57% | 50.00% |

**Interview 1: Hampden County**

This farm produced seasonal fruits, vegetables and corn for sale during the summer and fall months, and is staffed only by family members. Past Actions were where least points were awarded (less than 30%) and Combined Knowledge was at 35%. Use of Resources were met at 50%. The combined Adaptive Capacity score of all three components was roughly 37.9%.

**Combined Knowledge:**

Of the 20 points, this farm only was awarded 7 for Combined Knowledge. The lack of determination in issues and changes to farming being caused by climate change was mostly what prevented this farm being awarded more points, seen in Questions 1 and 1A. Questions 6 and 7 add to this farmer’s sense of knowledge as they are unsure of exactly how they would proceed under hypothetical weather stressing events. Their knowledge of organizations working on climate change in the Pioneer Valley and best practices was limited.

**Question 1:** Have you noticed any changes to your farming or crops over the last five to ten years? “Somewhat but I can’t say yes and I can’t say no. Well I plant a lot of different stuff, it’s just that out in the, you know, it depends on the weather basically, for how good of a yield you get.”
**Question 1A:** Do you think these are linked to climate change? “I don’t know I’m from the South, so you know the thing is it’s I’ve been here for 16 years now, and I’ve seen a little bit of a difference in the climate but can I say it’s climate change or can I say it’s just due to what’s going on with the weather…I know last year was a hot, dry summer and all the rest of the time it’s been hot and wet. This year was dry.” This was scored as “maybe.”

**Question 2:** Are you aware of (or heard) any climate change issues specific to your country, town or farm? No

**Question 3:** On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm now? Slightly likely. “Yeah, basically what I said already. As far as telling you there’s a climate change I can’t say, you know, but I know there’s a lot of difference last year. Now once we get this year under, and it’s the same way, then I might change my mind on everything…”

**Question 4:** On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the future? Highly likely. “A lot, it would highly impact the farm because we’re gonna have to come up with resources of water. I have no irrigation, I only have a pond on my place. I don’t irrigate much, I only irrigate if it gets real dry. If the pond dries up, then I’m out of luck.”

**Question 6:** According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn’t make it through the season)? “I don’t know what I would do. Being honest with you, if I don’t make it we’re all going to suffer. There’s not only gonna be me and my family suffering, but everybody else up there that buys from us gonna be suffering too. But I would try to find vegetables around off of somebody else.”
Question 7: What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available?

“Move. We’d have to go to the town water, if it was available. There’s ways to get water. I mean, if I had to haul it in from another place, another farm, another spring or whatever, I would still [have] water.”

Past Actions Taken:

A total of 3 points were scored of the possible 10 points, mostly due to the little detail this farmer provided to Questions 5 and 9 and the conflation of “preparation” with “confidence.”

Question 5: Have you changed any of your farming methods in response to climate change, and if so how? “I have changed a little on how I plant and where I plant a lot of different stuff.”

Question 9: On a scale from Extremely Unprepared to Extremely Prepared: How prepared do you feel to start following best practices/recommendations/policies (if you knew them)? Extremely prepared. “If it comes out that it could make a difference for me on what I could grow and how I could grow, I’m sure we’re gonna get prepared for it to help not only my family but everyone around us. It’s not only me I’m feeding, we feed a lot of people.”

Support and Resources:

This interviewee received 50% of the possible points for Support and Resources that they were aware of and used in the past. They were unaware of best practices related to climate change and were skeptical on accepting support to follow them if this was a resource available. Their knowledge of organizations in the Pioneer Valley that support farmers and working with them determined their 50% award.
Question 8: Are you aware of any best practices/recommendations/policies related specifically to climate change? No.

Question 8A: If yes, are you currently following any of those identified best practices/recommendations/policies? N/A.

Question 10: Would you use or do you currently want support in following these best practices/recommendations/policies? “Depends on basically the practice. If I could follow it myself, I would follow it myself. But if I could get someone to help me I wouldn’t turn it down. It’s a catch 22. If they’re gonna come in and tell us how to do it and they’re the ones in charge of what we have, that’s a no. But if they’re gonna come in and say “Here I have something for you to look at and this is how I can help you do it…these are ways to go about doing it.” That’s a whole different ball game…If you don’t give farmers the choice, you’re not going to have many farmers left.”

Question 11: Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change? I don’t know.

Question 11A: If yes, have you worked with any of these organizations in the past? I don’t know.

Question 12: Would you be interested working in the future with an organization or institution that supports farmers in preparedness? Yes.

<table>
<thead>
<tr>
<th>Interview 2</th>
<th>Combined Knowledge</th>
<th>Past Actions</th>
<th>Use of Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points Awarded from Questions</td>
<td>10</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Total Points Possible from Questions</td>
<td>20</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Adaptive Capacity Percent</td>
<td>50.00%</td>
<td>80.00%</td>
<td>57.14%</td>
</tr>
</tbody>
</table>
Interview 2: Hampshire County

This family-managed farm sells a variety of seasonal vegetables and strawberries on almost 400 acres. Combined Knowledge was lowest for this farmer at 50% but had utilized and knew of resources the most at 57.14%. The total adaptive capacity for this farmer was 62.4%, with past actions taken and use of resources leading the total score.

Combined Knowledge:

This farmer like others, doubted if the changes they had noticed were due to climate change or were just part of the climate’s cycle naturally. Further, this farmer did not consider climate change to be an issue in the future to be of concern due to their lack of belief in the theory altogether, along with knowledge of climate change issues. Their knowledge on best practices for climate change related farming was limited. The farmer had strong beliefs that they would be adequately prepared to handle hypothetical stressors despite a changing climate, which may or may not be an accurate indicator of preparation.

Question 1: Have you noticed any changes to your farming or crops over the last five to ten years? See below.

Question 1A: Do you think these are linked to climate change? “Yes, there’s been a minor increase in the length of the growing season and the weather has had seemingly a few more extremes… However, I’d like to point out that same kind of thing could have happened to a farmer 100 years ago…I don’t know if we’re just more aware of it, you know, we see things on TV. You know my grandfather would have never heard about the weather being extreme or something, I believe that the longer growing season has been a real benefit to us here and I’m grateful for the longer growing season… There’s changes in climate and temperature. I’m not sure if it’s new or if it’s from natural occurrences. In all fairness I don’t know if anyone knows for sure.”
Question 2: Are you aware of (or heard) any climate change issues specific to your country, town or farm? “No, not really.”

Question 3: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm now? Moderately likely. “I think I benefitted greatly. When I was young, it was not that unusual to get a frost a week or two after Labor Day and now it takes a week longer than when I was a kid.”

Question 4: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the future? Moderately likely. “I think there’s bigger challenges than this to us. But I mean I’ll tell you this, the longer growing season has been a big plus. I don’t know if that’s all caused by man or if it’s just a natural occurrence, but it has been helpful.”

Question 6: According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn’t make it through the season)? “One year, probably 25 years ago, we lost our crops and I just took the crew and we painted buildings and made a living for a month until the other crop came in. There’s still opportunities out there. I’m not certain that the climate change has really affected the yields to our detriment, I mean we’re in surpluses perhaps nationwide and worldwide that I’m not sure that this is such a catastrophe.”

Question 7: What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available?

“I’ll tell you, I cut a lot of produce to make a living. We actually take our produce one step further than most farms… Let’s say I lost of crop of zucchini squash and in New Jersey, maybe 400 miles away would have a good crop. I would just buy from them. The actual cost
of the basic commodity is not that high compared to the labor involved. My margins would be pretty near the same, honestly… The USDA or the SSA comes to me and they say “Well you’re going to lose your corn.” Well you know, to not do monoculture farming for the first time in twenty-something years is probably a good thing even though the payment from the USDA is probably set on monoculture farming but nature doesn’t really do that in real life. If you go to the woods there’s a variety of plants. I find a much bigger challenge is put on me from different viruses or diseases and government regulations than I do from climate change. I think from here we benefit slightly from it with my crop mix.”

**Past Actions Taken:**

The farmer’s confidence in ability to handle the future based on their current practices and shifts in farming methods helped them receive a moderate score for past actions taken.

Question 5: Have you changed any of your farming methods in response to climate change, and if so how? “I plant a few more acres because I feel like I can handle and harvest a few more acres because I can probably, hopefully, get another choice of a growing season.” This response was coded as “Yes” because they had agreed that the climate was changing despite their unwillingness to declare it was human-caused.

Question 9: On a scale from Extremely Unprepared to Extremely Prepared: How prepared do you feel to start following best practices/recommendations/policies (if you knew them)? Extremely prepared. “I try to be pretty progressive in our practices. I’d be extremely likely to try new and exciting things because I could use some exciting things in my life. I would be exactly prepared.”

**Support and Resources:**
This farmer had knowledge of different resources available to farmers along with different farming techniques that improve practices overall. They were also very likely to receive support in learning about best practices, and had extensive connections with different organizations throughout the Pioneer Valley.

Question 8: Are you aware of any best practices/recommendations/policies related specifically to climate change? See below.

Question 8A: If yes, are you currently following any of those identified best practices/recommendations/policies?

“I don’t know if it’s related specifically to climate change but we do some soil tillage where we don’t disturb the soil nearly as much. I think that’s beneficial because if you were to get pounding rains or more winds, you would not suffer with as much erosion. There are ways to moderate the effects that might be hurtful.”

Question 10: Would you use or do you currently want support in following these best practices/recommendations/policies? “I’d like to hear what they might be.”

Question 11: Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change? See below.

Question 11A: If yes, have you worked with any of these organizations in the past?

“The Farm Bureau, National Farmers Union, CISA try to help farmers with new technologies like strip till or less tillage to lessen the amount of erosion and effects of things like that. They would probably be the most likely to help us. On the other hand I’m kind of embarrassed that the farmers don’t work together better to make things happen... so they (legislators) support those guys so they have a voice and we don’t. It’s kind of sad that the farmers and groups like CISA and Farm Bureau and National Farmers Union, that we don’t get together and actually try. Farmers are like snowflakes, especially vegetable farmers.
everyone of them is different. It’s not like grain farmers they actually work together, because they’re very similar.”

Question 12: Would you be interested working in the future with an organization or institution that supports farmers in preparedness? “Yeah, I’d like to see farmers work together. We actually would work together I think better to try to push back on some of the government regulations. It’s punishable for farmers to touch something from another farm.”

<table>
<thead>
<tr>
<th>Interview 3</th>
<th>Combined Knowledge</th>
<th>Past Actions</th>
<th>Use of Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points Awarded from Questions</td>
<td>12</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Total Points Possible from Questions</td>
<td>20</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Adaptive Capacity Percent</td>
<td>60.00%</td>
<td>100.00%</td>
<td>42.86%</td>
</tr>
</tbody>
</table>

Interview 3: Hampshire County

This 30-acre family farm offers Community Shared Agriculture baskets that loyal customers can purchase during specific seasons catered to no synthetic pesticide or fertilizer vegetables. This farmer’s highest score was in Past Actions taken (100%), but fared low on Use of Resources and moderate on their Knowledge of Climate Change. Their overall Adaptive Capacity score is 67.3%.

Combined Knowledge:

For this farmer, they provided extensive descriptions of their dealings with changes to their crops and weather, and overall believed that climate change was the reason (though regretted to admit). Though this farmer was unaware of identified climate issues for their region, they showed significant knowledge on how to prepare for weather stressors and adapt behaviors even as part of their business model. This indicates not only a higher level of knowledge but also resilience as they are preparing for the future in anticipation. Where
this farmer struggled was to think into the future especially for unanticipated challenges due to weather, along with policies or best practices that addressed climate change.

Question 1: Have you noticed any changes to your farming or crops over the last five to ten years? “Yes, longer frost-free days and more intensity of storms and more intensity of droughts. And, storms that come at different times of the year than you’d expect like the October snowstorm. There was a lot of tree damage which made it hard to get to crops. Crops themselves weren’t really, mostly just had to wait to get in there. And then the crops that were harvested in the cooler were lost because we lost power for a week. So we had to shut down for a week. We lost some veggies that were in there. We couldn’t communicate with people to come down and get it because you know, you had no email, you had no phone.”

Question 1A: Do you think these are linked to climate change? “Yes, well they don’t, it would seem like too much of a coincidence for it to be linked to anything else. I can’t say that I’m a climate scientist or that I do enough reading to be overly intelligent and able to stand in front of a Congressional committee but from what I understand, I’ve seen macro changes in the environment that are big enough and persistent enough and consistent enough now that it kind of matches up to what I’ve heard about climate change...I also understand that the weather is varied and changes day to day. I don’t think people can really predict the weather very well. I’ve been involved in weather prediction and weather-related activities for a long time. These are consistent (certainly the issue of growing days being so different) we’re so organized around that. Definitely. I can’t say the micro, well I can’t say our experience with climate change has been necessarily negative, it’s been both... We don’t change our crop plan unless we see a consistent macro change. That is the kind of thing that leads me to believe, that like, yeah in 20 years I have really made some changes on my
planting schedule and on my general operations like when do I start getting ready for frost, when do I plant my basil until. Basil is such a sensitive crop. You know, for the first 10-15 years of farming, I never changed my dates. Now I take a lot more chances and I don’t frequently get burned by them.”

