Regenerative Farming Practices as Nature-Based Solutions: Potential Actions for Municipalities in Massachusetts

Regenerative Farming Practices as Nature-Based Solutions: Potential Actions for Municipalities in Massachusetts

A Thesis Presented

by

HELEN HARRISON

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

May 2024

Department of Landscape Architecture and Regional Planning

Regenerative Farming Practices as Nature-Based Solutions:
Potential Actions for Municipalities in Massachusetts

A Thesis Presented

by

HELEN HARRISON

Approved as to style and content by:

_____

Elisabeth Infield, Chair

_____

Lisa DePiano, Member

_____

Julia Freedgood, Member

_____

Robert Ryan, Department Chair
Landscape Architecture and
Regional Planning

DEDICATION

To Miren, Jane, and Em

שהגינה שלכן תתקן את העולם

May your garden repair the world.

ACKNOWLEDGEMENTS

I would like to extend my sincerest gratitude to my thesis chair, Professor Elisabeth Infield, for her wise and kind support. When I was overwhelmed, she helped me organize my research, and my analysis benefited greatly from her suggestions. Many thanks also to my committee, Julia Freedgood and Lisa DePiano, for inspiring discussions and excellent feedback that guided my way in a field I knew little about.

My research would not have been possible without the generosity of people from the following organizations who shared their time and expertise: Gardening the Community, Grow Food Northampton, Atlas Farm, Pioneer Valley Planning Commission, CISA, Regenerative Design Group, and American Farmland Trust, as well as Wayne Feiden. Thank you to my professors, my fellow students, A.J. Pion, Virginia McLaurin, and to LARP for the Thomas B. and Loraine K. LeNoir Scholarship, which helped support this work.

Finally, I would like to thank Dylan Welch for being my accountability buddy and cheerleader; Charlotte and Arthur Millman for being there in so many ways; my father, Philip Davenport, for being in my life and believing in me; my children, Miren and Jane, for their patience and hugs; and especially my husband, Dan Millman, for being so loving, for gracefully bearing extra chores and stress so I could pursue my passion, and for always giving me faith that I could do it.

ABSTRACT

REGENERATIVE FARMING PRACTICES AS NATURE-BASED SOLUTIONS: POTENTIAL ACTIONS FOR MUNICIPALITIES IN MASSACHUSETTS

MAY 2024

HELEN HARRISON, B.A., UNIVERSITY OF MASSACHUSETTS AMHERST

M.R.P., UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Professor Elisabeth Infield

This paper explores potential opportunities for municipalities to engage with farmers to promote and support the adoption of regenerative farming practices. With agriculture, ecosystems, and communities confronting climate change and other environmental crises, this paper proposes that regenerative farming practices can serve as nature-based solutions that improve the resiliency of farms and communities alike.

To investigate this thesis, the following research was conducted: case studies of three western Massachusetts organic farms, including semi-structured interviews with key personnel; reviews of municipal plans in their respective communities; a case study of a California county's plans for sustainable agriculture and carbon farming; semi-structured interviews with seven food system planners working in western Massachusetts; and a literature review including selected Massachusetts and New England plans relating to food systems, climate change, and ecosystem health.

The study found that the most salient barriers to adopting regenerative farming practices in the study region were lack of long-term access to land, the financial risks associated with changing farming practices, and lack of skills and knowledge. The most important potential actions for municipalities were promoting communities of practice in regenerative farming by supporting community farms and peer learning groups; promoting regenerative farming on agricultural land under municipal control and through key partnerships; including regenerative farming practices as nature-based solutions in municipal plans and regulations; and promoting these practices on farms to improve the resilience of riparian buffers and flood plains and as urban green infrastructure.

Keywords: Food system planning, regenerative agriculture, agroecology, urban agriculture, community farms, nature-based solutions, Massachusetts, New England, sustainability, climate change

TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

CHAPTER 1

INTRODUCTION

Many municipalities recognize the importance of local agriculture to community character and its role in the health and food security of their residents. In Massachusetts, farming faces threats from development and farmer attrition. In response to these threats, programs to protect farmland and improve farm viability have been enacted at federal and state levels; in some communities, these are bolstered by local zoning and ordinances. In addition, a number of Massachusetts communities and regions have created food system plans that integrate local agriculture with public health and food justice efforts.

As part of planning for climate change, Massachusetts and various local communities are turning toward nature-based solutions for carbon sequestration, water infiltration, urban cooling, biodiversity protection, and stormwater and flood-risk management at scales ranging from neighborhood to landscape. While agriculture is included among potential nature-based interventions in federal and state guidance documents, the environmentally damaging effects of conventional agricultural practices pose challenges to employing it in this way.

While its environmental impacts vary, agriculture itself faces threats from climate change. At a global level, these threats put crucial food supplies at risk. At a community level, climate change risks both increase the importance of local

farms as buffers against food supply disruptions, and compound existing threats to this resource.

Federal and state initiatives are increasingly directing resources to help farmers adapt to climate change through a variety of means, including improving farms' environmental impact through adoption of sustainable farming practices. At the same time, climate change initiatives such as Massachusetts' Municipal Vulnerability Preparedness (MVP) program and the Inflation Reduction Act offer funds for nature-based and natural and working lands solutions, which can be used to help communities plan and implement actions to support sustainable, climate-resilient farming practices.

CHAPTER 2

THESIS STATEMENT

Massachusetts municipalities have an interest in supporting local agriculture to preserve open space and community character and to enhance residents' health and food security. Local agriculture can also serve as a nature-based solution to climate change if ecologically sound practices are used. Such practices can also increase farms' long-term sustainability, reducing soil degradation and enhancing their climate resilience. *Regenerative agriculture* is a way of farming that emphasizes soil and ecosystem health. By supporting farmers in shifting to and maintaining regenerative farming practices, Massachusetts municipalities can increase both farm resilience and community climate resilience.

To explore the validity of this thesis, research was conducted to answer the following questions:

- What are barriers to farmers' adopting or maintaining regenerative farming practices?
- How have local governments sought to encourage regenerative agricultural practices?
- What can we learn from urban, suburban, and rural farmers about the potential role of municipalities in encouraging regenerative farming?

CHAPTER 3

METHODS

To provide a consistent context for understanding diverse agricultural actors' experiences, research for this thesis focused primarily upon Massachusetts. Research was conducted to explore issues facing sustainable farming operations at different scales and settings in a single geographical region: the Springfield, Massachusetts Metropolitan Statistical Area (MSA), colloquially known as the Pioneer Valley. Three sites were chosen for case studies. All have well-established organic operations and vary in their relationships with their respective municipalities. The case studies were based on interviews with key staff and board members, past and present, with news articles and the establishments' own websites and documents used for background information.

Alongside these case studies, municipal planning documents were reviewed to provide insight into the potential relationships between these farming enterprises and municipal plans and policy. These plans also provide a view into the interplay between local plans and policies and sustainable and community farming advocates. Furthermore, they demonstrate both examples that other municipalities can follow and gaps in planning that illustrate potential opportunities for supporting regenerative agricultural practices as nature-based solutions.

In addition, despite this thesis' focus on Massachusetts, plans from Marin County, California for sustainable agriculture and carbon farming were also studied because of the county's innovative approaches to positioning sustainable agriculture to support community character, agricultural preservation, and climate change goals.

To provide additional context and insights, semi-structured interviews were conducted with staff from organizations involved in food system planning, agricultural support, and nature-based research and design in the Pioneer Valley. A review of selected federal, regional, and state-level agricultural and climate planning documents was undertaken to understand existing research and plans in Massachusetts regarding sustainable agriculture and climate resilience.

In addition, a literature review was conducted on climate-change impacts on agriculture; nature-based solutions; definitions of regenerative agriculture and other sustainability-focused agricultural approaches; and the role of municipal planning in food systems planning.

CHAPTER 4

LITERATURE REVIEW

4.1 Agriculture's impact on the environment

Since the rapid rise of industrial agriculture in the 20th century, the Green Revolution and other advances have greatly increased global food supply. However, this expansion, which has relied heavily on monocropping, conventional tilling by tractors, large inputs of freshwater, pesticides, and nitrogen- and phosphorus-based fertilizer, is causing increasing environmental harm and depletion of the resources upon which it depends for its productivity, including soil health, water availability, and pollinator services (Campbell et al., 2017; McLennon et al., 2021; Springmann et al., 2018). Food production has been identified as the primary driver of several environmental harms and a growing contributor to others. Researchers have identified nine planetary boundaries, which are defined as the limits of the "safe operating space" for human activities before these systems are depleted or destabilized to the point where severe damage occurs or human existence is threatened (Campbell et al., 2017; Springmann et al., 2018). Of these nine planetary boundaries, agriculture is a major contributor to the degradation of four: land-use change, freshwater use, biochemical flows of nitrogen and phosphorous (boundary exceeded), and genetic and functional biodiversity (boundary exceeded). It also is a moderate contributor to climate change. Each of these global boundaries has unique regional boundaries, as impacts are unevenly distributed (Campbell et al., 2017).

It is crucial to limit or reverse the destructive elements of agriculture, while rising to the challenge of meeting the nutritional needs of a rapidly growing global population (Smith, 2013; Springmann et al., 2018; Wheeler & von Braun, 2013). "Sustainable intensification" has been proposed as a way to address the needs of a growing population while preserving crucial ecosystem and planetary system functions, albeit imperfectly. Sustainable intensification is defined as the ability to grow more food per unit of land while preserving the land's capacity to meet future food needs and reducing ecosystem harm, an approach advocated by the United Nations' Food and Agriculture Organization (FAO). Current practices that lead to erosion, top-soil and soil nutrient loss, and heavy use of chemical fertilizer and pesticides, are unsustainable paths to increased yields (Smith, 2013). Gerten et al (2020) propose several ways to meet global food needs while operating within the "safe operating space" of planetary boundaries. These include increasing water-use efficiency; dramatically reducing food waste; changing dietary patterns; shifting agricultural land-use away from threatened ecosystems while expanding it in non-threatened areas, including restoring degraded farmland; and reducing overall nitrogen fertilizer use – while allowing targeted increases in areas in which the boundary for this input has not been exceeded. Simulations employing these strategies found that planetary boundaries could be respected while producing 2,355 kcal per person for a population of 10.2 billion (Gerten et al., 2020). In addition to these approaches, Smith et al also mention the potential contributions of a variety of agroecological

approaches, such as agroforestry, silvopasture, intercropping, and other "mixed production systems" that provide ecosystem services and intensification without monocropping (Smith, 2013). While food system change must occur at international and national scales, many policies and programs will need to be implemented by local administrations (Gerten et al., 2020), and changes in practice will occur at the farm scale (Wheeler & von Braun, 2013).

4.2 Climate impacts on food systems

The IPCC states that increased droughts, extreme weather events, and pest pressure due to climate change are likely to decrease the productivity of crops as well as their nutritional value. Among other measures, reducing monocultures and adopting conservation agriculture and agroecological approaches is recommended as "an effective way to achieve climate change adaptation (robust evidence, high agreement)" (Mbow et al., 2019, p. 471).

The *Fifth National Climate Assessment* (Bolster et al., 2023) predicts that United States agriculture will be significantly affected by climate change in coming decades, causing shifts in plant hardiness zones that are already underway, changing the locations in which crops are most successfully grown. A more volatile climate with more intense droughts, heat waves, and floods will cause soil degradation and crop loss. Furthermore, our interconnected global food system is vulnerable to disruptions throughout food supply chains by immediate and long-term climate impacts – such as acute crop losses due to

droughts and hurricanes disrupting ocean transport or changing patterns of food production. The report states, "availability, accessibility, utilization (or usability), and stability are dimensions expected to be affected by climate change," adding that local food production and strong local food systems can help protect residents against these shocks (Bolster et al., 2023, pp. 11–14). Also of interest to this thesis, the report notes: "Conservation-based agroecological approaches that improve soil health are necessary to maintain productivity while achieving a healthier environment," and that these practices may overlap with nature-based solutions (Bolster et al., 2023, pp. 11–18).

Climate change has already begun to affect agriculture in the Northeast United States region with increased droughts, floods, and storm damage. In the Northeast United States, the USDA predicts that average temperatures, which have already risen 1 to 4 degrees Fahrenheit in the last 100 years, will increase by an additional 4.5 to 9.5 degrees in the next 65 years and heat waves will likely increase, causing drought and lower crop yields. Heavy precipitation events have increased by 70 percent in the last 70 years, and are projected to increase further, causing disruptions to farm operations, erosion and fertilizer runoff, and flooding leading to crop loss and soil compaction. Storms will likely become more severe and frequent, posing risks to livestock, crops, people, and farm infrastructure. Warmer temperatures are likely to increase pressures from insect

pests and disease. Increased atmospheric CO2 may benefit certain crops, but may also increase weed pressure (Janowiak et al., 2016, pp. 9–11).

4.3 Agriculture as a nature-based solution

International Union for Conservation of Nature (IUCN) defines nature-based solutions (NbS) as "actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges (e.g. climate change, food and water security or natural disasters) effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al., 2016, p. xii). NbS encompasses an array of approaches that include green infrastructure on local and landscape scales, conservation, ecological engineering, and ecosystem restoration. Forests, wetlands, coastal zones, riparian zones, and mangroves are mentioned as sites of restoration, ecological engineering, and adaptation. As suggested in the definition, NbS can have multiple benefits, including enhanced food production and access, and seeks to harmonize development and environmental goals. (Cohen-Shacham et al., 2016).

Pertinent to this thesis, urban green infrastructure, agroforestry, and "adapting food systems to environmental change" are cited as examples of NbS (Cohen-Shacham et al., 2016, p. 13). Eggermont et al call for enhancing benefits to humans and the environment through NbS that include "innovative planning of agricultural landscapes to increase their multifunctionality" – linking this to

agroecology and other ecologically oriented agricultural approaches (Eggermont et al., 2015, p. 244). In an IUCN case study of a region in Senegal experiencing land salinization, a community planning process shifted initial plans from "disaster risk reduction" to a focus on sustainable farming methods, which also addressed food security needs: "Making the project priorities more inclusive of local needs was relatively simple and yielded co-benefits like soil rehabilitation, biodiversity gains and higher food crop yields" (IUCN, 2020, p. 7).

In the United States, the Biden-Harris administration has made NbS an important part of its climate change policy. A 2022 report, *Opportunities to Accelerate Nature-Based Solutions: A Roadmap for Climate Progress, Thriving Nature, Equity, & Prosperity*, outlines a vision of possible actions. It describes NbS as important for climate change adaptation and mitigation, providing cooling, disaster risk management, crop loss prevention, and carbon sequestration. Among other examples, it specifically calls for "climate-smart agriculture," including "agroforestry, silvopastures" and "cover crops, no-till, [and] rotational grazing" and notes that the Inflation Reduction Act has committed unprecedented funding to climate change interventions, including nature-based solutions (White House Council on Environmental Quality et al., 2022, pp. 13–14).[1]

[1] Several other federal agencies encourage nature-based solutions, sometimes using other terms. For instance, to mitigate climate change hazards, the Federal Emergency Management Agency promotes NbS in the form of urban green infrastructure, watershed- and landscape-scale interventions, and coastal stabilization (FEMA, 2021; *Nature-Based Solutions | FEMA.Gov*, 2023).

Further guidance from the USDA promotes NbS for agriculture as both adaptation and mitigation actions. For instance, cover crops are recommended to reduce erosion and water loss; shade from silvopasture protects livestock from heat – and both of these practices sequester carbon. Stewardship of farmland for the benefit of larger ecosystems is also encouraged (Janowiak et al., 2016).

On the state level, the *Massachusetts 2050 Decarbonization Roadmap* does not mention NbS or green infrastructure, but does highlight the importance of natural and working lands, particularly forests, as a carbon sink (Massachusetts Executive Office of Energy and Environmental Affairs, 2020). In addition, while the *Massachusetts Clean Energy and Climate Plan for 2025 and 2030* does not forward specific nature-based solutions, an NbS working group has been established for the plan's implementation. In addition, the Executive Office of Energy and Environmental Affairs (EEA) has committed $3 billion per year to nature-based and greening projects within the Municipal Vulnerability Preparedness (MVP) grant program (Massachusetts Executive Office of Energy and Environmental Affairs, 2022). The *MVP Toolkit: Nature-Based Solutions* does not emphasize agricultural nature-based solutions. However, it does recommend regenerative food systems as an approach (MVP, n.d.).

4.4 Agricultural practices discussed in this thesis

This thesis uses the term "regenerative practices" to refer to an array of agricultural approaches that promote resilience to climate change and overall

ecological health. A number of similar agricultural approaches and associated terms were employed in literature reviewed and interviews conducted for this thesis. Prominent among them were *organic agriculture, sustainable agriculture, conservation agriculture, agroecology, climate-smart agriculture,* and *regenerative agriculture*. The goals and techniques associated with each of these often overlap; at the same time, the meanings of several of these terms have varied according to how, where, when, and by whom they have been used. This section provides a brief overview of these concepts.

Sustainable agriculture

Sustainable agriculture is an umbrella term that encompasses an array of practices meant to protect against the depletion of the natural resources that farming relies on. It generally includes some degree of environmental stewardship. In international contexts, it often includes the goals of human rights and social justice; while the USDA's definition includes "quality of life" for farmers and communities. (FAO, United Nations, n.d.-b; Oberč & Arroyo Schnell, 2020; Sustainable Agriculture Research & Education (SARE), 2020).

Organic agriculture

In the United States, organic food and farming rose in popularity as part of the back-to-the-land farmer movement of the 1960s. In the early 1970s, a group of California producers created CCOF (California Certified Organic Farmers), the nation's first organic certification program. These growers sought to differentiate

their products in the market from conventionally grown food and to set up a process for ensuring that certain farming standards had been followed. These standards included ecological stewardship and soil health, as seen in the CCOF's official definition of "organic" as

> "…an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony…. The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people" (Guthman, 2014, quoting CCOF, 1998).

In the context of this thesis, in which no-till methods are frequently mentioned, it is important to note that because it eschews herbicides, organic agriculture typically relies on tillage to control weeds (Donvan, 2020).

Eventually, the rising market strength of organic producers led to the national Organic Food Production Act of 1990, which focused primarily on the prohibition of synthetic chemicals in crop or livestock production. Soil health, the sole ecological concern represented in the Act, is only mentioned in reference to a requirement for an organic farm plan (*7 U.S. Code Chapter 94 - ORGANIC CERTIFICATION*, n.d.; Guthman, 2014). [2] While many farmers still practice organic agriculture in the interest of larger sustainability goals, large-scale

[2] The European Union's organic standards, however, include environmental stewardship and soil health (Oberč & Arroyo Schnell, 2020).

organic agriculture has become increasingly mechanized and an important agribusiness sector (Bless et al., 2023; Guthman, 2014).

Conservation agriculture

Conservation agriculture is a term with competing definitions, the common root of which are techniques employed to preserve topsoil, including no-till and reduced-till methods (a.k.a. conservation tillage), "permanent soil cover" through cover-cropping and mulching, and interplanting or rotations of two or more crops. A thick crop residue is often used to control weeds. From there, conservation agriculture's definitions and practices diverge into large-scale agribusiness applications and methods used by smallholder farms in high-poverty countries to increase productivity and resilience to climate change. In the latter context, herbicides and fertilizers may be used sparingly, especially as the farm system is being established (Donvan, 2020; FAO, United Nations, n.d.; Lal, 2020; Oberč & Arroyo Schnell, 2020).

In contrast, large-scale, mechanized conservation agriculture has been highly dependent on herbicides. Centered on no-till planting, it arose as a top-soil-sparing alternative to ploughing following the U.S. Dust Bowl of the 1930s. The development of herbicides and herbicide-resistant crops by chemical manufacturers has been central to its growth (Bless et al., 2023; Oberč & Arroyo Schnell, 2020). Famous examples are Round-Up (glyphosate) and genetically modified Round-Up Ready seeds. No-till farming has seen widespread adoption

among large-scale commercial growers. This sector is also a proponent of carbon credits for conservation agriculture practices.

In recent decades, herbicide use, due to more strategic applications, has dropped from 10 pounds per acre in the 1960s to "mere ounces per acre today" (Lessieter, n.d.). Furthermore, through relying on cover-cropping, crop selection, and mulching techniques, some farmers and researchers have demonstrated that organic farming and no-till practices can be successfully combined (*Organic No-till Is Elusive, but Study Shows Promise*, n.d.).

Agroecology

Agroecology arose out of collaborations between scientists and Indigenous and traditional farmers to forward their agricultural practices and values as the foundation of a new sustainable farming paradigm. Over time, it has developed into a movement that calls for transformations in economies, food systems, social and political structures, and nature-human relationships (Altieri et al., 2012). Its focus tends to be on smallholder farmers in the Global South, although agroecology is also advocated for other regions. The ten elements of agroecology have been adopted by the Food and Agriculture Organization of the United Nations (FAO) in support of its Sustainable Development Goals. These are: "Diversity; synergies; efficiency; resilience; recycling; co-creation and sharing of knowledge," "Human and social values; culture and food traditions," and

"Responsible governance; circular and solidarity economy" (Bless et al., 2023; FAO, United Nations, n.d.-a; Oberč & Arroyo Schnell, 2020, p. 12).

Its range of practices is broad; their uses, context-specific. Some, like no- or low-tillage, cover-cropping, mulching, intercropping, and crop rotation, overlap with conservation agriculture. Others, such as preference for biological and organic amendments and pest control methods, overlap with organic agriculture. In addition, agroecology's reliance on local resources, renewable energy, windbreaks, polyculture, livestock integration and silvopasture (grazing animals around fruit or nut trees), and riparian buffers, share features with climate-smart agriculture, carbon farming, and regenerative agriculture (Oberč & Arroyo Schnell, 2020).

Carbon farming

Carbon farming employs many of the same agricultural practices as agroecology, with the goal of capturing and sequestering carbon from the atmosphere – such as cover crops, intercropping and crop rotation, and reduced tillage. Managed grazing, and growing perennial crops, shrubs, and trees are also emphasized to increase carbon stores. Amending cropland, pastureland, and hayfields with biochar or compost is another common practice to increase carbon sequestration as well as improve soil quality, plant and livestock health, and moisture retention.

To some proponents, carbon farming necessarily is tied to earning carbon credits for removing atmospheric carbon via carbon markets. Other advocates and practitioners question carbon markets' ability to reduce net carbon, as carbon credits are used to balance greenhouse gas emissions elsewhere. While some research on the ability of carbon farming's ability to sequester carbon long-term has been promising, others have questioned these results. The value of carbon farming practices to stemming agricultural carbon emissions, providing short-term carbon sequestration, and improving soil and ecosystem health are more certain (Almaraz et al., 2023; Marin Carbon Project, 2024; Oberč & Arroyo Schnell, 2020; Schlesinger, 2022; Toensmeier, 2016).

Climate-smart agriculture

The FAO defines climate-smart agriculture not as a particular system of agriculture, but as a broad approach to agriculture that seeks to "sustainably increase agricultural productivity and the incomes of agricultural producers; strengthen the capacities of agricultural communities to adapt to the impacts of climate change; and, where possible, reduce and/or remove greenhouse gas emissions" (FAO, 2017, p. A1:1). The USDA also promotes the FAO's climate-smart agriculture goals. Like the FAO, it does not define climate-smart agriculture as new set of practices, but rather as an approach that can include practices such as managed grazing, nitrogen management, conservation tillage, agroforestry, and cover-cropping, as well as the restoration of natural lands. The National Resources Conservation Service (NRCS), a branch of the USDA,

promotes climate-smart and land conservation practices through a variety of programs – such as its COMET Planning program to quantify the carbon sequestration potential of a broad range of farming practices, including those listed above (NRCS, USDA, 2023; Swan et al., 2023; USDA, n.d.).

Regenerative agriculture

Regenerative agriculture is itself a contested term, with different actors using different definitions. Research by Tittonell et al (2023) suggests that "corporate" regenerative agriculture appears to be a rebranding of conservation agriculture's focus on minimal soil disturbance, with the addition of livestock integration. Other, non-corporate approaches look more like agroecology, but often lack agroecology's explicit political goals (Tittonell, 2023). Regenerative agriculture's practices closely align with agroecology's and carbon farming's. They are aimed at promoting flourishing soil microbial communities and root structures – leading to resilient plant immune systems, improved productivity and water infiltration, heathier ecosystems, and resilience to climate change (Lal, 2020; McLennon et al., 2021). In general, when using the term "regenerative agriculture," this thesis is referring to the more agroecological view of the practice.

Indigenous and traditional roots of regenerative agriculture

Like agroecology and carbon farming, many of the practices used in regenerative agriculture have roots in Indigenous and traditional cultures

throughout the world (Altieri et al., 2012; Bless et al., 2023; Toensmeier, 2016). This includes practices of the Indigenous people of New England, who used techniques such as the synergistic Three Sisters planting of corn, squash, and beans (Cole, 2022; McLennon et al., 2021). African polyculture, and African American agroforestry, mycology, and the research and promotion of crop rotation and nitrogen-fixing crops by George Washington Carver are all part of a Black regenerative farming heritage (Reid & Weinstein, 2023). Latin America has been a center of the agroecological movement (Altieri et al., 2012). Many regenerative farming practices can be conceived of as a continuation of diverse Indigenous and peasant agricultural traditions (Carlisle, 2022).