Question 2: Are you aware of (or heard) any climate change issues specific to your country, town or farm? No.

Question 3: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm now? Highly likely. “We are benefitting from it but we’re also seeing some damage. We’re gonna make sure we have irrigation equipment, and we’re gonna make sure we having a marketing model that allows us to deal with floods, which we’ve gotten over the last couple of years. We’ve gotten big rain storms, you know, crop losses due to flooding. We’ve seen that. You know we have to deal with field drainage issues, and the planting dates, we deal with that all the time.”

Question 4: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the future? Moderately likely. “I’m not really much in the prediction business, but I’d say the likelihood is that they’ll be somewhat likely to affect us. I’d say moderately. I’m certainly more yes than no but I’ll go with that you can’t totally predict the future. You can’t really predict the future at all.”

Question 6: According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn’t make it through the season)?

“A long time ago we tried to build a marketing model where we as a farm were not totally uninsured from crop losses due to weather problems. The whole CSA concept in a way is a way of sharing the risk of weather with 500 families as opposed to just my wife and
I. We built a model based on shared risk with our customers, much more than any conventional, capitalistic model would be. I feel that’s our biggest insurance against all these types of things. We’ve experienced that with when late blight killed our tomatoes three times in the last 10 years, you might want to add late blight to the climate change, pest problems in general I think are related in some way to climate change. As things get warmer it’s harder for us to have pest-free years because you don’t kill as many pests in the winter. And things are overwintering that never used to overwinter. We can add that (pest problems) retroactively…We have tried to figure out ways to deal with light blight organically so for instance, we’ve learned about how to spray copper effectively without poisoning ourselves and we’ve experimented with and gotten successful with disease resistant varieties. They’ve really worked in the last bunch of years. I would consider that to be a change that we dealt with, that was probably more to do with general climate change rather than storms in particular. Maybe you have to clear the trees around our property more cuz you know they’re gonna come down more. Maybe. It’s hard to protect your farm from too much rain. It’s one of the problems where from drought, it’s fine, you just get irrigation. But, it’s much harder to take water off than to put water on. That’s one that’s tricky, we don’t really have a way, that’s kind of a pray situation.”

Question 7: What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available?

“We would probably seek out new water sources, which would be difficult to find but we would look for them, ponds, deeper wells. But we do have some ponds that we’ve been able to use and we have a nice well here, a really great well that we dug, it’s pretty strong.”

Past Actions Taken:
This farmer was very willing to openly discuss their practices and how it has been a direct effect from the changes in weather (potentially due to climate change). Even though they felt only slightly prepared for following best practices if they knew them, they indicated that their organic and conservation practices were a great base for preparation.

Question 5: Have you changed any of your farming methods in response to climate change, and if so how? “Well the planting dates, that’s clear, we’ve done a lot of that. We’ve done a lot of things that have more intensified as opposed to changes. We always cared about irrigation, I mean this is a vegetable business, you need irrigation but the importance of it goes up when you realize you can have such a big drought. And road drainage and field drainage, we’ve always had to pay attention to it but when you can get a lot more storms of 2 to 3 to 5 or 7-inch variety, you really have to think about it a little bit more. So it’s not like we weren’t thinking about those things in the past, it’s just that we have to bump them up on the priority level or intensify our actions in those regards.”

Question 9: On a scale from Extremely Unprepared to Extremely Prepared: How prepared do you feel to start following best practices/recommendations/policies (if you knew them)?

Slightly prepared. “I think we’re kind of aware of the general trends that are theoretically going to happen and the general idea of what best management practices would be, but I can’t say I know specifically every single one of them. We tend to be, since we’re an organic farm and tend to be conservation minded, we organize around that type of thinking already so I feel like that would give us a leg up on being prepared, like we’re already conscious on our water use and drainage ideas and pest protection without toxic chemicals.”

Support and Resources:
Although this farmer was likely to work with resources offered to them catered to farmer climate preparation, they had little knowledge of best practices and organizations addressing these issues. Their willingness to receive help and learn benefitted their score for use of support and resources.

Question 8: Are you aware of any best practices/recommendations/policies related specifically to climate change? No.

Question 8A: If yes, are you currently following any of those identified best practices/recommendations/policies? N/A.

Question 10: Would you use or do you currently want support in following these best practices/recommendations/policies? “I mean if there was an enforcement mechanism I’d probably want some help to make sure I was in compliance, if there wasn’t then I would trust myself to be able to figure it out. That’s not a proponent there for “I hope they’re enforced.” If our bottom line is depending on the land be useful and sustainable, we can figure it out.”

Question 11: Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change? See below.

Question 11A: If yes, have you worked with any of these organizations in the past? “Specifically, no. My assumption would be that UMass Extension would be on the forefront on that when and if there was information in that. I trust that those guys would be paying attention to that. We work a lot with them.”

Question 12: Would you be interested working in the future with an organization or institution that supports farmers in preparedness? Sure.
Interview 4

<table>
<thead>
<tr>
<th>Points Awarded from Questions</th>
<th>Combined Knowledge</th>
<th>Past Actions</th>
<th>Use of Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

| Total Points Possible from Questions | 20 | 10 | 14 |

| Adaptive Capacity Percent | 55.00% | 80.00% | 42.86% |

Interview 4: Franklin County

This farm is 150 acres that grows wholesale vegetables and herbs. Past Actions taken was the highest awarded component of adaptive capacity, with Use and knowledge of Resources being the lowest. Overall, the adaptive capacity components were all in the moderate level but could be higher, as their total adaptive capacity score was 59.3%.

**Combined Knowledge:**

While this farmer openly discussed the changes they noticed to their farm longer than 10 years, their beliefs were not as strong of changes being an effect from erratic weather due to climate change. They could not identify climate issues specific to their area but did express that these changes they were noticing would have impacts on their farming in the future. Further, they did not have knowledge of climate change best management practices or policies, which limited their total knowledge awarding.

Question 1: Have you noticed any changes to your farming or crops over the last five to ten years? “Yes, I think I’d even say longer than that. I’ve seen an increase of the growing season by about a month, considering both the early part of the season, the spring and the fall. Comes on earlier and it stays longer. It seems, I have nothing to quantify it, but it seems as if the weather is getting more variable. It’s definitely getting hotter, but the number of storms, and the severity of the storms that we get seems to have changed. We certainly have had quite a few straight-line winds that have been incredibly destructive.”
Question 1A: Do you think these are linked to climate change? “To some degree, yes. Well, climate comprises your average climate comprises, a range around a mean and you can get anything in there but it seems to me over the last decades, it’s certainly gotten warmer. But it seems as if the rainfall patterns and the storms associated with them, can I attribute that all to climate change no, but I’m very suspicious. We came through a drought this past year which was the worse I’ve ever seen.”

Question 2: Are you aware of (or heard) any climate change issues specific to your country, town or farm? “No, All I know is that every single year the NWS declares it to be the hottest year on Earth.”

Question 3: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm now? Moderately likely. “I believe that it’s with the intense heat and the seeming change in the variability in the storms, I have invested significantly more in irrigation. You can’t dry it out when it’s too wet but I can put it on when it’s too dry, unless I run out of water like I did this summer.”

Question 4: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the future? Likely. “I don’t think it’s going to get better.”

Question 6: According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn’t make it through the season)? “Drink. Go ice fishing. It depends on what it is. Some things you can’t do anything about, like hail. What can you do? How do you stop the winds? There’s nothing you can do. Some things you just have to hope. We’ve altered our field prep work over the years to account for drier conditions. We’ve gotten much better at managing moisture.”
Question 7: What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available? “We’re going into year two right now. Severe? It would limit me drastically. My farm would be reduced to about 30%. I would become a part time farmer. I would go up on my mountain, log in the summertime for a little bit to try and offset my lack of income. The worst and most immediate thing that would have to happen is I would have to cut loose the labor force, and it would be hard to get them back.”

Past Actions Taken:

For this farm, they had indicated changes to their methods due to many motivations, one of them preparing for future climate change. Their confidence in their ability to respond to best practices was striking, especially since they felt they were already thinking ahead of the curve.

Question 5: Have you changed any of your farming methods in response to climate change, and if so how? “I plant earlier and I plant later. We do a lot of direct field seeding. We don’t have much choice to use other seed varieties.”

Question 9: On a scale from Extremely Unprepared to Extremely Prepared: How prepared do you feel to start following best practices/recommendations/policies (if you knew them)? Extremely prepared. “Very prepared to respond but I don’t think anybody is gonna outthink me with the best things to do, I don’t think any government or commission is going to come up with a better thing to do on my farm than I will. They just don’t have the experience.”

Support and Resources:

For this component, the farmer had little understanding of best management practices and resources to support farmers for utilizing them. They were reluctant to accept
assistance in adopting best management practices, but did say they would be open to hearing what types of assistance they could receive.

Question 8: Are you aware of any best practices/recommendations/policies related specifically to climate change? No.

Question 8A: If yes, are you currently following any of those identified best practices/recommendations/policies? N/A.

Question 10: Would you use or do you currently want support in following these best practices/recommendations/policies? “I’m not sure how to respond. I’m open to listen to reason. I have to go back to my statement that I would be very skeptical that someone would out-think me on this. I certainly don’t need to be regulated, I’m tired of that. We’ve survived USDA audits where they show up unannounced, take product from me, take it back to the labs and do tests for pesticides residues. They take a lot of information from me, I have to stop what I’m doing when they show up. We’ve survived two of those. And no pesticides residues.”

Question 11: “Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change? No. If there’s anything that can be done I would think that UMass Extension would be thinking of that. I mean the first thing to do would be think of a list of things of what can you do for climate change, what sorts of weather and climate changes you’re talking about: heat, rainfall (too much, too little), high winds. I’ve been targeting moisture and taking advantage of the longer season. List the problems and list the possible solutions is where you’d start. I think I’ve done that. What do you do when it doesn’t rain, you irrigate more so I bought more irrigation. What do you do when it rains too much? Drink.”
Question 11A: If yes, have you worked with any of these organizations in the past?

“Worked with them [Umass Extension] lots, and lots, and lots. I’ve been trying to cajole CISA into spending more time with the larger growers in the Valley. They’ve been going after the newbies and I rag on them telling that all they do is go after the low hanging fruit… I’ve actually considered relocating to start winter farming. I’ve got customers that would stick with me, if I showed up in the middle of winter instead of summertime, course it would cost a lot to get up here but prices usually skyrocket in the winter. I think if it [climate] progressively gets more and more pronounced, your chances of failure are going to become more often. Your impossible situations will crop up more. This area has always been an old jewel as in yeah it might get dry, it might get wet but the ground is good enough. The more extremes you put into it, the likely you are to get in trouble. I think a more immediate problem is an incredibly fast spread of new diseases that nobody can cure. Fungal diseases, bacterial diseases. There’s a whole list of crop after crop that I don’t grow anymore because I’m tired of losing it. I think some of it may have to do with climate change but I think it’s more likely that it has to do with general human population and the intensity that we’re farming.”

Question 12: Would you be interested working in the future with an organization or institution that supports farmers in preparedness? “Depends on the makeup and what they’re talking about. I’d work with a group if I thought they were going to amount to anything.”

<table>
<thead>
<tr>
<th>Interview 5</th>
<th>Combined Knowledge</th>
<th>Past Actions</th>
<th>Use of Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points Awarded from Questions</td>
<td>14</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Total Points Possible from Questions</td>
<td>20</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Adaptive Capacity Percent</td>
<td><strong>70.00%</strong></td>
<td><strong>100.00%</strong></td>
<td><strong>71.43%</strong></td>
</tr>
</tbody>
</table>
Interview 5: Franklin County

This 100-acre farm produces dairy and bread products, berries and vegetables. They sell these items in a farm store onsite and host a CSA for their community. The overall adaptive capacity for this farm is 80.4%, with the lowest component ranking at use and knowledge of resources and support.

Combined Knowledge:

The Knowledge of climate change and the distinction between that and weather were apparent throughout the interview with this farmer. They articulated changes they noticed directly but also changes in their region of the Pioneer Valley, and believed them to be direct effects from climate change. Their belief in climate change impacting their ability to farm now and into the future was also strong, which allowed this farmer to score higher than others. However, their knowledge of best practices or local policies aimed at climate change were limited.

Question 1: Have you noticed any changes to your farming or crops over the last five to ten years? “Yes, lots of changes. I would say that in general it’s just more erratic and more extreme. It’s harder to make hay, that’s probably the biggest impact.”