Use of the term "regenerative practices"

This thesis uses the term "regenerative practices" to refer to the types of farming practices that also serve as nature-based solutions to climate and other environmental concerns. There are several reasons this term was selected. Importantly, "regenerative practices," rather than "regenerative agriculture" is used to avoid the need to categorize entire farming enterprises as practicing "regenerative agriculture" or not. Farms may define themselves as conventional, organic, or by some other term, while using one or several regenerative practices. Furthermore self-labeling as a "regenerative farmer" does not guarantee that certain practices are being used (Alexanderson et al., 2023). The focus of this paper is on implementing nature-based solutions that are appropriate in

different agricultural contexts, rather than promoting a certain "brand" of farming.

However, the term "regenerative practices" does refer back to regenerative agriculture, which encompasses most, if not all, such practices found in the other categories. Despite its similar practices, agroecology includes social, economic, and cultural concerns that are beyond the scope of this research. Similarly, carbon farming's practices and regenerative agriculture's are extremely similar. However, the issues raised in carbon farming about the efficacy of these techniques in for carbon sequestration and concerns about carbon markets are also beyond this paper's scope. Climate-smart agriculture includes adaptations and energy management issues that go beyond agricultural practices, and also does not prescribe any particular practices. Sustainable is too undefined a term to use, and organic farming does not necessarily include many of the practices that have proven to be important to topsoil conservation, climate change resilience, and other concerns addressed by regenerative agriculture. Conservation agriculture's split identity between agribusiness and smallholders of the Global South, and the former's heavy reliance on herbicides and GMO crops make it inapplicable to this paper's context. While it is true that regenerative agriculture is a term increasingly adopted by agribusiness, this association seems less solid (Tittonell, 2023).

The term was also chosen because "regenerative agriculture" is a concept that is gaining increasing traction in the Global North (Bless et al., 2023; Tittonell, 2023). In addition, the terms "regenerative agriculture," and "regenerative farming" were found in several of the municipal, state-level, and regional plans and reports reviewed for this study (Cole, 2022; Massachusetts Department of Agricultural Resources (MDAR), 2023; Massachusetts Executive Office of Energy and Environmental Affairs, 2020; Northampton Planning Board, 2021; Regenerative Design Group & Conservation Works, 2022; Slaff et al., 2018; Town of Harvard, 2020) – as was the broader concept of the "regeneration" of communities and natural and working lands (Anderson & O'Connor, 2022; Massachusetts Executive Office of Energy and Environmental Affairs, 2022; Northampton Planning Board, 2021).

Finally, "regenerative" suggests both a reckoning and repair. As one interviewee for this thesis put it:

> I would make the argument that sustainable agriculture right now is inherently regenerative agriculture. …[W]e've already destroyed a lot of the land's capacity to sustain crops over time. It's inherently an extractive process if you're not building the landscape's capacity over time to heal and increase the amount of carbon. It's building the water. It's holding the nutrients' ability to cycle (K. Zaltzberg-Drezdahl, personal communication, January 29, 2024).

4.5 Regenerative agricultural practices in the study region

Regenerative Agriculture for New England: Sustaining Farmland Productivity in a Changing Climate, published by the American Farmland Trust, reports on the

potential of four regenerative farming practices to sequester carbon and increase agriculture's resilience to climate change in New England: cover crops, no till and reduced till, prescribed grazing, and nutrient management. In the United States, 9.3% of greenhouse gas emissions come from agriculture – mostly in the form of nitrous oxide and methane. Within agriculture, the largest source of emissions is agricultural soil management – contributing twice the next largest source: enteric fermentation from livestock (Cole, 2022, p. 6).

In 2017, Massachusetts had 491,653 acres of land in farms, of which 171,496 were cropland and 46,341 were pastureland, with the remainder being woodland or "other" (USDA NASS, 2017). According to the USDA, no-till or reduced till practices were used on 11% of cropland, and cover crops were used on 10%[3]. Together these practices mitigated 8,200 $MTCO_2e$ of greenhouse gas emissions annually. The cover crop rate was higher than the national average of 3.9%, probably partially due to types of primary crops grown. Massachusetts' rates of no-till and reduced-till adoption, however, were far lower than the national rates of 37% and 35% (Cole, 2022, pp. 16–17).

Regenerative agricultural practices would contribute significantly to New England's climate change mitigation and resiliency efforts. For example:

- New England's percentage of cropland using cover crops is 10%, mitigating 8,100 $MTCO_2e$ annually. Increasing the rate to 100%

[3] Acres under no-till and reduced till practices increased modestly between 2017 and 2022, while acres with cover cropping declined slightly (USDA NASS, 2022).

would mitigate around 77,900 $MTCO_2e$ per year. It would also reduce runoff of nitrogen, phosphorous, and sediment by 3.7 times or more (Cole, 2022, pp. 20–22).

- New England's percentage of cropland using no-till or reduced-till is 12%, mitigating more than 34,000 $MTCO_2e$ per year. If all New England cropland used reduced-till, 170,000 $MTCO_2e$ would be mitigated annually. At 100% no-till, the mitigation would be 298,000 $MTCO_2e$. In reality, both practices would likely be used. Furthermore, these practices would increase soil moisture and quality and improve water quality. For example, if all current cropland used no-till methods, this would reduce runoff of nitrogen, phosphorus, and sediment by 15.6 times or more (Cole, 2022, pp. 22–24).
- In New England, 16% of farms use prescribed grazing. At a 100% adoption rate, this would mitigate 6,500 MTCO2e annually. However, this may underestimate the sequestration potential, because transitioning to prescribed grazing would reduce the need for silage corn crops. This would lead to further carbon and environmental mitigations: Replacing just 20% of silage acres with prescribed grazing would mitigate around 38,200 $MTCO_2e$ per year. While a conversion from silage feed to prescribed grazing could be lengthy and challenging, it could have dramatic carbon

mitigation results. It would also promote animal health, biodiversity, and drought resistance (Cole, 2022, pp. 24–25).

- Switching from synthetic nitrogen fertilizer to dairy manure at a 100% adoption rate would mitigate 159,000 $MTCO_2e$ per year across New England. It would also improve soil health and water quality, and reduce air pollution associated with animal waste on farms (Cole, 2022, pp. 26-27).
- The greatest climate mitigation impacts per acre would be seen from increasing trees and shrubs on farms through riparian buffers and agroforestry. This is a place where small New England farms can make a big difference: Each acre of trees or shrubs planted on farms "can have the same climate mitigation potential of transitioning 14 acres of cropland to no-till or planting 37 acres of cover crops (Shoeneberger et al., 2012; Swan et al, 2015)." Woody riparian buffers and agroforestry can also provide habitat, stem erosion, and significantly improve water quality. Planting more than the mandated buffer area increases these benefits but raises costs for farmers. However, farmers can turn land converted to buffers into a revenue source by planting edible tree and shrub crops (Cole, 2022, pp. 28–29).

Regenerative Agriculture for New England identifies several barriers to adopting and maintaining regenerative practices: Costs of implementing new practices and monitoring results; time and labor commitments; lack of technical knowledge; need for specialized equipment; and lack of understanding the risks and benefits of transitioning. New England's lag in adopting some conservation practices may be partially due to its preponderance of small farms compared to the large, monoculture farms of midwestern and western states. Smaller farms and more diversified farms often have more difficulty in transitioning to practices requiring specialized equipment or financial risk (Cole, 2022). Enabling a system-wide transition to regenerative practices, "calls for strong local, state, and federal commitment and support, even as policy and technical support for the shifting practices are implemented or maintained" (Cole, 2022, p. 18). Specific recommended actions include providing technical assistance, promoting farmer-to-farmer learning, measuring CO2 mitigation impacts, assistance applying for NRCS grants, offering grants and loans for specialized equipment, and providing favorable taxation to farms using regenerative practices (Cole, 2022).

4.6 Regenerative agricultural practices and Massachusetts climate action plans

Massachusetts' two major climate planning documents, *Massachusetts 2050 Decarbonization Roadmap* and the *Massachusetts Clean Energy and Climate Plan for 2025 and 2030* both highlight the need for regenerative agricultural practices for carbon mitigation and climate resilience. The *Roadmap* calls for "soil management best practices" (Massachusetts Executive Office of Energy and Environmental

Affairs, 2020, p. 71) and the "Regenerative farming practices that increase soil carbon stocks on managed farm and pasture lands" as a CO2 reduction strategy. While the mitigation impact is limited by the small contribution of agriculture to the state's overall greenhouse gas emissions, the *Roadmap* notes that such practices are also important to ecosystem health (Massachusetts Executive Office of Energy and Environmental Affairs, 2020, p. 80).

The *Clean Energy and Climate Plan's* greenhouse gas inventory found that Massachusetts croplands emit a net 0.3 $MMTCO_2e$. Better management is needed for them to become a carbon sink rather than a source. The plan prioritizes farmland preservation, viability, and equitable access to farming.

The plan also sets a goal to "Incentivize 20% of privately owned forests and farms to adopt climate smart practices by 2030," as well as plant "5,000 and 16,100 acres of new urban and riparian trees by 2025 and 2030 respectively...." (Massachusetts Executive Office of Energy and Environmental Affairs, 2022). Towards these aims, it calls for expanding the state's APR and 61A programs to include farms that do not meet current criteria, which require a minimum farm size, and partnering with municipalities to increase conservation. In addition, it states an intention of adding a 61C tax relief program to private and municipal landowners for climate-smart forest management, which can be extended to farms that use "healthy soils practices" (Massachusetts Executive Office of Energy and Environmental Affairs, 2022, p. 97). It also puts forward a new Massachusetts Coordinated Soil Health Program, promotes riparian planting,

and calls for expanding the Greening the Gateway tree planting program targeting low-income, urban communities. It furthermore commits $3 million in funding through the Municipal Vulnerability Preparedness (MVP) program for "greening and nature based projects to lower heat island impacts and increase urban carbon storage" (Massachusetts Executive Office of Energy and Environmental Affairs, 2022, p. 98).

Starting in 2017, bills were introduced to the Massachusetts legislature supporting healthy soils. In 2019, the Commonwealth commissioned a *Healthy Soils Action Plan*. In 2021, Massachusetts passed two provisions in House Bill 5250 relevant to sustainable practices: Approval of a grant program to support urban farms, and a commitment to "assist in the development of a healthy soils program," with provisions addressing a wide array of settings and stakeholders, including "grants, technical assistance or education" for "private and public landowners, including commercial farmers" (Commonwealth of Massachusetts, 2021, p. 30). In 2023, $1,020,000 was appropriated for a Healthy Soils Program Fund in fiscal year 2024, administered by the Executive Office of Energy and Environmental Affairs. To be eligible for funding, an activity must "provide 1 or more of the following benefits: improve food production; encourage the health, growth and biological diversity of plants and forests; increase water infiltration reducing stormwater runoff; provide drought and crop resilience, enhance water quality; and reduce the use of fertilizers and herbicides; and provide greenhouse gas benefits." Out of this, $100,000 was allocated to a new Massachusetts

Coordinated Soil Health Program, led by the American Farmland Trust (Nerds for Earth, 2024).

4.7 Statewide plans addressing sustainable and regenerative agriculture

The *Massachusetts Farmland Action Plan*, published in 2023, highlights the value of farms to Massachusetts' economies, culture, ecosystem services, climate change resilience, culturally important food for immigrant communities, and food security in the context of risks to global supply chains. Although 15% of the state's farmland is permanently protected, loss of farmland and shrinking farm size continue to be troubling trends. The *Farmland Action Plan* lays out three overarching goals to promote thriving agriculture in the state:

1. Increase efforts to permanently protect farmland.
2. Increase access to farmland – with attention to equity.
3. Support and enhance the viability of farms and farmland.

(Massachusetts Department of Agricultural Resources (MDAR), 2023, pp. 5, 7–9).

Viability, farmland protection, and land access are closely connected with the ability of farmers to implement sustainable practices. The Farmland Action Plan notes a number of actions for cities and towns. Municipalities can make farmland available to beginning farmers, immigrant farmers, and farmers of color through licensing and leases of city land and working with land trusts and local organizations to create community farms and community land trusts (CLTs). Municipalities that have adopted the Community Preservation Act can

use CPA funding to protect land and can use tools such as Right to Farm ordinances and zoning mechanisms such as cluster development to promote development; the plan also proposes creating Transfer of Development Rights (TDR) programs to preserve farmland. Farmland should be included in municipal comprehensive plans and master plans; further, by including farmland in Open Space and Recreation Plans, it can become eligible for state-level conservation grants. Agricultural Commissions can act to protect land, and can "buy, hold, manage, license or lease land for agricultural purposes" (*Massachusetts General Law - Part I, Title VII, Chapter 40, Section 8L*, n.d.). Promoting community gardens and farms are important ways that municipalities can increase equitable access to farming for marginalized and immigrant communities (Massachusetts Department of Agricultural Resources (MDAR), 2023).