Question 1A: Do you think these are linked to climate change? “Yeah I think it’s likely that the more erratic weather, longer dry spells, longer wet spells, more extreme storms and things, are probably attributable to climate change. I mean I’m not, I went to school as a scientist, this is all anecdotal. This is my perception.”

Question 2: “Are you aware of (or heard) any climate change issues specific to your country, town or farm? I guess I’m not. Weather is bigger than that right? Last year we had a pretty bad drought that affected all of this, and although I think most years we tend to have more precipitation than we used to have, you never know, you might get a drought. In
general I think we’re very lucky. This valley, of all places, is probably one of the most resilient places in the world for climate change effects. We have, our aquifer in general is really great. We have a fast-refilling aquifer in this area. Under normal conditions there’s no worry about lack of water but we have a pretty wet farm, we’re low and swampy. This past year was the only year we’ve ever really felt it got too dry… We built a hoop house four years ago and we grow all of our tomatoes inside now under cover for that reason. That’s definitely something more farmers will be doing is growing tomatoes under cover from climate change, with high tunnels to put the tomatoes in… The other huge impact is gonna be our tree fruit, because last year we got almost no apples. It got warm in February, we had this really dramatic warm-up and all the trees opened their buds, and then it froze and got really cold again, and all of the buds winter killed.”

Question 3: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm now? Highly likely. “I’m convinced that climate change exists and it’s impacting all of us. I’m convinced it’s a fact and weather is really important to farming. It’s had, they’re two things that are very much intertwined, and your ability to farm is always dependent on the weather and the predictability of the weather. That unpredictability is going to make everything harder. The changes are harder on the animals and harder to make the feed like I explained.”

Question 4: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the future? Highly likely.

Question 6: According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn’t make it through the season)? “There’s lot of things we can’t do because of the wind and that could be more of a challenge in the future. Especially
when it comes to the market garden and intensive vegetable growing, people tend to use a lot of material like row cover and black plastic mulches and those materials, here, they always get blown away, no matter how many sandbags I do. I just can’t do that here with those materials because they’re gone. If we couldn’t make it through, I mean, I’m trying to imagine, we would just have to sell stuff. We wouldn’t not make it through. I have like a really secure feeling being a farmer that if the apocalypse comes I’m ready. This isn’t the kind of business, it’s just not a business like other businesses. You just don’t generally throw up your hands and say I can’t do this anymore. You change, you evolve, you adapt. You sell equipment, you sell animals or you sell land, but you’re here, at least the land feeds you. If all else fails you’re just a little self-sufficient farmstead. I think farms, if things were to get really dire, we’re gonna be the safe havens of the world, farms in general.”

Question 7: What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available? “If we couldn’t irrigate, well, we’d change what we grew. We would probably still be able to do a little bit of dairy because the grass based, the pastures are pretty resilient to drought. We’d grow what we could. We’d just face dramatically lower yields. We’d have to raise prices that’s for sure. It would be hard.”

Past Actions Taken:

The score was highest for this component, due to the examples provided of changing farming methods in response to climate change and their confidence to be prepared to handle responses in the future.

Question 5: Have you changed any of your farming methods in response to climate change, and if so how? “Well you could say we changed our response to climate change. We probably are more focused on the livestock and the dairy because in general raising livestock,
livestock are more resilient than many specialized crops are. Growing grass is generally easier than the strawberries, you know it’s less, it’s a little less risky I guess. Growing tomatoes inside, I didn’t know when I built that high tunnel I’d be growing all of them inside, but now I grow all of them inside it. It’s diversifying, always diversifying… If you’re diverse then there’s always some pluses and some negatives. More pluses than negatives. That’s why it’s important for our region too, so we have that resilience.”

Question 9: On a scale from Extremely Unprepared to Extremely Prepared: How prepared do you feel to start following best practices/recommendations/policies (if you knew them)? Slightly prepared. “You know sometimes what we’re doing feels like hard enough and crazy enough so it’s hard to imagine if things were even harder and more difficult. So in that sense I wouldn’t say I’m very prepared. But at the same time I feel very secure here, like I don’t foresee ever not being able to farm so I think we do have a lot of resiliency too.”

Support and Resources:

The interviewees knowledge of best practices or policies that address climate change was limited, along with being able to identify programs from the organizations they mentioned that were aimed at targeting climate change. Though they had a history working with different arming support organizations throughout the area, they were unaware of how to raise additional funds for developing new projects for their farm besides through programs past utilized.

Question 8: Are you aware of any best practices/recommendations/policies related specifically to climate change? “I guess, this sort of relates to the previous question too, just making better use of surface water instead of ground water.”
Question 8A: If yes, are you currently following any of those identified best practices/recommendations/policies? “Not really. That would be a potential change, using surface water instead of ground water for watering the cattle and irrigating. That would be a good thing to do in the future if we really needed to. But in general right now it’s easier to use our well for most of our watering and irrigating.”

Question 10: Would you use or do you currently want support in following these best practices/recommendations/policies? “Sure. I would love a grant to build another high tunnel, that would be awesome. You know, to design the water system I designed, a better watering system. I could certainly make use of that sort of help. Or invest in the equipment…”

Question 11: Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change? “CISA has been a great resource for all of us in lots of ways. I guess the Extension. We don’t use the Extension as much, I’ve used them once or twice. Those are all I’m aware of I think.”

Question 11A: If yes, have you worked with any of these organizations in the past? Yes.

Question 12: Would you be interested working in the future with an organization or institution that supports farmers in preparedness? Sure.

<table>
<thead>
<tr>
<th>Interview 6</th>
<th>Combined Knowledge</th>
<th>Past Actions</th>
<th>Use of Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points Awarded from Questions</td>
<td>13</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Total Points Possible from Questions</td>
<td>20</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Adaptive Capacity Percent</td>
<td>65.00%</td>
<td>60.00%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>
Interview 6: Hampshire County

This 6-acre organic farm sells most of their produce to local farmers markets and cooperatives in the Pioneer Valley. Total adaptive capacity for this farm is 74.2%, with the highest component (Use of Resources) at 100% and the other two only being roughly 2/3 met.

Combined Knowledge:

For this farm, though they had extensive knowledge on farming best practices that preserve soil and ultimately help with climate change mitigation, their responses for questions 3 and 4 did not award them as many points since they felt climate change only impacts their farming moderately likely in the present. The practices utilized at this farm were more within the realms of preparation in anticipation for future climate change, and they were knowledgeable to some degree of resources they could access. Because they had admitted to farming for the last 3 years, although they were knowledgeable, this did not suffice the timespan of my survey question and so they were given zero points.

Question 1: Have you noticed any changes to your farming or crops over the last five to ten years? “we’ve had several situations which may or may not be attributable to climate change. We had a very heavy winter in 2015 which generally was fine for the farm, having a lot of snow cover is actually good for the fields because we’ve got some perennials… So in New England, traditionally farmers could, and were affected by substantial snow cover. I would say since the 90s there’s been a noticeable higher frequency of warm weather in January and February. So twenty years ago we certainly would have had, it was unusual to have temperatures above freezing in January and then classically you’d have the diurnal variation in March when it gets like, in the day you would get above freezing and at night you’d get below freezing and that’s great for harvesting, that change in temperature below to
above freezing. We see a lot of that going on now in January, this past January and now first time in February. I would say that more than half of the days we’ve had this winter and probably last winter as well in these months where we expected it to be solidly below freezing, we’re seeing it above freezing during the day… But in terms of the farm, the main impact is having bare exposed soil in the winter time, especially those crops which are gonna be sensitive to that like garlic, it’s not great. In my limited experience that’s what I’ve noticed. There are crops that prefer to have that snow cover and I think to some degree, pests also. If you get a good cold winter that is going to be good for the population of certain pests. So having warm winters could be a negative impact.”

Question 1A: Do you think these are linked to climate change? “Yeah, I think it’s likely that the perturbations against of what we would expect may have something to do with human –induced climate change. It’s certainly not definite. There’s always been variability in climate and droughts were occurring years ago, especially in New England… Let’s say that the attitude among my crew and the people that I run into, the assumption is that human-induced climate change is having an impact, so I tend to attribute the changes I’ve noticed over the last 30 years, those changes I do attribute them part to climate change.”

Question 2: Are you aware of (or heard) any climate change issues specific to your country, town or farm? “Nothing specific particular to this area that I’m aware of beyond what I mentioned.”

Question 3: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm now? Moderately likely. “I would say there is a moderate impact. So for instance, we had a pretty severe drought last summer and a dry winter. The dry winter and plus the drought probably reduced my garlic crop by about 50%, so that has a modest impact. We probably lost about 4-5% of my income
because of that. It also meant a significant increase in the amount of irrigation we had to do… Certainly a lot more energy had to go in in terms of labor… Farmers have been dealing with drought for centuries but you know if this was partially due to climate change, there’s certainly an impact.”

Question 4: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the future? Likely. “We’re anticipating that it’s going to be increasingly significant. Part of what we’re doing out here is a semi-permaculture/no till approach to farming… Now we don’t do anymore tilling, so we try to keep the bare soil covered and it’s my expectation that I A) keep the soil covered with compost and mulch plus not tilling it up we’re creating increased soil health. My expectation by doing that that we will be much more tolerant during drier conditions. So we’re doing a lot of, sort of, general farm planning, soil maintenance in anticipation for the necessity of doing this as the weather gets wilder.”

Question 6: According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn’t make it through the season)? “Severe storms would include hail, high winds and say heavy flooding. Flooding could also include soil erosion… So high winds don’t have a big impact on us because all of our topsoil is sort of bound, we either have it covered with compost, or it’s we have pads in between our beds, so it’s not like one big open field out there, it’s 100 beds, between the beds are pads, we cover those beds either with grass or with woodchips, so that soil is completely protected and then on the beds we usually have a pretty good layer of compost on it, so I’m not losing any topsoil to winds. If we have a heavy rain event, because the soil is well bound, covered with grass or
covered with woodchips, or covered with compost, I don’t have a problem of standing water or erosion.”

Question 7: What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available? “The water table is such that we only have to go down about 20 feet here… On the other hand if the river level dropped 10 feet, because there wasn’t any rain in the region, I could potentially lose that source of water. I’m trying to think if there’d be anything I could still… that would reduce our output by 80%... But we use a lot of water. I think I’d be less impacted than people who don’t I mean the farms next to me don’t have any irrigation so if we had a drought like we did last summer, their crops, their production is being hurt immediately. But if I lost my water supply, I don’t know if the town would let me pump water, use their water.”

Past Actions Taken:

Although this farmer had noticed changes in their farming and responded to variable weather, their experience was limited to only 3 years of farming, which did not fall within the designated 5- to 10-year timespan. This reduced their score for Past Actions Taken, despite them showing extensive changes they had made in their approach.

Question 5: Have you changed any of your farming methods in response to climate change, and if so how? “would say in order of importance, the no till practices are number one, the elements of that are heavy compost application. So I’m spending about say over $10,000 a year on compost. That’s a large, you know we’re selling, like this year we sold, last year we sold over $88,000 on vegetables so you can see the large fraction of our operation. We also are working with USDA. We’re trying to build pollinator habitat…Basically all around the farm we have border plantings of flowering perennials. We’re doing that
primarily just to support native pollinators as well as, we had beekeepers here in the past, we
had beekeepers here in the past we didn’t last year. But crucial to any fruit production
(tomatoes and what have you), we need to have pollinators out there. That was a significant
effort last year. We had a modest grant from USDA, but we put a lot of effort into that.
We’re no longer using any pesticides. Even though we’re certified organic, there are some
naturally occurring pesticides, like a garden spray, which we had been using on our blueberry
previous years, but people from the Xerces Society were saying “Please don’t use that!”
because they think it’s harmful to pollinators.”

Question 9: On a scale from Extremely Unprepared to Extremely Prepared: How
prepared do you feel to start following best practices/recommendations/policies (if you
knew them)? Extremely prepared. It’s sort of our main guiding principle has to do with soil
health.

Support and Resources:

The farmer was very confident in their knowledge on farming techniques that were
positively “future-oriented” and conservation-focused. They were able to articulate best
practices and where they had heard of this information, along with supportive organizations
and funding opportunities.

Question 8: Are you aware of any best practices/recommendations/policies related
specifically to climate change? “I consider the no-till approach to be a best practice because I
would say that a large majority of the farmland is still being farmed conventionally. Because
of that there I think is a negative impact on soil health. So we’ve got some of the best soil in
the world here and you know it’s been farmed now for 300 years... I mean that’s another
thing I’m doing, is crop rotation obviously. So over time, if people continue to farm
conventionally around here, we’re not gonna have that great top soil, forever, it’s (soil)
gonna blow off into the Pelham Hills and be gone. My hope is that more farmers in the area will adopt no till techniques. There are no till techniques being used on large farms, you know, thousand-acre farms out in the Midwest are doing no-till… Maybe over time, climate change will encourage them then to adapt those techniques you know when finding problems like drought or what have you, higher temperatures… So the bottom line, the only way a farmer is gonna make his living out here will adapt to these other techniques is if it makes economic sense. He’s not gonna do it because it’s a nice idea if it’s gonna cost too much money. So it’s gotta be in his self interest to adapt his techniques. Now to some degree, the USDA, they have a field office around here, they could encourage these techniques, these practices. So hopefully the USDA will be providing support to adapt to new practices like no till.”

Question 8A: If yes, are you currently following any of those identified best practices/recommendations/policies? Yes.

Question 10: Would you use or do you currently want support in following these best practices/recommendations/policies? “Yes, so we’re in close contact with USDA over there.”

Question 11: Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change? “Yeah I would say the USDA is providing some support in that area. NOFA (Northeast Organic Farmers Association) week long conference in the summer at UMass. NOFA, they run workshops on organic farming. NOFA, because they are organic farmers, they have a strong interest in soil health. The general practices you would learn about in NOFA would be beneficial in dealing with the impacts of climate change.”
Question 11A: If yes, have you worked with any of these organizations in the past?

“Well, grants. I got grants, all the high tunnels here were built with under a USDA grant, as well as the irrigation system... We got a grant from the state of MA to fix up my wash house to have it be in compliance with the FDA.”

Question 12: Would you be interested working in the future with an organization or institution that supports farmers in preparedness? “Well sure, I feel like I am already but if there were other resources we’d probably be involved.”

<table>
<thead>
<tr>
<th>Interview 7</th>
<th>Combined Knowledge</th>
<th>Past Actions</th>
<th>Use of Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points Awarded from Questions</td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total Points Possible from Questions</td>
<td>20</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Adaptive Capacity Percent</td>
<td>30.00%</td>
<td>40.00%</td>
<td>28.57%</td>
</tr>
</tbody>
</table>

**Interview 7: Hampden County**

An 80-acre farm that grows a variety of annual, perennial, herb and vegetable plants for sale. Overall, this farmer’s adaptive capacity was low (32.8%), as each of their components were awarded almost evenly. Reading through the quotes provided for each component reveals that though they had been in the family farm business for many years, their ideology and methods were traditional and independent, so their awareness of climate change, its impacts, preparation and support were all low.

**Combined Knowledge:**

Knowledge on climate change was limited for this interviewee. They admitted to believing that climate change was part of the cause for the changes they were noticing in weather, but also noted that there is always variability in weather in general. Because of the
variability between year to year, this farmer believed it was not enough to make them change their farming methods, but instead persist with what they typically do.

Question 1: Have you noticed any changes to your farming or crops over the last five to ten years? “Well there’s always variability depending on the weather. Basically the frost in the Spring or an early frost in the Fall, drought, extreme heat and dry, they affect the crops adversely. Different years we experience some of those events, all of those events, or none of those events, there’s no pattern. It seems to be more prevalent in the past five years or so. You always have variability but yeah, it seems it’s been more extreme and more prevalent in the past 5 years.”

Question 1A: Do you think these are linked to climate change? “Yeah I have an idea that’s a result in climate change, yes. [Why?] Just because every year is always, no year is ever the same. It seems it has been more extreme these past few years, and it seems to be the general thinking that it’s due to climate change. I’m not an expert in meteorology and all that stuff but what they’re (scientists/climatologists) saying seems to make sense.”

Question 2: Are you aware of (or heard) any climate change issues specific to your country, town or farm? “Nothing specific to our area. Just that it seems to be affecting all parts of the world.”

Question 3: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm now? Slightly likely. “Some years you see it some years you don’t. Some years it’s more extreme so we’re still doing the same things every year so it doesn’t, so it has an effect. It can have an effect on the outcome but what we’re doing, we’re doing the same stuff every year. Right, what climate change is affecting is the weather, and that’s something we never control anyway so it’s just, we’re kind of in the same boat.”
Question 4: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the future? Likely. “I think it will only impact it more over time. A few I’ve heard on the TV and a few I’ve read articles from different publications.”

Question 6: According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn’t make it through the season)? “Not really sure what you’re looking for in that one. We would hope for the best. We’ve had hail damage before and lost crops, but there’s not really much you can do about it. We’re diversified, we grow a lot of different crops. We grow them at different times of the season or we grow on different fields. One year we did a 6-acre field of peppers and tomatoes to hail, that was just one field but the other farms weren’t affected by the hail. We planted multiple plantings throughout the summer to keep a continuous supply so that if we lose one, hopefully the other plantings wouldn’t be affected. Like I say we’re all trial and error.”

Question 7: What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available? “We maybe would explore a well or different property that had access to water. It’s really tough to go into the year knowing you wouldn’t be able to water. Some years you don’t irrigate much but you never know, so it’s a big risk to go into the year knowing you wouldn’t be able to. So that would be a tough one. What we could do is we have some fields that are very sandy and others with heavier soil that holds the water better. Maybe during the heat in the summer we would plant in the fields that are a little heavier and hold the water better, and the sandier ones we would maybe do a little earlier when there is usually a history of a little bit more precipitation like in the early Fall.”
Past Actions Taken:

Interviewee 7 had not made changes to their farming methods, especially in response to climate change. They were content with matching their year to year variability of growing seasons with their practices, and did not provide an answer for question 9 except for that they could not decide their preparation to follow best practices if they did not know what they were.

Question 5: Have you changed any of your farming methods in response to climate change, and if so how? “Not really the methods. Nothing’s changed, we evaluate the varieties like if there’s a heat-resistant variety, some years we’ve seen extreme heat and drought-resistant varieties, we’ll try all those to see if it’s worth using. Like if there’s a drought, we irrigate. We always have to have that ready for the season but you never know when you’re going to need it. It’s not really doing a lot different it’s just making sure you’re prepared to put on it when you need it. If we were a smaller farm we could cover our crops with a cover if a frost were called for but the stuff, it’s too much to do that with. Smaller crops, you know, people maybe might have a low cover available for a frost to protect it, things like that. We farm about 80 acres. Some of the smaller crops we could cover them up but when you have a 10-acre field it’s kind of hard, you just kind of hope for the best.”

Question 9: On a scale from Extremely Unprepared to Extremely Prepared: How prepared do you feel to start following best practices/recommendations/policies (if you knew them)? Don’t Know. “Not knowing the recommendations how could I know?”

Support and Resources:

For Support and Resources, this farmer was unaware of resources available in assisting their farming either through money or technical advising support. Though they were open to receiving support despite not knowing in what manner, they were unaware of
organizations they could partner with for support and best practices/recommendations to learn from those organizations.

Question 8: Are you aware of any best practices/recommendations/policies related specifically to climate change? No.

Question 8A: If yes, are you currently following any of those identified best practices/recommendations/policies? N/A.

Question 10: Would you use or do you currently want support in following these best practices/recommendations/policies? “I don’t know what any of these best recommendations are. I’m sure we would probably appreciate support, support is always nice.”

Question 11: Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change? No.

Question 11A: If yes, have you worked with any of these organizations in the past? N/A.

Question 12: Would you be interested working in the future with an organization or institution that supports farmers in preparedness? “Yeah, that’s a possibility.”

<table>
<thead>
<tr>
<th>Interview 8</th>
<th>Combined Knowledge</th>
<th>Past Actions</th>
<th>Use of Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points Awarded from Questions</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Total Points Possible from Questions</td>
<td>20</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td><strong>Adaptive Capacity Percent</strong></td>
<td><strong>30.00%</strong></td>
<td><strong>60.00%</strong></td>
<td><strong>42.86%</strong></td>
</tr>
</tbody>
</table>

**Interview 8: Hampden County**

A family-run 80-acre farm that focuses on corn and pumpkin production for agritourism, but maintains a greenhouse that produces plants for sale. This business also
sources produce from local farms in the county to sell at their grocery store. Although this farm no longer produces vegetables, it stopped this production about five years earlier. The interview was based on their past experiences of farming and compared to what they are noticing now with other farmers in the region. Overall, the adaptive capacity was rated at 44.29%, with the lowest component in Combined Knowledge. This was partially due to their reflection only from past year’s farming and what other farmers were articulating, but also their inability to commit that climate change was a determinant of the issues they were noticing in Hampden County agriculture.

**Combined Knowledge:**

Farming methods had changed over the last ten years with this farmer’s land as well as other farmers in the region. They believed that climate change impacts were speculation, as they were referring to their personal upbringing with agriculture and the variability in weather they experienced. Climate change issues for the region were unknown, and they did not think climate change would likely have impacts on their farming currently or into the future.

**Question 1:** Have you noticed any changes to your farming or crops over the last five to ten years? “No changes to the crops, to farming, yes. Irrigation strategies have become more key in the last 5-10 years. We have light sandy soil, so water is always an issue because our land may dry out quicker than other farm land. A crop that would not normally be irrigated like field corn for instance, over the last five years, we grow it for our corn maze, we have to make sure we have a strategy so that the corn looks good. The summers seem to be drier for longer periods of time…The farmers that I deal with, more drip irrigation versus overhead and much more specific irrigation so they can deliver the water where and when they need it.”
Question 1A: Do you think these are linked to climate change? “I don’t know I mean it’s pure speculation because it’s a small period of time. I grew up in a farm business farming crops but probably have spent 40 years in agriculture and local crops so I would have to say probably yes, especially there is more fluctuations in weather, where more severe weather. We kind of live in an area in the country where weather is not as severe or radical as other parts of the United States but a little more severe for us. But warmer winters for sure. And warmer longer into the fall, like into the 4th quarter of the year. We used to say by Thanksgiving everything was dormant, you could mulch strawberry plants and things like that, but the last couple of years that has not been the case.”

Question 2: Are you aware of (or heard) any climate change issues specific to your country, town or farm? No.

Question 3: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm now? Not likely. “I don’t think they impacted the ability, you just have to be, farmers that are farming now successfully, they’re good planners, you have to adapt. I think that that’s the impact, it’s never same old same old, you have to adapt. I think if farmers in general, they’re still in business they’ve adapted to the weather, economy costs, and regulations. For farmers, I think it’s always challenging, but that’s what farming is. I don’t know if I would say it impacts their abilities, they just have to adapt, and they do, they make changes all the time to adapt to changing economy, weather, economy, whatever is out there.”

Question 4: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the future? Slightly likely. “Because I think they’re going to continue to change. I don’t think the impact will be great but it’s going to be more strategy.”
Question 6: According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn’t make it through the season)? “Talking about drought adaptability….If it can’t occur it can’t occur. I think the level, the problem in the Northeast is they’re not the biggest supplier of food to the country. It would be easy for your town to regulate you out of the municipal water supply if that was gonna be your resource. I don’t know if that’s legal but I think a lot of farmers have relied on irrigation ponds, and rivers and streams, those kind of sources to irrigate, have had to use municipal water supplies in a lot of cases. Even though they’re more expensive, but more reliable for sure. So I think that in an extended drought, unless you were regulated out of being able to use municipal water supplies, that’s what you would have to do if one was available, or they’d be trucking in water, mulching, it would be a lot more expensive to farm. Farmers by nature, they adapt.”

Question 7: What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available? “With a severe storm, you can’t gauge that, I mean as many as I don’t know how many years ago, in the late 60s, we had a terrible hail storm in may when the fields were loaded with green strawberries, strawberries were our signature crop, there was so much snow in the aisle that it knocked the strawberries off the plants…I think that’s why most crops are diverse, and that they’re planting something for different times of the year.”

Past Actions Taken:

For Past Actions Taken, the responses were based on the farmer’s anticipation for future events based on their past experiences along with how they believed farmers would respond. They were confident that farmers would have the ability to adapt as a natural response, but was unsure of how besides utilizing methods of irrigation that many farmers
already rely on. This farmer had personally not changed what they were growing for corn or pumpkins, but did speak about other farmers changing their crops and rotating plantings.

Question 5: Have you changed any of your farming methods in response to climate change, and if so how? Used the responses for 6 and 7 to also answer question 5.

Question 9: On a scale from Extremely Unprepared to Extremely Prepared: How prepared do you feel to start following best practices/recommendations/policies (if you knew them)? Extremely prepared. “I have the financial resources to do what needs to be done to follow any best practices that need to be done or mandated. I think we’re ready and I have the financial resources, and probably the money and the manpower that we could get it done. The farmers I work with… have farmed for a long time so I think they’re extremely prepared.”

Support and Resources:

Due to the circumstances of this farmer not reliant on their agricultural production for income, they were unaware of best practices or recommended farming techniques related to climate change. They did not know organizations in the area that supported farmers in this manner, but could name organizations they had worked with in the past for other assistance. This farmer agreed with others about the sentiment that though they are willing to receive information about best practices, they would not want to be regulated, and did not feel that assistance was necessary for their business.

Question 8: Are you aware of any best practices/recommendations/policies related specifically to climate change? “Nothing I’ve retained so no. I would have read it and kept it in my brain.”