In addition, state farmland licensing programs can be redesigned to favor sustainable management plans, rather than the highest bidder. Licensing of state-owned land already prioritizes farmers from historically underserved groups. The *Farmland Action Plan* recommends that municipalities establish their own farm licensing programs for city-owned land (Massachusetts Department of Agricultural Resources (MDAR), 2023).

Published in 2023 by New England Food Planner Partnership, *New England Feeding New England* presents a plan for New England to increase its

food security by security by producing 30% of its own food by 2030 (Peters et al., 2023). (This is an update to the A New England Food Vision which set a goal of the region's producing 50% of its food by 2060, which would require tripling the current amount of land devoted to agriculture (Donahue et al., 2014)). Currently, eighty percent of food, as measured by weight, comes from outside of the region. To achieve 30% food self-sufficiency, the region would need to clear between 289,147 and 588,430 additional acres for agriculture (Peters et al., 2023, p. 17). The plans' focus group participants expressed concerns about climate change increasing weather hazards and pest pressures, but also noted the possible benefit of a longer growing season (Peters et al., 2023).

The prior plan, *A New England Food Vision,* stated that to achieve higher levels of food production, actions were needed at federal, state, local, neighborhood levels – as well as the "the choices of thousands of property owners about how to manage their land" (Donahue et al., 2014, p. 3). While the plan sees the region's small farms generally as good stewards, it also states that "'Local' agriculture is not intrinsically sustainable; it must be made so deliberately by strong incentives that reinforce the desire of conscientious farmers and fishermen to employ best practices" (Donahue et al., 2014, p. 8). The plan notes that good pasture practices can increase soil organic carbon, which in turn sequesters nitrous oxide, another greenhouse gas. Several additional steps, including planting riparian buffers and providing edge habitat, are

recommended for protecting water quality and biodiversity, respectively (Donahue et al., 2014).

A New England Food Vision further estimates that in a scenario in which global food supplies become more limited, the region could boost production to provide 67% of its food. This would require clearing additional forest and adopting a more plant-based diet. While the plan assumes that more intensive farming would require more intensive tillage, it also sees roles for permaculture and for "silvopastoral and agroforestry systems on marginal grazing lands, which could help expand fruit and nut production" (Donahue et al., 2014, p. 9)

Harvard Forest's report, *Wildlands and Woodlands* calls for conserving 70% of New England's land as forests, while preserving the 7% currently categorized as agricultural. Despite increasing threats to both, there have been positive counter-actions: Conservation efforts in the last quarter century are proceeding at four times the rate they were previously. The report calls for accelerated actions to increase the region's ecological resilience, including increasing local "food and wood" production that supports healthy ecosystems and communities, and "promoting close interactions with nature and food production" (Harvard Forest, 2017, p. 5). It further states that greater production and consumption of *local* resources in wealthier areas of the world like New England would benefit the global environment by making local residents more conscious stewards (Harvard Forest, 2017).

The *Massachusetts Local Food Action Plan*, published in 2015 by the Massachusetts Food Policy Council, sets goals for promoting local agriculture, supporting local food systems, protecting the environment, and promoting food security and food justice (Massachusetts Food Policy Council, 2015b). It advocates for numerous farmland protection and farm viability actions. Several of its goals include supporting farmers to adopt more sustainable, ecologically sound practices. While there is federal and state cost-sharing assistance for soil health and other sustainable practices, many smaller farmers are unaware of these programs, and there is not enough funding for outreach, education, and technical assistance to help farmers implement them. The plan calls for compensating farmers for their important work as stewards of the land, potentially through credits for water quality and carbon sequestration and by developing regional carbon markets (Massachusetts Food Policy Council, 2015a, pp. 38-39). It also recommends enlisting municipal commissions and boards to engage agricultural landowners in conservation, farmland restoration, and land management practices and programs (Massachusetts Food Policy Council, 2015a).

The Resilient Lands Initiative: Expanding Nature's Benefits Across the Commonwealth – A Vision and Strategy (RSI) is a companion document to Massachusetts' 2050 *Decarbonization Roadmap* and *Clean Energy and Climate* plans. It offers a vision of "no net loss of food or farmlands" while increasing equitable

housing, promoting food security, and improving public transit through land conservation and cluster zoning. Among its strategies are the creation of urban green spaces to reduce flooding and heat islands, particularly in identified climate risk zones and environmental justice communities; incentivizing carbon storage through conservation and healthy soils practices; land restoration at the watershed level; promoting climate-smart farming; expanding jobs in sustainable farming, climate-resilient practices, and "maintaining healthy soils" (Executive Office of Energy & Environmental Affairs (EEA), 2023, p. 11). In its calls for increasing riparian buffers and tree planting on farm edges, it recommends agroforestry systems and fruit and nut tree planting as ways to supplement farmers' incomes while accomplishing these objectives.

The RSI views urban farms and gardens as important ways to increase food security and green space in cities while decreasing development pressures in rural areas, including the pressure to convert forest to farmland. It offers examples of numerous partnerships between local and national NGOs and neighborhood organizations and municipalities to promote urban green space development and farmland preservation. To address the need for both housing and increased green space, it recommends that municipalities inventory and assess vacant lots, both private and public, for suitability for either infill housing development or green spaces, and advocates the use of city lands for agriculture where appropriate. It also calls for building relationships with the Indigenous

tribes, nations, and bands of Massachusetts to protect Indigenous lifeways and cultural values related to the land and promoting collaborations on land conservation - and for promoting access to farming and farmland to people of color and immigrant and refugee communities. Urban farms, new farmer programs, and traditional Indigenous practices all tend to focus on sustainable agricultural practices. Thus, such programs and approaches simultaneously promote equity, physical and mental well-being, food security, and climate resilience (Executive Office of Energy & Environmental Affairs (EEA), 2023).

The Massachusetts Healthy Soils Action Plan (HSAP), published by Massachusetts' Executive Office of Energy and Environmental Affairs, focuses on soil health as a foundational element in supporting biodiversity, ensuring food security, and managing heavy precipitation events. Crucially, soil also contains 80% of global terrestrial carbon, making it the world's largest non-ocean carbon sink (Anderson & O'Connor, 2022, p. 9, citing Lal, 2008). These functions of soil are increasingly critical as climate change impacts intensify and soil faces threats from development and deleterious human activities. The overarching goal of the plan is "No net loss of soil organic carbon between 2021 and 2050" (Anderson & O'Connor, 2022, p. 7). It calls for action on state and municipal levels to identify and protect critical soils and to promote soil health stewardship. It suggests the Municipal Vulnerability Program (MVP) could help fund this effort (Anderson & O'Connor, 2022). It also notes that although National Resources Conservation

Servies (NRCS) is available for conservation agriculture, it is unavailable to a growing sector of Massachusetts farmers because they are too small to qualify.

While there are several ways that soil health can be measured, the most widely accepted metric is the concentration of soil organic carbon (SOC). SOC is generally improved by reducing soil disturbance, and SOC improves soil function in turn. For example, a 1% increase in SOC on an acre of land increases its ability to hold water by as much as 20,000 gallons (Anderson & O'Connor, 2022, p. 20, citing Bryant, 2015). This is significant to soil retention on farmland: A study from central Indiana showed that in a 4-inch rainfall on corn or soy fields, about half of the rain becomes runoff. This is four times the runoff rate from forests, more than twice that of turf, and 50% of the runoff from impervious surfaces (Anderson & O'Connor, 2022, citing Frankenberger, 2020). In addition to reducing runoff – and, by extension, erosion – increased SOC in agricultural land sequesters carbon, promotes nutrient retention, and protects against drought.

The HSAP states that "reversing the astonishing loss and degradation of agricultural soils is a vital part of ecosystem restoration" (Anderson & O'Connor, 2022, p. 5). This requires minimal disturbance to "soils and their plant communities," allowing them to turn atmospheric carbon into SOC over time (2022, p. 6).

The HSAP estimates that 4% of Massachusetts' land is devoted to agriculture[4]. While the land area it covers is small, the plan states that is critical to protect this land and its soils for food security, particularly "with increased impacts of climate change and other disruptions like global pandemics" (Anderson & O'Connor, 2022, p. 5). The plan recommends increasing an array of management practices (BMPs). The first is conservation agriculture, as defined by the NRCS – which includes reduced tillage, cover crops, and crop rotation – and often is eligible for NRCS and MDAR funding. The plan states this is currently practiced on 26% of Massachusetts cropland. The second is organic farming, practiced on 3% of Massachusetts cropland. In addition, it recommends a variety of agroforestry and managed grazing practices, including riparian buffers, silvopasture, and alley cropping (Anderson & O'Connor, 2022).

Despite available funding, the HSAP found that farmers face several barriers to adoption of these practices. Minimum size requirements for state and federal funding eligibility leave out smaller farmers, who represent a growing subset of Massachusetts farms. Many farmers are not aware of evolving understandings of soil health. Finally, farmers, operating on thin margins, often cannot afford the added costs in equipment, supplies, labor, and risks involved in converting to these techniques. HSAP advocates for financial incentives and

[4] Other sources place the percentage at 7% or 8% (Harvard Forest, 2017; Massachusetts Department of Agricultural Resources (MDAR), 2023).

support for farmers, which could be based either on practices or on outcomes. Programs in New York and Maryland pay farmers $50/acre/year for engaging in soil health practices, while some international programs pay for the amount of SOC sequestered at $50-$200/ton (Anderson & O'Connor, 2022, pp. 67–68). It also sees roles for local governments in promoting soil health education (Anderson & O'Connor, 2022, pp. 112).

4.8 Community food system planning: An overview

In 2009, the American Planning Association created a *Policy Guide on Community and Regional Food Planning*. While food system planning had not been traditionally been considered a primary interest of urban and regional planners, growing recognition of the ways in which local food systems intersect with many concerns – including public health, social justice, cultural traditions, rural and urban economies, the environment, labor and workforce issues, land use, and the community character of rural areas – led to the increasing involvement of urban and regional planners in food systems planning.

Generally, the primary concern of regional and municipal food systems planning has been increasing food security – the ability of all residents to have access to adequate, healthy, and culturally appropriate foods at all times. This goal requires integrated planning involving myriad sectors. Municipal and regional planning have played roles in strengthening local food networks, including facilitating access to local food (American Planning Association, 2007).

The APA addresses agricultural land preservation in a separate policy document. Among its key priorities are creating zoning, urban growth boundaries, and purchase of development rights mechanisms to preserve farmland; protection of agricultural activities through Right-to-Farm ordinances; distinguishing agricultural land preservation from open space preservation; and the integration of environmental stewardship with agricultural preservation (*APA Policy Guide on Agricultural Land Preservation*, 1999).

Specific planning actions endorsed by the APA include helping to establish food policy councils; incorporating food system planning into comprehensive and neighborhood plans; planning for transportation for food access and agricultural work; economic development planning for agricultural communities; foodshed assessments; mapping and identifying important soils, threatened farmland, low food access areas, and municipal parcels suitable for agriculture; assessing environmental impacts of agriculture; serving as conveners and liaisons for diverse interest groups, including residents, farmers, agricultural workers, and business owners, youth employment programs, public health, hunger, agricultural, and environmental advocacy organizations, and city and regional agencies and officials; and hazard planning regarding food access (American Planning Association, 2007; Raja et al., 2008).

A growing area of municipal food planning is promoting urban agriculture and community gardens. Numerous municipalities have adopted

ordinances, plans, and resolutions creating agricultural districts, which allow farming as a land use within the district; and have created city-run urban farming programs that help interested residents identify and secure vacant city or private land for farming. One community has created urban farming plans with measurable goals and timelines (Campbell, 2017; Growing Food Connections, n.d.; Raja et al., 2008). In 2013, California passed the Urban Agriculture Incentive Zones Act, which "authorizes a city, county, or city and county and a landowner to enter into a contract to enforceably restrict the use of vacant, unimproved, or otherwise blighted lands for small-scale production of agricultural crops and animal husbandry"; contracts are good for a minimum of five years (*Urban Agriculture Incentive Zones Act - California State Board of Equalization*, n.d.). Los Angeles and San Franciso have adopted this zoning. Numerous municipalities have also included an agriculture element in their comprehensive plans. In some cases, agriculture is explicitly linked in plans to climate change resilience and sustainability goals (Growing Food Connections, n.d.).

A Planners Guide to Community and Regional Food Planning: Transforming Food Environments, Facilitating Healthy Eating provides examples of communities that have promoted organic or sustainable farming through comprehensive plans, programs, and policies. Seattle's P-Patch program is a city-wide program that helps groups find land for, establish, and run community gardens; the city

requires that they use organic methods (Raja et al., 2008). Seattle's comprehensive plan supports "community gardens as a land use," and a voter-approved levy allocated funds for establishing community gardens (Growing Food Connections, n.d.). In Madison, activism from residents to save community gardens on city-owned land led to the creation, with the city's support, of Troy Gardens, an affordable co-housing development with community gardens and a CSA (community supported agriculture) farm, on land held by a community land trust. Two core goals of the Troy Gardens community are sustainable land use and promoting community food security (Raja et al., 2008).