Question 8A: If yes, are you currently following any of those identified best practices/recommendations/policies? N/A.
Question 10: Would you use or do you currently want support in following these best practices/recommendations/policies? “I would want information certainly. Not that farmers would necessarily embrace it but if it’s something they have to follow, yeah, they want support with that, they want help with the dollars. Massachusetts actually has had some good programs I don’t know if they still do.”

Question 11: Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change? No.

Question 11A: If yes, have you worked with any of these organizations in the past? “CISA, but I do more PR kind of stuff with them. (They are) excellent at UMass Extension and are based in Amherst. I’m getting a monthly news from the MA Department of Agricultural Resources. MA Flower Growers has an executive director and then it’s all members. They keep up with pretty much what’s going on. Massachusetts Nursery and Landscape Association (MNLA). You can get all that information off the website.”

Question 12: Would you be interested working in the future with an organization or institution that supports farmers in preparedness? “No (doesn’t really apply). I’ve learned to say no.”

<table>
<thead>
<tr>
<th>Interview 9</th>
<th>Combined Knowledge</th>
<th>Past Actions</th>
<th>Use of Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points Awarded from Questions</td>
<td>16</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Total Points Possible from Questions</td>
<td>20</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Adaptive Capacity Percent</td>
<td>80.00%</td>
<td>90.00%</td>
<td>64.29%</td>
</tr>
</tbody>
</table>

Interview 9: Hampshire County

This farm dedicates 15 acres to vegetable production among other acres where it supports livestock and pasture. The location also offers different CSA packages. This
farmer’s adaptive capacity score was exceptionally high in 2 of the 3 components, with the lowest score earned in Use of Resources. The total adaptive capacity score was 78.1%.

**Combined Knowledge:**

For this farm, the interviewee was well-versed in climate change terminology along with best practices for farming. They had strong belief that climate change was a direct driver for the issues and changes they had noticed with weather in all their years of farming. Belief that climate change impacts their farm currently and into the future was Likely and Highly Likely, respectively, with detailed examples to support their future anticipation.

**Question 1: Have you noticed any changes to your farming or crops over the last five to ten years?**

“Yes, and it’s certainly last year is a year that sticks out as a drought year. So over the last two years there have been notices with last year as the drought year and the year before was actually a pretty good growing year. Yields were down last year and the labor to acquire those yields was up in some ways but in other ways it was down. On the other hand, disease incidents was down last year, year of the drought. So the drought, some of the effects were good and some were not good, and I think as an organic farmer, the effects, the good effects would be more noticeable than a conventional farmer because one of the effects was lower disease pressure and the other effect was lower weed pressure, which organic farmers deal with this differently than conventional. Conventional farmers, they would have had to reduce sprays, which would have reduced their costs a little bit but the organic farmers, reducing their costs in labor was probably greater. Mainly in that the predictability has changed, when it’s wet it’s really wet and when it’s dry it’s really dry. When it’s cold it’s really cold and when it’s warm it’s really warm. The extremes are more radical, with the exception of the fall, I feel like the falls are warmer. So we’ve had milder falls and extending the growing season a little bit farther into the fall, and so I have adjusted the crop planting to
expect to be able to have things further into the fall. But otherwise it’s really hard to plan because you don’t know “Oh is it a year that’s gonna be super wet, is it going to be year that is super dry?” So it’s harder to plan.”

Question 1A: Do you think these are linked to climate change? “I would say yes, certainly the unpredictability makes a big difference and I think that’s one of the things they’re talking about with climate change, it’s not just about averages, it’s about swings-peaks and valleys. Yes, and the peaks are higher and the valleys are lower. As a farmer you have to plan for both things simultaneously which is difficult to do. To be more resilient, you have to be resilient in whatever is gonna come. And that is not only crop mix it’s crop scheduling, it’s equipment, it’s labor force, it’s spraying materials, it’s a lot of different pieces.”

Question 2: Are you aware of (or heard) any climate change issues specific to your country, town or farm? “Yes- I don’t know how you could not be. Just to reiterate all of the stuff we just talked about, it’s like to use last year as an example again, it was a drought year so there were no peaches North of Southern Connecticut this year. And that was one weather event with a really warm winter and then a -20 degrees in February for two nights and it just killed all the flower buds. That’s something if it wasn’t quite so warm and then all of a sudden really cold, it devastated the entire crop. You can’t be a farmer and not see it (climate change) unless you have your head in the sand. So in some years, higher temperatures, less rain. In some years it’s warmer temperatures in the winter, some years it’s colder temperatures. Some years it’s too much rain in the summertime. Essentially, you’re really looking at rain and temperature and that it’s kind of all over the place.”

Question 3: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm now? Likely.
“Same answer- The predictability of the weather is major issue and the ability to, it is expensive to have yourself lined up for any contingency and it’s expensive to deal with issues that come up. I don’t know. I think as a farmer it would be hard for me to say, well I spend this much money on irrigation, I mean I know what the equipment costs I supposed if I paid attention to it I could log how many hours I spend on it. But farmers in the Northeast, it’s not something they’ve really had to pay attention to as closely as they do now I think. It used to be you could count on a certain amount of, like I said earlier…”

Question 4: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the future? Highly likely.

“Because I don’t see it getting better. If you listen to the scientists, all the predictions are that that it’s gonna get worse no matter what we do. It’s like it’s already set in motion. We could stop burning fossil fuels tomorrow and it would still continue.”

Question 6: According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn’t make it through the season)? “For our farm, the challenge is that having the infrastructure and the ability to be prepared for anything, having the infrastructure and ability to be prepared for a very wet season so having the ability to apply fungicides or things like that in a timely manner. Simultaneously being able to handle a drought year because you don’t know what you’re gonna get. You’re also kind of hedging your bets like on what kind of spring or fall, you know the shorter seasons, you know how warm is it gonna be how cold is it gonna be. And the ability to go in either direction depending on what’s happening, it requires A) more management and B) more capital inputs to have the infrastructure you’re gonna have to deal with.”
Question 7: What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available? “I think that it would be trying to find a way to find more water, digging a new well, and the options for that are limited because clearly if we’re in a drought like going to municipal water supplies will not be an option. So I think I also would right now I currently have an irrigation system that could be seen as more wasteful so I would change the infrastructure and go to more drip irrigation rather than overhead irrigation.”

Past Actions Taken:

Past personal experiences with weather variability provided time for this farmer to make changes according to how they would predict the year’s weather would be. They had made many changes to their techniques including disease and irrigation management and equipment upgrades. Despite the changes they had made, they felt it was not enough to prepare them for the future of a changing climate and that they needed more information to learn how to prepare.

Question 5: Have you changed any of your farming methods in response to climate change, and if so how? “So yes, so I’ve added spraying equipment and I’ve added a monitoring program for late blight disease for tomatoes on the computer that the Extension offers. I think the one I use is from Cornell. So I’ve added that, so I have the ability to use more disease or pest control. I’ve upgraded equipment for disease and pest control, I’ve done more close monitoring of diseases and pests, so I’ve upgraded irrigation equipment. ’ve changed the crop mix a little bit, I’m growing fewer tomatoes, trying to make and shift some crops to later in the season when I feel like it’s been warmer. ore time moving hoses around, so irrigation at least our irrigation set up, it requires a certain amount of labor to make sure
it’s running and working, and again, disease control and pest control requires a certain amount of labor.”

Question 9: On a scale from Extremely Unprepared to Extremely Prepared: How prepared do you feel to start following best practices/recommendations/policies (if you knew them)? Slightly prepared. “Five years ago, I would have been extremely unprepared. I just had to deal with issues that are already coming up, I had to deal with current issues like having more equipment makes me more prepared for future problems down the road. So I have the ability to, I have the equipment to deal with pests or seasons no matter if it’s the ones I’m already dealing with or future ones, so it’s things that have already come along, I’ve had to adjust so that if other comes I have been more prepared for them.”

Support and Resources:

Lack of knowledge in best practices specifically identified for climate change was identified but they were aware of different types of support they had received in the past from various organizations around the Valley. They were hopeful that many of the organizations they had worked with in the past would lead efforts to create information to distribute for farmers in regards to climate change and wanted to work with them in the future.

Question 8: Are you aware of any best practices/recommendations/policies related specifically to climate change? “No, not really. I don’t know that anybody has really tackled it. I think there’s a lot of people thinking that they need to think about it but I don’t think anybody really is, even if they’re thinking about it. There hasn’t really been crop insurance for vegetable growers, but that may be changing, it may be through the USDA.”

Question 8A: If yes, are you currently following any of those identified best practices/recommendations/policies? N/A.
Question 10: Would you use or do you currently want support in following these best practices/recommendations/policies? “I think I already do like with the support that I get from UMass Extension. Just more of that. More, for example, if I have a pest problem there is somebody I can call that can help me figure it out or I can go and look in. Sometimes it’s just like oh everybody has got the same problem it’s not just my farm. Yeah I would say that Extension services need to be funded more.”

Question 11: Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change? “Yes- Extension, CISA is doing it, they have a loan fund for farmers who are dealing with weather-related issues, so it was formed after Hurricane Irene and they are no interest loans to farmers, they’ve done some for peach growers. So CISA, USDA Risk Management and Extension, those are the three I know about. I get my information from the UMass Extension mostly, so they have a program where they do a weekly newsletter during the growing season and I’ll go to workshops that are put on from other Northeastern states the Cornell Extension or other areas, to know where the pests are. There’s a lot more monitoring now that goes on with a lot more computer…”

Question 11A: If yes, have you worked with any of these organizations in the past? “Yes, Extension. All three of those are now just figuring out what they need to do, so those are all pretty new realizing that we gotta find a way of how to deal with this (climate change).”

Question 12: Would you be interested working in the future with an organization or institution that supports farmers in preparedness? Yes.
This farm encompasses nearly 400 acres of mostly asparagus and berry production. Adaptive capacity components were all low (below 50%), which yielded a low total score 37.82%. The type of farming was at a large scale and highly engineered, which the farming indicated would allow them to be more prepared for future climate issues.

**Combined Knowledge:**

Specific changes to weather were identified and believed to some degree that they were a causal impact of climate change. They had no knowledge of climate issues specific to their region or farm’s produce, and they believed it unlikely that climate change was impacting their ability to farm in the present. Only a slight impact to their agriculture may be anticipated in the future in which they felt they would be prepared to manage.

**Question 1:** Have you noticed any changes to your farming or crops over the last five to ten years? “Yes. We’ve noticed more hundred-year events, or bigger events, the history of the farm in the 30s, we had water to the edge of the street (flooding) but that got fixed with the Turner’s Falls dam…They’re more frequent than 100 years. April freeze 2007 or April freeze last year, those extreme events we see a little bit more. AC: How long have you been farming? I’ve been farming 30 years.”

**Question 1A:** Do you think these are linked to climate change? “Yeah there’s some evidence that there’s climate change. It’s not hard to say that most farmers haven’t ever seen an April freeze like we had last year or the driest summer that we had last year. If you look
back in the records and it’s not the hottest summer and it’s not the driest summer, but it’s part of a cycle and I get that. I think it’s pretty natural what we see, and then sometimes seemed a little bit severe than normal, like the tornado in Conway last week in the middle of winter. That’s crazy. It’s not to say it hasn’t happened before, it’s just.”

Question 2: Are you aware of (or heard) any climate change issues specific to your country, town or farm? No.

Question 3: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm now? Not likely. “We manage water, we’ve always had water, that’s part of our infrastructure, to be able to put water down. We can manage other things, that’s what we grew up learning. A good grower is going to manage those things the best they can. AC: do you use drip irrigation? Yes. AC: Have you ever had to buy municipal water? No, we have seven farms on the Connecticut River and we utilize that water resource.”

Question 4: On a scale of Not Likely to Highly Likely, please rate: How likely do you feel that climate change issues impact your ability to farm in the future? Slightly likely. “It’s gonna be marginal. As farmers we deal with the climate every day, so we prepare for those things. And for thirty years my father has been adding to the infrastructure to control those things. So having Cultural practices of irrigating and other things. You have a rainy day or dry day, you deal with that.”

Question 6: According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn’t make it through the season)? “We’ve never had that issue in the worst year. We’re proactive in our practices that we prevent a lot of that stuff so
it doesn’t affect us as much. So the drought last year was perfect for us, we had our best strawberry season ever and we will continue to have great berry seasons if it’s dry.”

Question 7: What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available? “We could go to drip, and we have mostly solid, we could go to other things. It’s currently overhead irrigation normally, all the infrastructure is in place, we need very little to change. We realized our competitors out West in California, there’s actually one of the worst drought in California, they’ve done it (adapt) there’s no reason we can’t. There’s a lot of farm ponds being built.”

Past Actions Taken:

This farmer was very adamant when distinguishing why they changed their farming methods to match the climate of Western Massachusetts and not because of climate change. They believed that because of their changes according to match the climate as it changes in time, they were fully prepared to follow best practices. Because of the scientific engineering they used in their production, confidence in not only being prepared but also being the source of many of the practices was mentioned.