Some municipalities have created plans and incentives promoting organic, sustainable, or regenerative practices. Woodbury County, Iowa adopted an Organics Conversion Policy, offering tax incentives to farmers who converted to organic practices (Growing Food Connections, n.d.). The Town of Harvard, Massachusetts's MVP-funded *Agricultural Climate Action Plan* includes a chapter on "Nature-Based Resilient and Regenerative Practices." Priority actions in this section are to, "Protect and enhance pollinator habitats. Enhance soil health and maximize carbon sequestration. Maintain biodiversity. Encourage resilient and regenerative practices among farmers" (Town of Harvard, 2020). A comprehensive plan for Marin County, California, established clear priorities for promoting organic and sustainable practices as part of its plan for agriculture

(Raja et al., 2008). A review of this plan and subsequent Marin County plans and policies is the basis of one of this thesis' case studies.

4.9 Synthesis of literature review

The literature review supports accelerating adoption of regenerative agricultural practices to reduce agricultural harms and increase its function as a nature-based solution for climate change and other environmental stresses. As climate change threatens agriculture globally and in the Northeast United States, maintaining food production while increasing agriculture's existence is an urgent problem.

Agricultural approaches that reduce these harms include agroecology, regenerative agriculture, and carbon farming, as well as elements of conservation agriculture and organic farming. In their ability to stabilize soil; reduce fertilizer runoff, erosion, and agricultural chemical use; promote drought and pest resistance; sequester carbon; and protect ecosystem health, these practices can also serve as nature-based solutions (NbS). Indeed, farmers have been involved as stakeholders in NbS projects around the world, some of which have had a primarily agricultural focus.

Federal and state-level climate planning promote NbS as mitigation and adaptation strategies. The Inflation Reduction Act and USDA recommend and provide funding for NbS in the form of agricultural practices. Perhaps due to the small percentage of agricultural land in the state, Massachusetts climate action

plans place less emphasis on agricultural practices as NbS. However, funding to promote such practices is available through MDAR climate-smart agriculture programs, MVP grants, and the Massachusetts Coordinated Healthy Soils Program.

Recent New England-wide and Massachusetts plans and initiatives to support farming, natural and working lands, and soil health also point to the importance of integrating farming and NbS. Sustainable and regenerative farming practices are recommended in several plans to improve soil health, farm viability, carbon sequestration, and ecosystem health. Several state plans also point to the green infrastructure function of urban agriculture.

Farmers face several barriers to adopting regenerative practices. In general, lack of time, knowledge, funds, and labor hamper adoption. Some farms are too small to qualify for NRCS grants. Lack of access to land is another barrier.

The literature review points to several ways in which municipalities intervene in local food systems, as well as ways they can promote sustainable farming practices specifically. Planning can intervene in food systems in multiple ways, and these actions can be mutually reinforcing. For instance, supporting farmers' markets that accept SNAP and WIC benefits in low-income areas increases access to healthy foods while supporting local farmers. This strengthens the viability of local farms, which also helps preserve farmland (Massachusetts Department of Agricultural Resources (MDAR), 2023).

The way in which community food planning brings together multiple interest groups to forward intertwined goals suggests ways in which planning can support regenerative farming practices. Similar to the ways in which communities have integrated federal nutrition programs and farmers markets, and youth job programs and community gardens, planners can bring together farmers and environmental groups, using USDA, Inflation Reduction Act, and state agricultural and climate change action funding streams for coordinated initiatives promoting regenerative practices.

Municipalities can also have direct influence on farming practices through conditions set for city-run agricultural and gardening programs and agriculture conducted on municipally owned land. Influence on privately owned and managed land can come in the form of tax incentives for converting to sustainable practices. Payments for ecosystem services and carbon sequestration are being implemented in some states; municipalities could advocate for and leverage such programs or implement such programs themselves.

Municipal action for regenerative agricultural practices as NbS is needed to accelerate adoption and coordinate these efforts with town and city priorities. Although estimates of the use of regenerative practices on Massachusetts farms vary, they are not widely used, let alone the norm. While agriculture is recognized in local climate planning and vice versa, there are gaps in planning to coordinate these concerns. With increasing climate hazards, municipalities with

significant areas of agricultural land or agricultural land in particularly vulnerable areas, the negative impacts of neglecting nature-based solutions on farms are likely to be significant. Urban communities also stand to reap multiple benefits from urban farms and gardens that function well as green infrastructure. The remainder of this thesis will explore existing actions, needs, barriers, and opportunities for further action in Massachusetts.

CHAPTER 5

CASE STUDIES AND INTERVIEWS

5.1 Interviews with food system planners

To gain a greater understanding of the challenges Pioneer Valley farmers are facing and available resources and strategies to assist them, seven professionals involved in food system planning were interviewed from the following organizations:

- *American Farmland Trust (AFT), Washington, D.C.* With its Farmland Information Center located in Northampton, Massachusetts, the American Farmland Trust is a national non-profit organization providing advocacy, research, grants, and technical assistance to support the preservation of farmland and farming and the promotion of regenerative farming practices. It was a partner in authoring the *Massachusetts Farmland Action Plan,* contributed to the *Resilient Lands Initiative,* and is the coordinating organization for the Massachusetts Coordinated Soil Health Program for farmers (*American Farmland Trust - Saving the Land That Sustains Us since 1980*, n.d.; *Massachusetts Coordinated Soil Health Program*, n.d.; Executive Office of Energy & Environmental Affairs (EEA), 2023; Irby, 2021; Massachusetts Department of Agricultural Resources (MDAR), 2023).

- *Community Involved in Sustaining Agriculture (CISA), Deerfield, Massachusetts.* CISA is a local non-profit organization dedicated to building a stronger, more equitable local food system. It began in 1999 as a "buy local" group and has expanded into programs supporting farm viability and sustainability and promoting access to fresh, local foods to people at risk of food insecurity. Climate change adaptation has become a major focus of the organization; CISA provides technical assistance, workshops, peer-to-peer learning, funds and grant-writing assistance for climate change adaptation, hazard planning, and disaster recovery (*CISA*, n.d.).
- *Pioneer Valley Planning Commission (PVPC), Springfield, Massachusetts.* PVPC is the designated regional planning organization serving Hampshire and Hampden Counties in Massachusetts. It works with 43 member municipalities to provide technical assistance and to coordinate region-level planning. It is involved in many areas of planning, including climate change, hazard mitigation, green infrastructure, environmental justice, and food access issues. It published the 2014 *Pioneer Valley Food Security Plan* and contributed to the 2015 *Massachusetts Local Food Action Plan* (*PVPC*, n.d.; Massachusetts Food Policy Council, 2015b; Pioneer Valley Planning Commission, 2014).

- *Regenerative Design Group (RDG), Greenfield, Massachusetts.* RDG is a worker-owned firm that provides site design, research, and planning with a focus on ecological resilience, including regenerative agriculture. It contributed to the *Massachusetts Healthy Soils Action Plan* and the Town of Deerfield's *Healthy Soils Report* and has provided design and consultation for urban and community farms, including two of this thesis' case study sites, Gardening the Community and Grow Food Northampton (Anderson & O'Connor, 2022; A. Klein & M. Skillicorn, personal communication, February 6, 2024; E. O'Gilvie, personal communication, January 15, 2024; Regenerative Design Group & Conservation Works, 2022; *RDG*, n.d.).

Several themes came up in multiple interviews. These are summarized below.

Climate change impacts are putting farmers in an increasingly precarious position. The most salient problems are more extreme and unpredictable weather and increased flooding, precipitation, and drought. Interviewees noted that, while farmers historically have been prepared for one large weather-related loss per decade, these events are now happening nearly annually. Specific impacts include loss of trees in riparian buffers following storms; mass erosion events caused by river flooding; more difficulty working in fields due to standing water; crop loss and crop failure; and increased pest pressures. Farmers need to invest

more in irrigation and drainage. The increased expense and difficulty of operations has meant that some farmers are abandoning land too difficult or risky to farm, seeking drier land, or abandoning farming altogether (M. Christie, personal communication, January 17, 2024; J. Fine, personal communication, January 12, 2024; S. Water, personal communication, January 11, 2024; K. Zaltzberg-Drezdahl, personal communication, January 29, 2024).

Some experts noted that, despite funding and technical assistance available from federal, state, and non-profit entities, a lack of cover-cropping and inadequate riparian buffers are common on area farms. Barriers to adopting these practices include learning about new crops, techniques, and timing, and taking marginal land out of production – all of which can incur loss. Adopting new practices often also requires new investments – and forsaking previous investments – in equipment and supplies. Furthermore, diversification, a strategy often presented as adaptive, comes with its own risks. Crop insurance is not as available for diversified farms, and diversification requires more labor and knowledge. In addition, although risk are diversified, they are also multiplied (M. Christie, personal communication, January 17, 2024; Z. de Jesus Barros, personal communication, January 11, 2024; S. Water, personal communication, January 11, 2024).

Some interviewees said that farmers tend to be risk-averse and distrustful of government. They more often trust what has been successfully tried by other

farmers; thus, peer-to-peer learning is crucial. Organizations such as Conservation Districts and the American Farmland Trust coordinate peer-learning groups, and the Town of Hadley's Climate Change Committee is holding forums on climate change impacts with town farmers.

Farmers need help rapidly recovering after climate-related losses. One interviewee noted that a significant portion of riparian trees lost to Hurricane Irene's floods in 2011 still have not been replaced. Farms also need financial help, financial resilience, and the ability to quickly get back into production. Several interviewees remarked that community connections with and support for local farmers are crucial to this type of resilience. Municipalities and planning agencies can foster these relationships and income streams by supporting farmers markets and programs like the Healthy Incentives Program (HIP), through which SNAP (Supplemental Nutrition Assistance Program) recipients can have their purchases of produce from participating farmers reimbursed (B. Basch, personal communication, January 10, 2024; M. Christie, personal communication, January 17, 2024; Z. de Jesus Barros, personal communication, January 11, 2024; J. Fine, personal communication, January 12, 2024).

Several interviewees also stressed the importance of local farms for resilience to regional or global crises. During the COVID-19 pandemic shut-downs, local farmers made a decision to plant in the spring and mobilized to make local food available in local communities. This became an important food

source during global supply chain disruptions, especially for people with limited transportation options. One expert stated that growing more local food is needed for regional food security; another stated that farmable state-owned land should be made available for farming, particularly to people of color and new and immigrant farmers; this could also help facilitate the transfer of farms to new farmers as current farmers retire.[5] Another said there was a lot of excitement around municipalities' use of Community Protection Act (CPA) funds to protect local farms. Two municipalities, the towns of Harvard and Hatfield, have used Municipal Vulnerability Preparedness (MVP) grants to plan for climate-resilient local agriculture; another, the Town of Deerfield, used MVP funds to conduct a healthy soils survey, which included research on, and recommendations for, local farms (B. Basch, personal communication, January 10, 2024; M. Christie, personal communication, January 17, 2024; Z. de Jesus Barros, personal communication, January 11, 2024; K. Zaltzberg-Drezdahl, personal communication, January 29, 2024).

Interviewees spoke of the urgency and promise of regenerative practices to ensure that farms remain viable in the face of climate change. Tree crops, agroforestry, silvopasture, and perennial crops can introduce new income streams while increasing the soil organic carbon and resilience of pastureland, cropland, flood plains, and riparian buffers, including land that otherwise can no

5 Sixty-four percent of principal farmers in Massachusetts are age 55 or older; 34% are 65 or older (Massachusetts Department of Agricultural Resources (MDAR), 2023).

longer be farmed sustainably. On the other hand, continued tillage and use of synthetic additives in floodplains pose great risks of pollution run-off and mass erosion events, and soil organic carbon has been depleted from decades of extractive farming. In addition, new crops will need to be trialed and adopted. One expert suggested learning from farmers in other parts of the world about crops that are adapted to the emerging conditions here, such as drought, increased heat, and floods (Z. de Jesus Barros, personal communication, January 11, 2024; J. Fine, personal communication, January 12, 2024; K. Zaltzberg-Drezdahl, personal communication, January 29, 2024).

Experts stated that incentives and rewards for farmers for adopting regenerative practices would be helpful, while regulations would feel punitive. Similarly, special branding or financial rewards for "types" of farms would be divisive and counterproductive. The label of the farm – such as "organic," "regenerative," or "sustainable" is less important than the practices. Along these lines, motivated by high phosphorous levels in Lake Champlain caused by agricultural runoff, Vermont is piloting payments for ecosystem services; these are provided for specific practices, such as reducing nitrogen fertilizer or cover-cropping. (M. Christie, personal communication, January 17, 2024; J. Fine, personal communication, January 12, 2024; K. Zaltzberg-Drezdahl, personal communication, January 29, 2024). Said one interviewee, "In this unique period where we're facing unprecedented climate change, and we're under the gun to

decarbonize rapidly, what would it mean for the next 50 years to pay farmers for the ecosystem services they're providing?" One option could be to reward them based on increases in soil organic carbon (K. Zaltzberg-Drezdahl, personal communication, January 29, 2024).