Question 5: Have you changed any of your farming methods in response to climate change, and if so how? “No not because of climate change, because of the climate. I wanted those high tunnels 15 years ago and it took me ten years to get them. We’ve had them five years now. Some say it’s because of the weather and some say it’s because of climate change. It’s hedging your bet and protecting yourself, and limiting the liability. Plus you’re a lot more consistent, it had nothing to do with climate change it everything to being a producer.”

Question 9: On a scale from Extremely Unprepared to Extremely Prepared: How prepared do you feel to start following best practices/recommendations/policies (if you
knew them)? Extremely prepared. “We’re fully prepared. We actually develop those policies for people. Irrigation times and all those cultural practices, we work with people to do that. Q: Are there other organizations you work with from an engineering or science lab background? Yeah, well right over here in our issue culture lab, we work with the NCPN scientists, develop the protocol for the testing of the plants, and our lab person actually helps modify those tests to be better.”

Support and Resources:

This farmer was unaware of best practices or policies related to climate change and did not want support to follow best practices because they indicated they were actually helping to develop best practices for the berry industry. They had knowledge of farmer-aid organizations in the Valley but neglected to work with them as the size of their farm was too great to receive aid from many of them.

Question 8: Are you aware of any best practices/recommendations/policies related specifically to climate change? No.

Question 8A: If yes, are you currently following any of those identified best practices/recommendations/policies? N/A.

Question 10: Would you use or do you currently want support in following these best practices/recommendations/policies? “No, they won’t. They (the government) look to us to be the leaders in this berry bracket for sure. Hey when you’re leading the path, there’s a responsibility with that.”

Question 11: Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change? “Yes, the Farm Service Agency and USDA. Yes, there are several, they have money to dig out your pond, they helped us buy an irrigation pump, they helped us put up a greenhouse. There’s a lot of money out there. Q:
But is there something that you are aware of that specifically says climate change aid in its name? No.

Question 11A: If yes, have you worked with any of these organizations in the past? Yes.

Question 12: Would you be interested working in the future with an organization or institution that supports farmers in preparedness? “Maybe, a lot of them aren’t very helpful. USDA program helps you buy a 30 by 96 high tunnel but it has to be to specific engineered specifications which makes it more expensive. We were gonna get our $5,000, and it wasn’t gonna be worth it, so we didn’t go after it. We’re putting up 2 acres and to put up a tenth of an acre is not very practical or efficient. But if I was a smaller grower and had a smaller scale it would work, but for us it doesn’t work. So with these programs I’m very skeptical of most of the time.”
CHAPTER VI
DISCUSSION

This thesis asked what are individual farmers’ adaptive capacity in preparation for climate change, and how that translates to the agriculture industry for the Pioneer Valley. Of the 80% of farmers that noticed changes to their farming or crops over the last five to ten years, only one interviewee had knowledge of climate change issues specific to their geography. Despite not knowing or hearing of specific climate issues to their county, town or farm, 80% agreed they had changed their farming methods in response to climate change. This expands the concept of Knowledge, as these interviews show that farmers can understand what climate change is and provide examples of support, but may not have scientific or policy-related Knowledge.

Along with not being informed of specific issues, most were unaware of best practices or policies that could address climate change, or even the use of crop insurance to protect from future extreme weather damages. Only half of the interviews agreed to receive support in following best practices/policies if they knew of any, while the other half were mostly unsure or slightly inclined (maybe). Many of the farmers expressed mistrust towards government involvement, especially through regulation, even if it resulted in them receiving support either through education or money. This could be a response because farming is already regulated at federal, state and even township levels, with more rules for certain types of agriculture.

Half of those interviewed were able to name an organization in the Pioneer Valley that provided some mode of support to farmers in climate or weather preparedness. Discrepancies came about here when they were asked what types of support they associated with those organizations; many of them named programs or initiatives they had used in the
past that were meant to support farming best practices and not necessarily climate change. The benefits of best practices can ultimately have served as climate change mitigation practices, which is why I still included their responses. Another key distinction to notice is the difference in responses between Questions 10 and 12. The responses for Question 10 were more distributed whereas for Question 12, 80% answered they would be interested working in the future with an organization that supports farmers in preparedness despite not being able to name a specific policy or organization that targets climate change adaptation for farmers. There may have been negative bias associated with government regulation that impacted responses for Question 10 since it asked support in following “best practices/recommendations/policies.” Farmers may have associated these terms to be directly correlated with government, whereas asking general support in the future from an organization may have left farmers more likely to accept.

Combined Knowledge was identified slightly more times than farmers Belief in Climate Change, which could be partially caused due to the subjectivity of the coding in deciding what was considered “Knowledge” or “Belief.” The farmers’ statements do show that Knowledge is identified separately from Belief, as many were able to explain their understanding of climate change but also articulate (either with or without confidence) their belief that climate change is human-caused and occurring. The kinds of issues presented also helped to determine farmer’s understanding of climate change and how it could have direct weather impacts on their farm if not now, but into the future.

The greatest farming issue is ‘Precipitation’ (36%), but when broken down, lack of precipitation (‘Dry Conditions/Drought’) is discussed more than ‘Wetter Conditions/Storms’ by about 10% (45% to 35% respectively). This may be in part due to that this past year the region, along with the entire country, experienced a drought. Many
farmers indicated they irrigate their farms from the Connecticut River or another local water source such as a river, pond or well, and thus the drought becomes a significant issue the longer it continues. Droughts present more long-term impacts to farmers as it can greatly reduce yields and needs for labor, whereas a storm or period of more precipitation is often isolated, and the damage is only experienced in that single period.

Questions 3 and 4 present a shift in farmer’s opinions in the likelihood that climate change issues will impact them from the present into the future. While more than half of farmers felt they were adequately prepared to follow best practices/recommendations/policies (if they knew them), slightly less thought climate change was an issue in the present but would become a greater issue in the future. The likelihood of climate change impacting farmers more in the future may also have influenced their decision-making to accept support from a local organization in preparedness, though this may change if it were solely government support. The majority of farmers were between the ages of late thirties to late sixties, and all but one had family history in agriculture. It is possible that age of participants could have been a slight determinant of likelihood to adapt based on updated science and availability of information today.

Question 9, which asked farmers about their preparation to follow best practices and such, was asked after two hypothetical questions that presented worst-case scenarios for agriculture due to weather disasters (presumably caused by climate change). The ordering of the questions may have also given time for farmers to consider the reality of these hypothetical scenarios and present fear or uncertainty, thus influencing further their likelihood to accept aid. Despite being unaware of the practices that would be required to change and the climate change projections specific to their area, almost all admitted to some level of preparation. Of actions taken by farmers, Irrigation was mentioned the most, which
correlates directly to the greatest issues presented, Dry Conditions/Drought. The second greatest issue was Wetter Periods and correlated directly to the second most mentioned action Soil Techniques. Among the other Actions taken by farmers, most were scattered which may be a product of the length of time and experience of the farmer, along with geography. All farmers were between the ages of late 30s to late 60s, so level of climate knowledge varied and could possibly be due to science available throughout their lives, which could influence the information they received and how they would respond.

**Index for the Pioneer Valley**

The sample is not representative of the total population, which made aggregating responses by county unreasonable. The survey developed was meant to be a primer for future research on the farmer population, if more were gathered for this research. Because only 10 farmers participated, each farm was assessed heavily for qualitative content to better understand farmers’ perceptions and actions and ways to support them. Each farm’s adaptive capacity score was combined into a total score for the Pioneer Valley, which can be seen in Table 10. After adjusting Hampshire County for a fourth interview by taking the average of the adaptive capacity values of the four interviews, averages were then taken for each of the counties. Hampshire County, even after adjustment of its average adaptive capacity, still ranked highest (62.99%) of all three counties and Hampden County fared lowest (38.34%). For reference again, the Index is below. Franklin and Hampshire Counties are Progressing and Hampden County was rated as Needs Improvement. Franklin County has the most land acreage dedicated to farms yet still received a poor rating. Hampshire County only is Progressing, despite it having the most farms of all counties (USDA, 2012). The average for the entire Pioneer Valley ranked at 53.51%, or Progressing on the Adaptive Capacity Index. Using these ratings, Adaptive Capacity for farmers of the Pioneer Valley is
extremely limited, particularly in the Hampden and Franklin counties. According to these results, not only is climate change adaptation a necessary issue to be planned for regionally, but will likely require a collaboration of different entities to implement components of PVPC’s Climate Action and Clean Energy Plan which should include farmers and other key persons in the agricultural field.

Exceptional = Above 80.48
Satisfactory = 80.47 – 64.01
Progressing = 64 – 49.01
Needs Improvement = 49 – 33.01
Unsatisfactory = Below 33

Table 10: Adaptive Capacity Index

<table>
<thead>
<tr>
<th>Adaptive Capacity</th>
<th>Interview Adaptive Capacity Totals</th>
<th>Sum within County</th>
<th>Average Adaptive Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Franklin County</td>
<td>37.86 80.48 59.29</td>
<td>177.63</td>
<td>59.21</td>
</tr>
<tr>
<td>Hampshire County</td>
<td>48.1  74.2  67.29</td>
<td>251.97</td>
<td>62.99</td>
</tr>
<tr>
<td>Hampden County</td>
<td>44.29 32.86 37.86</td>
<td>115.01</td>
<td>38.34</td>
</tr>
<tr>
<td>Total PV Sum</td>
<td>--     -- --</td>
<td>544.61</td>
<td>160.54</td>
</tr>
<tr>
<td>Average PV Adaptive Capacity Score</td>
<td>--     -- --</td>
<td>181.54</td>
<td>53.51%</td>
</tr>
</tbody>
</table>

A limitation that was realized after completing the interviews was the interchange of the term “climate change” with meaning “weather” and vice versa. For Question 5 when farmers were asked if they changed their practices because of climate change, the phrasing implies that they must already agree that the changes they have experienced are due to
climate change, which they may or may not agree with. This distorts the answers they gave and totals for responses because as some farmers noted, they change their practices for many reasons such as the economy, competition, or just to try new things. These changes are not solely due to climate change but can simultaneously serve as acts of climate change resistance.

For Question 1 when farmers were asked if they noticed any changes to their farming methods or crops over the last five to ten years, an assumption was built into this question that farmers would indicate the changes due to weather as the cause. Their belief systems would determine if the changes that they were noticing with weather and ultimately impacting their farm/crops would be a part of the greater belief in climate change. By not specifically writing weather in the question, this assumption creates inconsistencies in interpreting what farmers are seeing on their fields and then deciding which is the cause, weather or climate change. Another possible limitation of Question 1 may have been the time span of 5 to 10 years that some farmers were to reflect on when considering changes in agricultural methods. During the testing of survey questions, originally the time limit was under 3 years. It was suggested that the time span be expanded since climate is a process that can only be noticed over time; this 5 to 10-year limit was also sensitive to asking farmers to recall their practices within a relatively recent amount of time. However, this meant that one farmer who had only had three years of experience could not be considered for responses of Past Actions.

For the questions regarding best practices/recommendations/policies, although half of the interviews agreed they knew of some sort, it was realized that through the interview transcripts that these were more speculative answers based on how progressive and helpful these organizations had been in the past. Many assumed that best practices and policies
specifically for climate change were developed by organizations even though they may not have heard of these specifically. Another assumption, later realized, considered education from organizations to farmers about what to expect related to climate change could still be considered as best practices/recommendations/policies. While the information provided from these places can help farmers on what to expect of climate change in the future, there are little to no best practices, materials and policies for farmers that specifically address climate change as the primary goal, rather than a secondary or tertiary impact of a more general best practice. In all of the interviews, there was no mention of crop insurance to aid in disasters that may or may not be brought on by climate change, or even of past events. In Massachusetts, Federal crop insurance only protects growers of potatoes, corn, grapes and apples. However, there is a program through the USDA’s Farm Service Agency “Non-Insured Disaster Assistance Program” that provides coverage up to 65% crop production and up to 100% on price. It is uncertain then why the vegetable and berry farmers did not mention this in their past experiences or knowledge of resources as crop insurance could be one resource that farmers could utilize.

Despite these limitations, the Pioneer Valley total adaptive capacity rating is still lower than I expected but seems to be Progressing overall. While these limitations can account for some error, this study reveals that knowledge, best practices for action and different modes of support are all still necessary to enhance amongst the agricultural stakeholder population in order to best prepare for climate change in the future.
CHAPTER VII

CONCLUSION

Every farmer has their own approach and take on the weather, and is also based on the types of crops they grow along with geography. This research, though limited to one region of the United States, shows that farmers are able to work through many challenges they face in order to still persevere, even if for only one growing season. The determination to succeed and “beat the odds” has allowed for most of these farmers to continue their businesses and thus their livelihoods, which may be considered its own indicator for resilience. For some farmers, despite lacking in one components of adaptive capacity, they could make up for it in another. Regardless of shortcomings, the majority of farmers willing to accept support in climate change preparation provides for a track of likelier implementation of best practices and climate change policies in the Pioneer Valley.

Recommendations for Farmers and Agricultural Stakeholders

In Canada there are programs that work at the individual property level that have been found to be highly effective in changing the farming industry: The Environmental Farm Plan (EFP) and Canada-Ontario Farm Stewardship Program. According to the website of Ontario Ministry of Agriculture Food and Rural Affairs, a nonprofit farm organization, (2016):

Environmental Farm Plans (EFP) are assessments voluntarily prepared by farm families to increase their environmental awareness in up to 23 different areas on their farm. Through the EFP local workshop process, farmers will highlight their farm's environmental strengths, identify areas of environmental concern, and set realistic action plans with time tables to improve environmental conditions. Environmental cost-share programs are available to assist in implementing projects.
Twenty-two information sheets were created for the 23 identified actions as tools for farmers to eventually create their own action plans after the assessment phase. This program has created significant improvements in farming practices throughout the region and even wider effects on water, soil and public health. The initiative would not be accomplished just by farmers alone, and is more probable that either local or state professionals would propose for implementation. Because there is no incentive established in the U.S. currently to complete Environmental Farm Plans, farmers would need to research and volunteer on their own. This could be an opportunity for collaboration where UMass Agricultural Extension professionals work with MDAR and USDA to educate farmers and help conduct these plans as they become more established.

The Rural Land Stewardship Guide, modeled after the Environmental Farm Plan, was created as stakeholders realized that “...the health of the rural landscape depends upon the actions of all rural landowners, and not of farmers alone” (2017). This guide articulated that by protecting aspects of the natural environment such as ground and surface waters, quality of the greater environment and its ecosystems can be ensured, including agricultural landscapes. A physical handout could be replicated by agencies at the Federal or state level and be advertised digitally but also at workshops and conferences. Farming advisors and Extension faculty could also learn how to guide those interested in techniques that promote more stewardship with possible land trust designation and farmland protection.

As far as agriculture techniques, farmers had shown diversity among their methods and actions, Diehl et al. (2015, p. 26) provide numerous examples of adaptation strategies for farm management practices: “planting dates, fertilizer application, and crop varieties), land use practices (i.e., crop rotation and tillage), water management practices (i.e., irrigation), pest
management, financial risk management, and climate forecasting and crop modeling (Anwar et al. 2013).” These strategies may be more intermediate to long term implementation, whereas other short-term resistance solutions may include “variable-rate irrigation, sod-based rotation, sensor-based Nitrogen application, soil moisture monitoring, and online decision support tools such as AgroClimate (AgroClimate 2014; Asseng et al. 2013)” (ibid).

**Recommendations for Future Research**

According to the Cornell Institute for Climate Change and Agriculture (2016), there are certain regions that are less studied than others, with the Northeast region being one and the Pacific Northwest another. The Cornell Institute suggests that a wider breadth of disciplines be incorporated in studying regions as they relate to climate change and agriculture, including those from economics, social sciences and earth systems sciences. Another issue they stress is that researchers work with Extension educators to understand the best format and techniques in making climate information available to farmers. “For example, researchers should account cost-benefit analyses and adoption feasibility when presenting suggestions for management practices to farmers” (ibid). This attempt would incorporate a more holistic support approach for farmers that is not only limited to providing scientific information with best farming application practices. As literature like Diehl, Bartels, Arbuckle etc. suggest, studies must include other stakeholders related to agriculture and related fields like agricultural advisors, researchers, private consultants and nonprofit staff “to better understand the social networks and institutions that inform agricultural management and decision-making” (Cornell Institute for Climate Change & Agriculture, 2016). To consider making this information readily available for farmers and other stakeholders, an increase in funding and technical advising support is necessary at both the federal and state levels. As other countries have done, by working at the policy level,
programs can be adopted over time that support farmers in their attempts to adapt to climate change and mitigate greenhouse gas emissions (ibid).

For future research, the Adaptive Capacity Index would benefit by incorporating local towns’ climate plan initiatives/recommendations as one way to measure if support was initiated at the town level for farmers to potentially utilize. Presumably, areas where municipal and regional plans do not mention and relate both agriculture and climate change will be less prepared for future weather changes. Similarly, if food or agriculture plans do not consider climate change, both parties will be unprepared which could have wider effects onto sectors such as land use, conservation, economy, food security and cultural heritage. As Hamin, Gurran and Emlinger suggest, multiple leaders must work together in order to support towns in climate adaptation. This directly applies to small-scale family farmers, whom require different types of support from a variety of players. Wayne Feiden, a professor at UMass Amherst and Planner for the city of Northampton, spoke on the need to plan for both climate mitigation and adaptation due to their relationship over time:

The things that we do for climate mitigation are important because overtime, they become the multiple mitigation efforts that combine as the adaptation strategy. While many farmers, planners and Extension professionals may not believe the need to start planning with the consideration for climate change and agriculture in the Pioneer Valley, because we don’t know to the degree of impacts and when and for how long, it is still necessary to plan for adaptation. For instance, the city of Northampton uses zoning as a tool to prohibit any development within the 100 or 500-year floodplain with a Special Conservancy Floodplain District (personal communication, March 2017).
Too often is preparation determined as necessary after a disaster. For a region that many would agree is more progressive than other areas of the state, following business as usual protocol for its agricultural practices could lead to detrimental costs in the future.

While mentioned in the limitations, it is important to reconsider that this entire thesis was a pilot that will set the precedence for future research by other students. Much consideration was given to the development of this study, but there were numerous unexpected developments that prevented full implementation as initially planned. The main takeaways that should be considered for a more robust and accurate representation of the Pioneer Valley and its agricultural well-being considering climate change are below:

- Eliminate farms from the study that do not fit the initial requirements of the study period, i.e. length of time with hands-on farming experience. This applies also to questions where the if the farmer does not fully answer the question, it should be eliminated from the total scoring of the interview in order to still accurately compare across farms.
- Survey a sample size that is large enough to translate results to the greater Pioneer Valley. This requires much preparation to acquire contacts and incentives that can acquire commitment early on. Many farmers declined because they farmed into through the winter and could not afford to take time off even for an hour, and/or wanted to be compensated for their time. Randomization of survey participants will still be difficult because ultimately some farmers will still decline to partake and thus the results will not be entirely from random selection.
- Find an adaptive capacity score range that constrains within the realm of possible scores, i.e. develop scores that fit with the results and does not
create unattainable goals. Originally, I began my scoring at 0 and went to 100, with making anything under 50 as Failing. It was realized that this may not be an accurate scoring measurement as farmers should not be penalized for what they had no practice and time to meet expectations. Thus, most would be starting below the Failing score, skewing the results and interpretation whereas if scores were cushioned around the lowest score and highest score, the range would be much more accurate. Further, create a score range that translates into tangible and understandable ratings so that farmers do not feel deflated but rather know how to improve.

- Aim for even distribution of interviews between each county and ensure that survey population is as homogenous as possible. My original intent was to only survey vegetable farmers but had to expand to berry and farm sales due to limited availability of other farmers. If there is an uneven distribution of interviews between counties, it is best to average the total number of interviews per county in order to compare across them.

- When assigning point values to survey responses, make sure that points are not subjectively dealt. Because I was the only one to evaluate the responses and weigh them for points, it was a challenge to ensure consistency between interviews and giving points to certain responses over others. This could be resolved by asking a committee member or second team-member to help with evaluating survey responses.

Moving forward in the Pioneer Valley and even in agriculture across the U.S., it will be necessary to craft policies, plans and procedures/best practices that are meant to address climate change first. Small farms especially may not have the monetary or educational means
to seek additional information to adapt in the future, which makes federal lead on this necessary and likely more accessible. With this information is now publicly accessible amongst UMass Extension Faculty and students, the future may allow for more research to paint a finer detailed picture of the Pioneer Valley and its agriculture as it relates to climate change.
APPENDIX I

SURVEY

Questions for Farmer Interviews

Project Title: Assessing Pioneer Valley Farmers’ Adaptive Capacity towards Climate Change

Hello,

My name is Angelica Carey. I am a graduate student in the department of Regional Planning at the University of Massachusetts Amherst. I am conducting a series of interviews with small family farmers throughout the Pioneer Valley as part of my Master’s thesis. Thank you for agreeing to meet for this interview.

The goal of my project is to understand a clearer picture of farmers’ knowledge on climate change and preparation to adapt to specific climate challenges anticipated for the future. I aim to interview 15 farmers amongst Franklin, Hampden and Hampshire counties, with each interview lasting no more than one and a half hours. If you decide to participate in this interview, you will receive a consent form to review and sign (either by email or in-person). These interviews will be audio-recorded, transcribed, and then analyzed to help determine themes to present in my findings. If you would like to decline your interview being recorded you may, and only notes will be taken. This information will be kept confidential and secured as per Institutional Review Board protocol, and destroyed once the thesis is published.

Your participation is entirely voluntary, and your time and expertise in the field of farming is greatly valued. You may not benefit from this research directly, but findings from this work can initiate recommendations that support adaptive agriculture practices throughout the Pioneer Valley amongst farmers and researchers alike.

Taking part in the study is your decision. You do not have to be in this study if you do not want to. You may also quit being in the study at any time or decide not to answer any question you are not comfortable answering. I will be happy to answer any questions you have about the study.

For this interview, we will be discussing climate change preparation as it relates to farmers in the Pioneer Valley. Climate change will be discussed first. In this interview we will be using the definition for Climate Change: (USGCRP) Changes in average weather conditions that persist over multiple decades or longer. Climate change encompasses both increases and decreases in temperature, as well as shifts in precipitation, changing risk of certain types of severe weather events, and changes to other features of the climate system.
1. Have you noticed any changes to your farming or crops over the last five to ten years?
   a. Yes. If Yes, Please explain:
   b. No

   *(If Yes to question 1) Do you think these are linked to climate change?*
   a. Yes, If Yes, Please explain:
   b. No

2. Are you aware of (or heard) any climate change issues specific to your county, town, or farm?
   a. Yes. If Yes, What types of issues and how did you come across this information?
   b. No

3. On a scale of Not likely to Highly likely, please rate: How likely do you feel that climate change issues impact your ability to farm now?

   (Not likely)       (Slightly likely)        (Moderately likely)       (Likely)       (Highly likely)

   Please Explain Why:

4. From Not likely to Highly likely, rate on a scale: How likely do you feel that climate change issues will impact your ability to farm in the future?

   (Not likely)       (Slightly likely)        (Moderately likely)       (Likely)       (Highly likely)

   Please Explain Why:

For these questions I will be asking you about your **Preparedness** for climate change. Being prepared or not for purposes of this interview will mean: *(USGCRP) Actions taken to build, apply, and sustain the capabilities necessary to prevent [and] protect against negative [climate change] effects.*

5. Have you changed any of your farming methods in response to climate change, and if so how? I.e. Planted different seed varieties, Used different farming techniques, Used irrigation and water saving methods…

6. According to climate change predictions, projections call for more frequent and severe storms. What challenges would you anticipate for your farm and what would you do (if your farm couldn't make it through the season)?

7. What would you do if the region experienced an extended drought (3+ years) severe enough that your current option for irrigation was not available?

8. Are you aware of any best practices/recommendations/policies related specifically to climate change?
a. Yes. If Yes, Please specify which ones:
b. No- Proceed to #4

(If Yes to the question above): Are you currently following any of those identified best practices/recommendations/policies?
   a. Yes. If Yes, Please specify which ones:
   b. No

9. On a scale from Extremely unprepared to Extremely prepared: How prepared do you feel to start following best practices/recommendations/policies?
   ___ Extremely unprepared
   ___ Slightly unprepared
   ___ Don’t Know
   ___ Slightly prepared
   ___ Extremely prepared

Please Explain:

10. Would you use or do you currently want support in following these best practices/recommendations/policies?
    a. Yes. If Yes, please explain:
    b. No

11. Do you know of any organizations/institutions in the Pioneer Valley that supports farmers in preparedness for climate change?
    a. Yes. If Yes, Please explain:
    b. No- Proceed to #9

   (If Yes to question 8) Have you worked with any of these organizations in the past?
    a. Yes. If Yes, Please explain:
    b. No

12. Would you be interested in working in the future with an organization or institution that supports farmers in preparedness?
    a. Yes. If Yes, Please explain:
    b. No

Thank you for your time and I appreciate your honest responses. You may contact me at 361-877-2985 or alcarey@umass.edu or my faculty advisor Elisabeth Hamin at 413-577-4490 or emhamin@larp.umass.edu, if you have study related questions or problems. If you have any questions about your rights as a research participant, you may contact the Human Research Protection Office at 413-545-3428.
APPENDIX II

CONSENT FORM

Consent Form for Participation in Research Study

Title: Assessing Pioneer Valley Farmers’ Adaptive Capacity towards Climate Change
Researcher: Angelica Carey

You are being asked to take part in a research study towards the completion of a thesis under the Department of Regional Planning at the University of Massachusetts Amherst. This study will ask farmers throughout the Pioneer Valley of their experiences with changing climate, its impacts to their farms, and their preparation for future changes to the region’s climate and farming practices. This consent form will give you more information about your participation in this research. Please read this form carefully and ask any questions you may have before agreeing to take part in the study.