Municipalities and planning agencies can also help by mapping important soils, which can open up funding opportunities from the National Resources Conservation Services (NRCS) and Massachusetts Department of Agricultural Resources (MDAR). Local and regional climate action plans can also make grant funds available for adaptation by identifying farms as an important land use (K. Zaltzberg-Drezdahl, personal communication, January 29, 2024). Experts spoke of the need for municipalities to view farms as "valuable businesses" and that many farmers don't feel rewarded for being "a good neighbor" (J. Fine, personal communication, January 12, 2024). In addition, as farmers are highly attuned to the environment, we should be learning about their observations of local climate change impacts (K. Zaltzberg-Drezdahl, personal communication, January 29, 2024).

Important resources for farmers are local, regional, and national non-profits, UMass Extension, and Conservation Districts. Conservation Districts are "local units of government established under state law to carry out natural resource engagement programs at the local level" (*About NACD*, 2016). Among other services, they provide soil testing, technical assistance, grants, and other

resources to farmers. The Hampden-Hampshire Conservation District in Massachusetts provides rentals of a no-till planter – a highly expensive piece of equipment – crucially reducing costs for farmers wishing to adopt or experiment with this practice. Interviewees emphasized that rather than duplicating shared resources and programs such as these, that municipalities and planning agencies could connect farmers to them (M. Christie, personal communication, January 17, 2024; Z. de Jesus Barros, personal communication, January 11, 2024; K. Zaltzberg-Drezdahl, personal communication, January 29, 2024).

5.2 Marin County, California

Marin County, located in the San Francisco Bay Area of California, is an affluent, highly educated community of 262,321 (U.S. Census Bureau, 2020, 2022); U.S. Census, 2022). A significant amount of land is zoned as agricultural or open space (*MarinMap Map Viewer*, n.d.). Traditionally, animal agriculture, including dairy, has been the largest part of the agricultural sector; however, orchards, row-crops, and value-added products are becoming increasingly important (Marin County Community Development Agency, 2023; Raja et al., 2008). Although only one percent of the population is still employed in agriculture (U.S. Census, 2022), Marin agriculture continues to be highly productive and significant to its cultural character. Much of this is due to protections and supports for farming and ranching instigated by residents concerned with the loss of agricultural land to fierce development pressures within the San Francisco Bay real estate market (Raja et al., 2008).

Marin County has been included in this thesis' otherwise Massachusetts-focused research because of its unique adoption of policies to promote specifically *sustainable* agriculture. This became codified in its 2007 *Marin Countywide Plan,* which won the American Planning Association's (APA) National Planning Excellence Award for Implementation. Although California differs significantly from Massachusetts in climate and local governmental systems (California has county governments; Massachusetts does not), Marin County's innovative approach offers lessons that can be adapted to other planning contexts (Raja et al., 2008).

Over the past half century, Marin County residents and government have taken a number of steps to preserve agriculture and encourage sustainable practices. In 1972, the county created the A60 agricultural zone to protect farmland and pastureland. As development pressures continued, in 1980, a group of residents formed the Marin County Agricultural Land Trust (MALT), the first land trust in the nation focused on protecting agricultural land. In 1990, a partnership of organic farmers and the Marin County Agricultural Commissioner established Marin Organics, a local organic certification program that was later accredited by the USDA. In the 12 years that followed, the number of acres dedicated to organic practices increased from 67 to 1,560 acres – a 23-fold increase[6] (Marin County Community Development Agency, 2023; Raja et al.,

[6] However, this still represented less than one percent of Marin County's 169,000 acres of farmland (Marin County Community Development Agency, 2023; Raja et al., 2008).

2008). The Marin County Agricultural Commissioner's office also created a grass-fed livestock certification program in 2004, the first in the state. Meanwhile, by 2008, MALT had preserved about 25% of Marin County's agricultural land (*About*, 2020; *Marin Family Farming*, 2013; Marin County Community Development Agency, 2023; Raja et al., 2008).

The *Marin Countywide Plan* is a comprehensive development plan, which is required of all cities and counties in California. Its unifying theme is "Planning Sustainable Communities." The plan defines *sustainability* as "aligning our built environment and socioeconomic activities with the natural systems that support life. In the long run, sustainability means adapting human activities to the constraints and opportunities of nature. Central to this definition is meeting the needs of both the present and the future" (Marin County Community Development Agency, 2023, p. 1.3-3). The plan declares its alignment with the "Three E's": social equity, the economy, and environment, as well as sustainability principles set forth by the United Nations and American Planning Association (Marin County Community Development Agency, 2023, p. 1.3-4).

Marin's first Countywide Plan, adopted in 1973, designated several environmental zones which form the basis of its planning, one of which centered on farming. Mitigating greenhouse gas emissions and protecting natural and agricultural assets rank among the plan's guiding principles – along with affordable housing, transportation, and social justice, among others (Marin

County Community Development Agency, 2023). The strong environmental orientation of Marin's planning is reflected in the ecologically focused plan for agriculture articulated in the 2008 Countywide Plan and subsequent updates. The "Agriculture and Food" section begins with a definition of *agroecosystems*:

> Agricultural ecosystems, or "agroecosystems," integrate elements of natural systems and managed agricultural practices into working landscapes that balance environmental soundness with social equity and economic viability. Inherent in this definition is the idea that sustainability must be extended not only globally but indefinitely in time, and to all living organisms, including humans (Marin County Community Development Agency, 2023, p. 2.10-2).

All of this rests, the plan makes clear, on protecting agricultural land, which is under threat by low profit margins in the context of increasing land values. Goal AG-1, "Preservation of Agricultural Land and Resources," lays out numerous strategies for reducing tax burdens on farmers, supporting farm viability, and increasing land protections, particularly agricultural easements. This goal also includes protecting the quality of the land itself, such as mapping important soils and creating indicators of "ecologically sound farming and ranching, to assist in determining farm activities that protect agricultural land, promote farm economic viability, and further social activities necessary to sustain agriculture" (Marin County Community Development Agency, 2023, p. 2.10-16).

Goal AG-2, "Improved Agricultural Viability," links farm viability to sustainable practices. Along with more conventional approaches to supporting

local farms, such as marketing local foods, and supporting diversified farm production and value-added products, the plan includes strategies to promote "local, organic, grass-fed, and other ecologically sound agricultural practices,"(p. 2.10-17) and makes the case that these practices can increase farmer income, promote community health and food security, and promote biodiversity (Marin County Community Development Agency, 2023). Call-out boxes feature definitions of *sustainable agriculture* and Integrated Pest Management. Action steps include the following:

- Increasing staffing for the county's organic certification program.
- Creating incentives to help farmers transition to "ecologically sound" practices.
- Forging a partnership with the University of California Extension and Marin County's Agricultural Commissioner's office for developing and promoting sustainable farm products.
- Reviewing the county's Development Code to ensure its alignment with sustainable farming goals regarding agricultural processing and sales (Marin County Community Development Agency, 2023, p. 2.10-19).

Goal AG-2 also calls for increasing local food distributed to the Community Food Bank and farmers market coupons for WIC and food stamp recipients.

The final goal, AG-3, "Community Food Security," links sustainable local food production to secure and equitable food access and notes that local food is more readily available in the face of emergencies or supply chain disruptions. Strategies for AG-3 include facilitating community gardening on county land and through amendments to the Development Code, while partnering with organizations to use "ecologically sound techniques" (p. 2.10-21); supporting groups such as the Marin Food Policy Council, which advocate for sustainable food systems; educating the public about "ecologically sound techniques of farming" (p. 2.10-22) using local and organic food in county services and local schools, and promoting edible landscaping (Marin County Community Development Agency, 2023).

Marin's three-pronged approach to food and agriculture – preserving the county's unique agricultural character, protecting the environment, and improving residents' health and food security – was the result of a collaborative process that included the Marin Food Policy Council (MFPC), MALT, and area farmers. Raja et al (2008) describe it as lesson in careful leadership in forging key partnerships and the successful coordination of working groups by Marin's planning staff. The Marin County Planning Director at the time, Alex Hinds, reported that he selected participants for the plan's revision projects "who had cutting-edge ideas that would foster creative solutions and would limit political infighting between interest groups." Notably, while the goal of food security was

readily embraced by the community, some farmland preservation goals, such as limiting house size, were contentious (Raja et al., 2008). Outreach to heighten residents' awareness of the value of farmland was important in moving public opinion (Hinds, 2007, quoted in Raja et al., 2008).

Implementation of the plan's sustainable agriculture goals is evidenced on the county's website, which includes a page on sustainable agriculture and information on the Marin Organic Certified Agriculture (MOCA) program (County of Marin, 2022) . In addition, University of California's Cooperative Extension (UCCE) runs the Grown in Marin program, which offers farmers resources on sustainable agricultural practices, organic certification and more, including an Agricultural Ombudsman to helps them with all aspects of permitting and regulations, in partnership with the County of Marin and other partner organizations (University of California, Division of Agriculture and Natural Resources, 2024)

Marin created a funding mechanism for its food justice and sustainable agriculture goals, with the passage of Parks Measure A in 2012 (Marin County Parks, 2014). This measure levied a transaction and use tax of 0.25% to fund open space, parks, and sustainable agriculture in Marin County for a period of 10 years; the measure was renewed in 2022 (Parks Measure A, 2022). Twenty percent of the funds raised are allocated to promoting and supporting sustainable agriculture. Of the sustainable agriculture program funds, 30% is

devoted the Food, Agriculture, and Resilient Ecosystems (FARE) program (Marin County Parks, 2023), a matching grant created by the county to support organizations engaged in work in a wide variety of activities, including sustainable and regenerative agriculture, soil health improvement, ecosystem restoration, and food justice work. Another 20% goes to the Marin Conservation District for carbon farming plans and other ecologically beneficial projects on agricultural lands. The remaining 50% is dedicated to permanently preserving agricultural land through purchasing agricultural conservation easements and easement enforcement (Parks Measure A, 2022, Exhibit A, Page 3 of 6).

In June, 2014, Marin County residents voted in favor of a ballot measure put forth by the Marin County Board of Supervisors to designate the Marin Civic Center as the future site of a permanent farmers market, to be developed, managed, and funded by The Agricultural Institute of Marin (AIM), a non-profit engaged in promoting farmers markets. The measure's language appealed not only to economic development, the health benefits of local food, and farm viability, but also to Marin's "agricultural heritage" (Measure B, 2014). Dubbed the Center for Food and Agriculture, AIM's fundraising materials link farm viability, nutrition, equity, Marin's agricultural history, and sustainable food production:

> The Center will embody regenerative principles and be among the first closed loop, zero-waste farmers markets in the world. It will serve as an essential connection point between those who need quality, nutrient-dense foods and those who make their livelihoods providing this produce

> in a way that protects soils, pastures and seas. It will reflect AIM's values of building a food system that is equitable by supporting small to midsize farmers, family businesses, and underrepresented communities (AIM, 2022, p. 3).

In this way, AIM states, the Center will raise awareness of the role of sustainable agriculture in combating climate change, loss of farmland, and diet-related diseases. Furthermore, it makes the case that by providing a direct-to-consumer revenue stream, farmers markets also have a particular role in supporting climate-smart practices. When farmers have more financial resources, they can invest in practices that foster climate resilience. Furthermore, according to their research, farmers markets are important sources of income for organic farmers, almost half of which "sell through local food markets" (AIM, 2022, p. 13).

The plan for the Center for Food and Agriculture was endorsed by the *Marin County Unincorporated Area Climate Action Plan 2030* (Marin CAP) as part of food and agriculture carbon mitigation goals. In addition to supporting the Center, the plan sets ambitious goals for greenhouse gas emissions reductions and carbon sequestration through carbon farming – acknowledging that any such interventions depend upon continued efforts to conserve agricultural land.

Agriculture contributes about nine percent of Marin County's greenhouse gas emissions, primarily from enteric fermentation by ruminants, manure management, and fertilizer use. While reducing these emissions is important, the county sees a greater opportunity in making agriculture a net carbon sink by

promoting carbon farming practices, with the aim of sequestering 185,839 $MTCO_2e$ annually by 2045. Out of the county's 300 ranches and farms covering around 170,876 acres, the plan seeks to ultimately engage 180 operations covering approximately 90,0000 acres in carbon farming. (Marin County, 2020). The plan notes that carbon farming practices also have many co-benefits, including "increased soil health and soil water retention; reduced feed costs for farmers; improved water quality; enhanced biodiversity; increased climate resilience and an ongoing supply of local food and fiber to support our community" (Marin County, 2020, p. 54).

Tests of carbon sequestration strategies on nineteen Marin County farms conducted by The Marin Carbon Project laid the foundation for the strategies and goals set in the Marin County Climate Action Plan.[7] This data was used in modeling and mapping to create the estimates for potential total carbon sequestration and the potential of individual practices, listed in Figure 1 (p. 75).

[7] The Marin Carbon Project is a consortium of conservation land trusts, farmers, researchers, agricultural agencies and extensions dedicated to carbon sequestration and greenhouse gas reduction in farmland, woodland, and pastureland (*About MCP – Marin Carbon Project*, n.d.; Velasquez-Manoff, 2018).

- Conservation cover
- Residue and tillage management (no-till)
- Critical area planting
- Filter strip
- Compost application
- Nutrient management
- Forage biomass planting
- Prescribed grazing
- Range planting
- Riparian forest buffer
- Riparian restoration
- Tree and shrub establishment
- Silvopasture establishment
- Windbreak/shelterbelt establishment

Figure 1: Regenerative practices tested for carbon sequestration (Marin County, 2020, p. 56).

An average of eight practices were used at each site. Some practices, like compost application, demonstrated a high sequestration potential resulting from the large area of terrain on which they could be deployed. Others, like riparian restoration, had higher per-acre sequestration. Finally, some practices, such as silvopasture, demonstrated greater duration of carbon retainment, with a "sequestration lifespan" of 80 years (Marin County, 2020, p. 56).

To reach its carbon sequestration goals, the plan identifies the following actions addressing the following needs and barriers:

1. *Funding:* Establishing a committee to research funding and financing sources for carbon farm plans, such as providing matching grants. Funding could also be generated through participation in existing carbon markets or by a cap-and-trade-style program, described as a

"local carbon or ecosystem marketplace, including partnerships with local businesses focused on carbon neutrality" (Marin County, 2020, p. 55).

2. *Technical assistance:* In partnership with local non-profits and agencies with expertise, provide expanded technical assistance to farmers with permitting, carbon farm plan development, design, funding, and regulatory compliance.

3. *Capacity building:* Facilitate peer learning, equipment-sharing, and group purchasing of supplies and equipment among farmers.

4. *Monitoring and contractors:* Provide monitoring assistance and contractors for implementation of highly technical sequestration infrastructure.

5. *Tracking database:* Support the creation of a tracking database of the carbon benefits accrued via practices implemented by ranching and farming operations (Marin County, 2020, p. 55).

6. *Ease permitting barriers:* Soften or eliminate permitting barriers "such as triggers that classify restoration as development." Streamline the permitting of carbon farming infrastructure and activities within health and safety parameters (Marin County, 2020. p 55).

Analysis

Marin County's longstanding promotion of sustainable agriculture provides examples of concrete actions available to local governments. These efforts can be classified into four general groups:

1. *Elevating and framing the issue:* Including sustainable agriculture as a goal in comprehensive and climate action plans and articulating its importance to other community goals and values.
2. *Facilitating productive collaborations:* Bringing together county governmental entities such as the Marin Food Policy Council and Agricultural Commission, agencies such as University of California Cooperative Extension, non-profits as the Marin Carbon Project, the Marin Agricultural Land Trust, and local farmers; forging links between interests such as food security, equity, environmental protection, and farmland preservation; and leveraging these partnerships to provide resources such as the Agricultural Ombudsman and organic and grass-fed certification programs.
3. *Creating new funding mechanisms; facilitating funding access:* Supporting sustainable agricultural activities through funding, particularly through levying a tax partially earmarked for such purposes, as well as consideration of a local carbon or ecosystem credit system for farmers.
4. *Promoting a friendly regulatory environment:* Recommending and adopting laws and policies facilitating sustainable agriculture, such as

a ballot measure dedicating space for a permanent sustainability-focused farmers market and setting a goal to streamline permitting for carbon-farming related activities.

5.3 Northampton, Massachusetts

Enterprise studied: Grow Food Northampton

Figure 2: Grow Food Northampton, Florence, Mass. (Google Earth, n.d.).

Overview

Grow Food Northampton (Figure 2) is a multi-faceted organization based around a 121-acre community farm with a mission of building "a just and resilient local food system that nourishes our community and the earth" (Grow Food Northampton, 2021, p. 12). The organization is dedicated to equitable land access and stewardship, providing people experiencing food insecurity with

culturally appropriate food, and educating and encouraging the community to participate in a "just local food system" (Grow Food Northampton, 2021, p. 12).

The organization was founded as the result of a long process of advocacy and eventual partnership between the City of Northampton and a group of residents regarding the use of a parcel of farmland. In 2009, members of a Northampton-area listserv concerned with promoting local agriculture learned of the city's pending purchase of a farm, part of which it intended to convert to athletic fields while conserving some land as farmland (W. Feiden, personal communication, January 22, 2024). Worried about the potential loss of prime agricultural soil, the listserv members began organizing to preserve the land for farming. After a sometimes-contentious public process, an adjacent farm became available for sale as well. The Trust for Public Land (TPL) purchased 121 acres to temporarily hold it and worked with the City of Northampton to put it under agricultural preservation. In the meantime, members of the listserv groups founded Grow Food Northampton (GFN) as a non-profit and began raising money to buy the land from TPL for a community farm. The remaining 60 acres was purchased by the city for athletic fields. In part to help GFN meet its fundraising needs, the city used Community Preservation Act (CPA) funds to lease of a portion of GFN's land for an 198-year term for community gardens, which GFN would manage (*A Timeline of Grow Food Northampton's History*, n.d.; Anonymous, personal communication, January 31, 2024; W. Feiden, personal

communication, January 22, 2024; A. Klein & M. Skillicorn, personal communication, February 6, 2024).

Today, Grow Food Northampton manages the community garden and leases 10 farm plots. It also runs farmers markets, a mobile market bringing local produce to low-income neighborhoods, and a variety of community activities and educational programs (Grow Food Northampton, 2021; A. Klein & M. Skillicorn, personal communication, February 6, 2024).

Both the community garden and the farm-lease program prioritize providing equitable access to farmland and sustainable stewardship of the land. GFN promotes equity within its farm-lease program through outreach and recruitment of farmers from marginalized communities and a sliding-scale rental structure, starting at $1 per year (Grow Food Northampton, 2024b). Their 10 leased farm plots represent farmers with diverse backgrounds and interests. Crimson and Clover, a community supported agriculture (CSA) farm, is the anchor tenant with a 99-year lease. Of their nine other plots, four are leased to farmers of color, including a cooperative of 24 Somali Bantu refugee families who are part of All Farmers, a non-profit assisting immigrant and refugee farmers (All Farmers, 2022b). Farmers may grow produce for sale, for community distribution, for personal use, or a combination (Grow Food Northampton, 2021, 2022b; A. Klein & M. Skillicorn, personal communication, February 6, 2024).

Regenerative practices

A 2023 guide for its farmers, *Community Farm Land Use and Access Frameworks,* highlights GFN's commitment to "the biodiversity of our natural and cultural systems, and the capacity of our organization to model and promote climate resilient practices." It asks farmers to employ "ecological land management and regenerative agriculture," and to follow "organic certification standards," although organic certification is not necessary (Grow Food Northampton, 2023, p. 1). Through these practices, GFN seeks to promote drought and flood resilience, pollution prevention, water management, soil health, erosion prevention, and biodiversity. New farmers must attend a training on organic gardening methods, and GFN has begun holding annual winter meetings with farmers to develop farm management plans (A. Klein & M. Skillicorn, personal communication, February 6, 2024).

Renters of community garden plots have a less formal induction into sustainable practices but do receive a list of allowed and prohibited practices. They also have access to a variety of gardening workshops, which are often peer-led. In summer of 2024, GFN will offer a series on gardening in a changing climate, including workshops on permaculture and no-till techniques (Grow Food Northampton, 2024a; A. Klein & M. Skillicorn, personal communication, February 6, 2024).

GFN supports farmers by providing shared access to tools, supplies, and infrastructure, which lowers barriers to farming. The executive director stated, "The biggest thing that I heard from farmers is that farmland is hard to come by, finding but farmland with any infrastructure is impossible, really impossible to come by" – yet crucial to initiating and maintaining a successful farm operation (personal communication, February 6, 2024).

Climate change impacts

The inspiration to save the city's farmland and found GFN sprang partly out of a belief in "the importance of local agriculture for feeding ourselves in the face of climate change" (A. Franks, personal communication, January 31, 2024). Said one founder, "When you can do things locally and not depend on regional or global systems, you are more resilient when big systems break down" (Anonymous, personal communication, January 31, 2024). The first year of the COVID-19 pandemic provided a demonstration of the role of local agriculture in community resilience, when GFN mobilized to connect local farmers cut off from traditional channels for selling their food with residents at risk of food insecurity by creating a mobile market bringing produce to 14 subsidized housing sites weekly, a program that continues to this day (Grow Food Northampton, 2020, 2022a; A. Klein & M. Skillicorn, personal communication, February 6, 2024). (Grow Food Northampton, 2022b).

GFN is increasingly feeling the impact of climate change. Significant portions of GFN's site, including the community gardens and some small farm plots, lie in 10-year and 100-year flood plains. Growers within those zones suffered significant losses in 2023, leading GFN to reflect on the most prudent use of land in these areas. A recent assessment of climate impacts by Regenerative Design Group led GFN to abandon a previous goal of expanding the number of community garden plots: the increase in cars and people on the land would make the land too vulnerable to degradation. The assessment also determined that flood-prone land should be used primarily for perennials, trees, and shrubs – whether ornamental or food crop – rather than annual crops, because the soil is more at risk of erosion in flood-prone zones. This awareness has translated into a special section in GFN's *Community Farm Land Use and Access Frameworks for Farmers* on flood resilient practices. While not mandating any specific practices, GFN notes that certain crops and practices enhance flood resilience and protect soil, including "flood-tolerant trees, shrubs, and other perennials." Diversifying growing locations and avoiding high-risk crops is also recommended (Grow Food Northampton, 2023; A. Klein & M. Skillicorn, personal communication, February 6, 2024).

GFN has taken other steps toward climate resiliency as well. An edible hedgerow buffering its south parcel from the street also provides habitat and food for wildlife and people. The organization also is planting a riparian buffer.

GFN's farming operation is too small to qualify for National Resource Conservation Services (NRCS) funds for this; they have, however, received funds from the Connecticut River Conservancy for this work. In addition, they are in communication with the City of Northampton about invasive species control and tree-planting on their shared border (A. Klein & M. Skillicorn, personal communication, February 6, 2024).

With droughts also becoming more intense and frequent, GFN has installed water lines and pumps to allow farmers to use water from the Mill River that borders the property. GFN also encourage resilient practices by providing free cover crop seed and paying cover-cropping costs to farmers (Grow Food Northampton, 2023; A. Klein & M. Skillicorn, personal communication, February 6, 2024).

Experimentation

As part of its role in supporting sustainable community agriculture, GFN encourages its farmers to experiment in resilient practices without mandating specific actions, recognizing that "a variety of practices can achieve the same goals" (A. Klein & M. Skillicorn, personal communication, February 6, 2024). The organization uses its Giving Garden, which grows food for donation to local food programs – along with three of its community garden plots – as a "'living laboratory,'" to learn and teach about "farming practices that give back to the land and enhance climate resilience" (Grow Food Northampton, 2020, 2021).

Smith College agroecology researcher Piyush Labhsetwar is also using a plot to experiment with intercropping perennial wheat and paw-paw trees – a planting that withstood the 2023 flooding well. GFN plans to engage more researchers to run demonstration projects on climate adaptive and mitigative practices (A. Klein & M. Skillicorn, personal communication, February 6, 2024; Smith College, n.d.).

Leases

GFN's farm leasing program began with four farms. Its expansion to ten farmers in recent years was the result of a concerted effort to increase land access to, in GFN's framing, "farmers from communities that have been marginalized and harmed by the industrialized food system." GFN engaged in significant outreach to connect with farmers of color, as well as queer and women farmers (A. Klein & M. Skillicorn, personal communication, February 6, 2024) .

Leases for farmers vary in length and type. The anchor farm, Crimson and Clover CSA, has a 99-year lease and acts as a quasi-owner of the community farm overall, which includes maintaining the infrastructure and the unfarmed areas. The other farms are only in charge of their own plots, with leases ranging from one to six years. These include rolling leases, in which a short, multi-year lease is renewed annually; for example, a farmer with a three-year lease would always have three years ahead of them (A. Klein & M. Skillicorn, personal communication, February 6, 2024).

Interactions with city

By virtue of the city-run athletic fields bordering GFN's land, the City of Northampton and GFN communicate regularly about management of their shared borders. The city also recently contributed Community Preservation Act funds to allow GFN to clear more of its land for farming (A. Klein & M. Skillicorn, personal communication, February 6, 2024). A founding member remarked that with parts of GFN and other Northampton farmland being in flood zones, the city should have a long-term food system plan that takes a pro-active approach to securing farmland that is not in flood zones (A. Franks, personal communication, January 31, 2024).