What the study is about: The purpose of this study is to assess farmers in the Pioneer Valley about their farming, which may or may not be attributed to a changing climate, along with their knowledge and preparation for identified climate change issues specific to agriculture in the region.

What you are being asked to do: If you agree to be in this study, I will conduct one interview with you that should last about one and a half hours. There will be about seven or eight questions that ask your knowledge of scientific climate change, any noticeable changes to your farming or regional climate, farming best practices or policies and preparation for climate issues. With your permission, we would also like to tape-record the interview.

Benefits: You may not directly benefit from this research but your participation will be beneficial to expanding knowledge to planners and Extension professionals that can help future farmers adequately prepare for a changing climate.

Risks: I do not anticipate any risks to you participating in this study other than a small inconvenience for the amount of time it takes to complete the interview.

Your answers will be confidential:
No information that would identify you personally will be asked. The researchers will record your answers to questions, but only identify you as a number on this sheet and only by county in any publication. Tape recordings of this interview will be secured on an external hard drive in a locked box inside a locked cabinet in the Research Library of my department. All study records in a secure password protected computer and destroyed 3 years after the close of the study. Only the members of the research staff will have access to the passwords. At the conclusion of this study, the researchers may publish their findings. Information will be presented in summary format and you will not be identified in any publications or presentations. While there is always the potential for a breach in
confidentiality, I have taken the necessary steps as per International Review Board protocol to ensure your protection as part of this research.

**Taking part is voluntary:** Taking part in this study is completely voluntary. You may skip any questions that you do not want to answer. If you decide not to take part or to skip some of the questions, it will not affect your current or future relationship with the University or myself. If you decide to take part, you are free to withdraw at any time.

**If you have questions:** If you have further questions about this project or if you have a research-related problem, you may contact Angelica Carey at 361-877-2985, or email alcarey@umass.edu. If you have any questions concerning your rights as a research subject, you may contact the University of Massachusetts Amherst Human Research Protection Office (HRPO) at (413) 545-3428 or humansubjects@ora.umass.edu.

**Statement of Voluntary Consent:** When signing this form I am agreeing to voluntarily enter this study. I have read the above information, and have received answers to any questions I asked. I understand I can withdraw at any time. I consent to take part in the study.

Your Signature __________________________ Date _________________

Your Name (printed) ________________________________________________

In addition to agreeing to participate, I also consent to having the interview tape-recorded.

Your Signature __________________________ Date _________________

Signature of person obtaining consent ___________________________ Date ______

Printed name of person obtaining consent ____________________________

*This consent form will be kept by the researcher for at least three years beyond the end of the study.*
## APPENDIX III

### TOTAL REFERENCES FROM ALL NODES

<table>
<thead>
<tr>
<th>Name</th>
<th># Sources</th>
<th># References</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Farmers’ Actions</td>
<td>10</td>
<td>222</td>
</tr>
<tr>
<td>Irrigation</td>
<td>10</td>
<td>56</td>
</tr>
<tr>
<td>Water Sourcing or Pumping</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Municipal water</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>General Farmers’ Actions</td>
<td>10</td>
<td>51</td>
</tr>
<tr>
<td>Soil Techniques</td>
<td>7</td>
<td>33</td>
</tr>
<tr>
<td>Costs and Labor</td>
<td>6</td>
<td>23</td>
</tr>
<tr>
<td>Equipment</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Planting Dates</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Disease control</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Seed Variety</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Drainage</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Changed farming model</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Farmers working together</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Buy product elsewhere</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Heat resistant variety seeds</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Combined Knowledge</strong></td>
<td><strong>10</strong></td>
<td><strong>119</strong></td>
</tr>
<tr>
<td>Knowledge of Weather or Climate Variability</td>
<td>10</td>
<td>62</td>
</tr>
<tr>
<td>Experienced Weather or Climate Changes</td>
<td>10</td>
<td>57</td>
</tr>
<tr>
<td><strong>Farming Issues</strong></td>
<td><strong>10</strong></td>
<td><strong>111</strong></td>
</tr>
<tr>
<td>Precipitation</td>
<td>10</td>
<td>135</td>
</tr>
<tr>
<td>Drought (Extended dry conditions)</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Dry Weather and Loss of Water Supply</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>Rainier or wetter periods</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>Storms</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>Wind</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Flood</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Erosion</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Snow Cover</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Event</td>
<td>References</td>
<td>Frequency</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Hail</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Temperature</td>
<td>67</td>
<td>4</td>
</tr>
<tr>
<td>Seasonal Swings or Changes in Season Length</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>Frost and Colder temperatures</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>Extreme Heat and Warmer Temperatures</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>Irrigation</td>
<td>56</td>
<td>10</td>
</tr>
<tr>
<td>Municipal water</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Loss of Money or Yield</td>
<td>39</td>
<td>9</td>
</tr>
<tr>
<td>Diseases and Pest</td>
<td>32</td>
<td>7</td>
</tr>
<tr>
<td>Costs and Labor</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>Government Regulation</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td><strong>Preparation</strong></td>
<td>107</td>
<td>10</td>
</tr>
<tr>
<td><strong>Support and Resources</strong></td>
<td>61</td>
<td>10</td>
</tr>
<tr>
<td>Organizations</td>
<td>31</td>
<td>10</td>
</tr>
<tr>
<td>Extension</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Government Regulation</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>Money or Grant funding</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>Education</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td><strong>Belief of climate change</strong></td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td><strong>Farmer Type</strong></td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Vegetable Production</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Gardening Supplies and Groceries</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Berry Sector</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Nodes are presented from most references to least*
APPENDIX IV

ADAPTIVE CAPACITY NODE BREAK-DOWN

Figure 4: Nodes within Adaptive Capacity
APPENDIX V

CURRENT PRECIPITATION

https://maps.massgis.state.ma.us/dfg/climatechange/?urls=Precipitation%20-%20current%20%28modeled%29%7C1%7Chttps%3A//services1.arcgis.com/hGdibHYSP059RG1h/arcgis/rest/services/Precip2010_45b/FeatureServer/0
APPENDIX VI

2080 PRECIPITATION MODELED

https://maps.massgis.state.ma.us/dfg/climatechange/?urls=Precipitation%202080%20Moderate%20Emissions%20Scenario%20%7C%7C1%7C1%7Chttps%3A//services1.arcgis.com/hGdibHYSP059RG1h/arcgis/rest/services/Precip2080_45b/FeatureServer/0,Precipitation%20current%20%28modeled%29%7C%7C1%7C%7Chttps%3A//services1.arcgis.com/hGdibHYSP059RG1h/arcgis/rest/services/Precip2010_45b/FeatureServer/0
APPENDIX VII

CURRENT SUMMER TEMPERATURE

https://maps.massgis.state.ma.us/dfg/climatechange/?urls=Summer%20Temperature%20%C2%B0F%20current%20%28modeled%29%7Chttps%3A//services1.arcgis.com/hGdlbHYSPQS9RG1h/arcgis/rest/services/SummerTemp_2010_pub2/FeatureServer/0
APPENDIX VIII

2080 SUMMER TEMPERATURE MODELED

https://maps.massgis.state.ma.us/dfg/climatechange/?urls=Summer%20C2%B0F%202080%20Moderate%20Emissions%20Scenario%207C1%7Chttps%3A//services1.arcgis.com/hGdibHYSP059RG1h/arcgis/rest/services/SummerTemp_2080RCP45_Pub2/FeatureServer/0,Summer%20Temperature%20C2%B0F%20Current%2020%29%207C1%7Chttps%3A//services1.arcgis.com/hGdibHYSP059RG1h/arcgis/rest/services/SummerTemp_2010_pub2/FeatureServer/0
APPENDIX IX

CURRENT SEASONAL CHANGES

https://maps.massgis.state.ma.us/dfg/climatechange/?urls=Growing%20Degree%20Days%20current%20%28modeled%29%7C1%7Chttps%3A//services1.arcgis.com/hGdibHYSP059RG1h/arcgis/rest/services/gdd2010_45_pub3/FeatureServer/0
APPENDIX X

2080 SEASONAL CHANGES

https://maps.massgis.state.ma.us/dfg/climatechange/?urls=Growing%20Degree%20Days%202080%20Moderate%20Emissions%20Scenario%7C1%7Chttps%3A//services1.arcgis.com/hGdibHYSP059RG1h/arcgis/rest/services/gdd2080_45_pub3/FeatureServer/0,Growing%20Degree%20Days%20Current%20Modeled%7C1%7Chttps%3A//services1.arcgis.com/hGdibHYSP059RG1h/arcgis/rest/services/gdd2010_45_pub3/FeatureServer/0
APPENDIX XI

RESOURCES

A list of resources is provided in Appendix 11, which had been aggregated over the time spent writing the thesis. These may be beneficial for agricultural stakeholders as a means of providing more information and ideas to consider for future modification and collaboration.

- Statewide Policy Intervention: Bill S.472; An Act providing for the establishment of a comprehensive adaptation management plan in response to climate change.
  

- American Farmland Trust; Working to keep soil healthy due to climate change and later food resilience. They also develop strategic farmland plans for the future.
  
  [https://www.farmland.org/our-work/areas-of-focus/soil](https://www.farmland.org/our-work/areas-of-focus/soil) and
  
  [https://www.farmland.org/our-work/areas-of-focus/food](https://www.farmland.org/our-work/areas-of-focus/food)

- Farmland Information Center; Federal Farmland Conservation efforts on the toolbox include: Agricultural Conservation Easement Program, Conservation Reserve Program, Conservation Reserve Enhancement Program, Conservation Security Program (for tribal and private farms) and Environmental Quality Incentives Program, along with programs available by state.
  

- The Farmland Information Center; Offers trainings for new and existing farmers and advertises through social media along with online information and newsletters.
  
  Research between American Farmland Trust and Land for Good looked at New England states and the population of farmers young/new and experienced/old, which revealed that over half of farmers are over 65 with most having no one
training under them. This can be used advantageously as agriculture is planned for in the future by instituting climate change information and best practices for mitigation and adaptation in farmer aid organizations such as CISA, American Farmland Trust, USDA, Faculty Extension, etc. http://www.farmlandinfo.org/gaining-insights-gaining-access-infographics

- Massachusetts Land Trust Coalition; Taxes and managing conservation land information provided for landowners online, along with various listservs depending on the farming sector. http://www.massland.org/landowner-information-library

- Shaping the Future of your community workshops through Mass Audobon; http://www.massaudubon.org/our-conservation-work/advocacy/shaping-the-future-sustainable-planning/about-the-program

- American Farmland Trust; There is mapping of farmland released in the report “State of Farming” for farmers and planners to have to reference in monitoring future development. https://www.farmland.org/initiatives/state-of-americas-farm-and-ranch-land

- Massachusetts Department of Agricultural Resources (MDAR); Launched in December 2016, the Agricultural Environmental Enhancement Program (AEEP) supports water conservation projects for farmers in drought. MDAR participates with the Drought Management Task Force which makes recommendations to policy makers. Further, MDAR administers the Massachusetts Food Ventures Program (MFUP) and the Agricultural Energy Grant Program, and leads the Food Policy Council. There is a bi-monthly newsletter which posts happenings throughout the Pioneer Valley that consists of: grants, assistance programs, association meetings,
fairs, policy changes, conferences, start-up farming, workshops and food safety.

http://www.mass.gov/eea/agencies/agr/

• Community Involved in Sustaining Agriculture (CISA); Hosts workshops on resilience due to drought along with other workshops for different farming sectors. In 2011 they created the CISA Emergency Farm Fund for farmers affected by Hurricane Irene. “Through four rounds of loans since its opening, the Fund has distributed $221,000 in loans to twenty-five farms,” including loans for farms affected from this past year’s drought. CISA also works with PVGrows, by recommending farmers and entrepreneurs to the Investment Fund for additional funding up to $250,000. One-on-one assistance for farmers is offered to aid in marketing and advertisement, graphic design, press-release writing, etc. and worksheets that provide other resources and grants are available on CISA’s website under the ‘Resources for Farmers’ tab. https://www.buylocalfood.org/resources-for-farmers/cisa-emergency-farm-fund-2/

• Northeast Organic Farming Association Conference; A yearly conference lasting three days each summer is a “solutions-oriented celebration of the grassroots organic movement.” https://www.buylocalfood.org/event/nofa-summer-conference-2/
BIBLIOGRAPHY


EPA Cleanup Grant FY14 Baskin_Final (2).pdf. (n.d.).