Northampton's planning documents

Northampton, Massachusetts, is a relatively affluent, majority-white city of 29,571 (U.S. Census Bureau, 2022). All of its Census tracts are at or above the 94th percentile for "Expected agricultural loss rate: Economic loss to agricultural value resulting from natural hazards each year" related to climate change (Council on Environmental Quality, n.d.).

Sustainable Northampton Comprehensive Plan (2021), which includes the city's comprehensive, open space, active transit, and climate action plans, presents agriculture as a sector vulnerable to climate change and regenerative practices as a climate resilience strategy. Its Framework for Resilience & Regeneration is built upon five principles: Resilience, Equity, Regeneration,

Economic and Cultural Vitality, and Regional [action] (Northampton Planning Board, 2021, p. 55). Within this framework, actions that could be leveraged to support regenerative agricultural practices are frequently mentioned, such as creating a school curriculum on resilience and regeneration; promoting public lands' ability to sequester carbon, infiltrate stormwater, and provide habitat; coordinating green space protection with affordable housing needs; considering *Massachusetts Healthy Soils Action Plan's* recommendations; and creating a voluntary carbon credit and offset fund (Northampton Planning Board, 2021).

Section Energy 3C of Northampton's plan includes a call to "Support education and training in regenerative agriculture, agroforestry, silvopasture, and urban forestry." Noting the carbon sequestration potentials of these practices, it recommends supporting training and education in these practices. It further states:

> Consider peer-to-peer learning models through collaboration with local and regional farming initiatives with the explicit goal of developing contextually-specific practices for enhancing carbon sequestration and storage. Use such collaborations as a platform for identifying adjustments to municipal policies or systems, such as aligning lease lengths with harvest rotations for longer-term perennial plantings, which can further facilitate adoption of regenerative agriculture practices (Northampton Planning Board, 2021, p. 68).

Under Equity 1C, "Support workforce development in resilience and regeneration solutions," the plan advocates training in "nature-based resilience and regeneration solutions" through local partnerships. As an example, it suggests that vocational and agricultural high school students could plant

perennials in the city's floodplain, "fostering career development, generating a new harvest crop for farmers, reducing erosion, and creating pathways to increase local food production and food security" (Northampton Planning Board, 2021, p. 77). Northampton also owns several parcels of agricultural land that it licenses to farmers. Two of these are licensed to groups of groups of immigrant and refugee farmers, a relationship facilitated by All Farmers, a non-profit that connects immigrants and refugees, most of whom are experiencing farmers, to land[8] (All Farmers, 2022a; *Northampton Agricultural Commission - Agenda*, 2024). The city gives preference to "sweat equity" in lieu of cash payments, and to organic farming except when infeasible" (City of Northampton, n.d.). The complete text of the city's policy is reproduced in Figure 3 (p. 89).

[8] From All Farmers' web site: "Refugees and immigrants entering the United States are by and large farmers. It is central to their identity and cultural integrity. Restoring these landless farmers to the land opens new possibilities for the health and vibrancy of refugee and immigrant communities and the well-being and equity of society at large" (All Farmers, 2022b).

Figure 3: Best management practices for licensed farmland (City of Northampton, n.d.).

The City, through the Conservation Commission, licenses the use of farmland that it owns as part of conservation areas, managing the property based on local needs.

The purpose of these policies are to manage the properties:

1. **Consistent with the City's Open Space, Recreation, and Multi-Use Trail Plan.**
2. **Support local farmers to the extent possible.**
3. **Encourage best management practices appropriate to the parcel to be farmed and prefers organic farming except when infeasible; each license will be reviewed and approved by the Commission.**
4. **Support neighborhoods and public access to public land.**
5. **Preference to sweat equity improvements from agricultural land license holders instead of cash license payments.**

Public land available to farming and related best management practices:

1. Mineral Hills Greenway farmland: Best management practice: Transition to no-till agriculture OR organic.
2. Mineral Hills Greenway maple sugaring: Best management practice: Traditional taps and buckets only.
3. Connecticut River Greenway farmland: Best management practice: Organic farming only.
4. Meadows Greenway at Montview: Best management practice: Neighborhood organized only.
5. Meadows Greenway at Manhan Road: Best management practice: Organic farming only.

The attention to regenerative practices is a change from previous city planning. The city's prior comprehensive plan, *Vision 2020* (City of Northampton, 1999), highlighted farmland preservation, but only spoke of the value of Northampton's local agriculture in terms of cultural and scenic considerations. It did not mention food security or sustainable agriculture. A greenhouse gas inventory conducted for the city (City of Northampton, 2001) did not mention agriculture as an emissions source or sink.

Sustainable Northampton's "Community Participants" advising on the plan include Grow Food Northampton, Smith Vocational and Agricultural School, and climate change and conservation groups, among others (Northampton Planning Board, 2021). While there were likely multiple sources of influence leading to *Sustainable Northampton*'s focus on regenerative agriculture, it seems fair to that GFN has helped influence the direction of Northampton's planning.

Analysis

Grow Food Northampton serves as a community resource in a variety of ways, including providing enhanced food security during the COVID-19 crisis and improving food access for low-income residents in the long term. It also provides access to 325 community garden plots and ten tenant farm plots, with priority for leases given to members of marginalized groups. In addition, it provides workshops in sustainable agriculture for community members. Importantly, it gives its tenant farmers low-risk ways to enter into farming and to experiment with different crops and approaches within a framework of sustainable land stewardship.

The planning documents and interviews made clear that a feature that GFN shares with some of Northampton's most extensive stretches of farmland is the location of part of its land in a floodplain (Anonymous, personal communication, January 31, 2024; W. Feiden, personal communication, January 22, 2024; A. Franks, personal communication, January 31, 2024; A. Klein & M.

Skillicorn, personal communication, February 6, 2024; Northampton Planning Board, 2021). Floodplains are important to the city for safe flood control, but as more floods occur during the growing season, they put crops and farmer livelihoods at risk. This is a problem for growers throughout the Pioneer Valley, as a significant amount of farmland is in flood zones (Mass.gov, n.d.)[9]. A GFN founding member believes that Northampton should have a long-term food system plan that takes a pro-active approach to securing farmland that is not in flood zones, as part of developing a long-range plan for local agriculture (A. Franks, personal communication, January 31, 2024).

Sustainable Northampton reflects a planning process that brought in the experiences of community-based sustainable farms, other stakeholders, and experts to create a forward-thinking plan for climate resilience that includes regenerative agriculture. A challenge for Northampton will be expanding its support for these practices beyond city-owned properties and into initiatives and partnerships that support farmers on privately owned land to transition to and maintain regenerative practices.

This case study suggests several ways in which municipal planning could support a transition to and sustainment of these practices.

1. *Regenerative practices can be supported by licenses or leases of city-owned farmland and by helping community farms acquire land.* Northampton

[9] Flood zone data not available for Franklin County, Massachusetts.

licenses several parcels of farmland that stipulate organic or regenerative farming as best management practices. Northampton also assisted with GFN's acquisition of land by contributing Community Preservation Funds and working with a land trust to place the property under APR.

2. *Municipalities and farmers share vulnerabilities and interests in fortifying riparian buffers and stabilizing flood zones.* Farms in flood zones serve as open space that provides flood risk mitigation for municipalities. However, increased flooding due to climate change puts crops at risk. Furthermore, conventional agricultural activities can increase erosion and waterway pollution impacts. Municipalities can promote collaborations with schools and other programs to assist farmers in cover-cropping and planting fruit and nut crop trees and shrubs in riparian buffers and flood plains to provide farmers with resilient, marketable crops. These collaborations should solicit the expertise of local farmers who have experimented with these approaches, such those from GFN. Municipalities could prioritize licensing city-owned agricultural lands to farmers willing to create riparian and flood-zone demonstration projects. They can connect farmers to agencies and funding to assist them in these efforts.

3. *Municipal plans can highlight the role of regenerative agricultural practices as nature-based solutions.* Municipalities can bring together the agriculture sector, conservation sector, public health sector, and climate activists to create synergistic plans addressing multiple concerns and aspirations. Measurable goals can be set and reported on in comprehensive plans, Open Space and Recreation Plans, and climate action and hazard management plans.

5.4 Springfield, Massachusetts

Enterprise studied: Gardening the Community

Figure 4: Gardening the Community Walnut Street Farm, Springfield, Mass. (Google Earth, n.d.).

Overview

Gardening the Community (GTC) (Figure 4, p. 93) was founded in 2002 by Springfield resident Ruby Maddox in partnership with the Northeast Organic Farming Association as a program promoting youth leadership development and skill-building through engagement in urban agriculture (Roman, 2016). It currently runs two community gardens and a nearly 1-acre urban farm in Mason Square and Six Corners, a diverse neighborhood in Springfield's urban center identified as "low income and low [food] access" by the USDA (U.S. Department of Agriculture (USDA), n.d.), also described as food apartheid by advocates[10] (Belmonte & Smith, 2023; Garth, 2020; E. O'Gilvie, personal communication, January 15, 2024). Longstanding efforts by residents to attract a mainstream supermarket to the areas have failed (E. O'Gilvie, personal communication, January 15, 2024; Roman, 2016). The neighborhood has a strong history of community engagement and activism, including around food access and public health, led by neighborhood councils, religious organizations, and local community centers, and others.

The Mason Square and Six Corners area served by GTC is composed of five distinct neighborhoods within the city's urban core: McKnight, Bay, Upper Hill, Old Hill, and Six Corners. It is a racially diverse, majority Black and Latino

---

See Hanna Garth's "The Violence of Racial Capitalism and South Los Angeles's Obesity 'Epidemic' (2020) in *American Anthropologist,* 122(3), 653–654. https://doi.org/10.1111/aman.13444.

community of around 27,000 with high poverty rates (Springfield Planning and Economic Development, 2019), and is identified by the Climate and Economic Justice Screening Tool (CEJST) as having high environmental health and socioeconomic burdens (Council on Environmental Quality, n.d.).

GTC got started by turning trash-filled vacant lots into thriving sites of youth-led urban agriculture. Over the years it was repeatedly forced to abandon gardens and start over in new lots when the city or private owner's needs for the property changed (I. Ali, personal communication, January 11, 2024; E. O'Gilvie, personal communication, January 15, 2024; Paine, 2005; Roman, 2016). To provide more stability and support for community gardens, GTC drafted and advanced a community garden ordinance, which passed in 2012. It commits the city to grant approved gardens on city-owned land five-year licenses after a one-year trial period. The city is also bound to provide free city compost on request and waive sewer fees. It is allowed to withdraw from license agreements to pursue development opportunities, while helping garden groups find alternative sites (Amending Title 7, Chapter 7.70 of the Revised Ordinances of the City of Springfield, 1986, As Amended, by Inserting a New Chapter 7.70 - Community Gardens, 2012).

Despite this ordinance, GTC saw the need to purchase its own land for a permanent farm. The current director, then a board member, approached the city planner about buying a city-owned lot. The city planner wrote a request for

proposals for sale of the property which stated the city's preference that it be used for agricultural purposes. (I. Ali, personal communication, January 11, 2024; E. O'Gilvie, personal communication, January 15, 2024). In 2012, the city deeded the property to GTC for $2,500 ("Hampden, Hampshire & Franklin Deeds," 2014).

This gave GTC a permanent farm and base of operations, allowing it to install infrastructure, such as a greenhouse, and a farm store, perennial plantings, and nature-based solutions such as raingardens for stormwater management (I. Ali, personal communication, January 11, 2024; "Gardening The Community Urban Farm --- Springfield, MA," n.d.; E. O'Gilvie, personal communication, January 15, 2024). The organization continued its focus on youth-run urban agriculture and operates two other community garden sites on licensed land. The current director aims to permanently protect the land through a land trust arrangement. In addition, she is working on an urban farming ordinance to strengthen the city's commitment to urban agriculture. She also believes that the city should develop a long-range agricultural plan (E. O'Gilvie, personal communication, January 15, 2024).

Regenerative practices

Since its founding, GTC has used organic growing methods, although it does not seek organic certification. As previously mentioned, it features nature-based solutions and perennial plantings. In addition, GTC composts (using only

scraps from sustainably grown food) cover-crops, and rotates crops (E. O'Gilvie, personal communication, January 15, 2024). The organization's commitment providing affordable fresh produce to help combat the neighborhood's high rates of diet-related disease are tied to the way it grows its food (I. Ali, personal communication, January 11, 2024; E. O'Gilvie, personal communication, January 15, 2024). GTC's current director also spoke about how these practices push back against historic and current injustices:

> Our urban environmental health is crappy, and we recognize that communities of color and urban communities suffer disproportionately from climate change the impacts of climate change. And by growing in the way that we do, we're recapturing carbon or sequestering carbon and not contributing to the horror and chaos that mass production farming creates. So that's one reason. It's very good for our mental health. And it's how everybody farmed before farming became a corporate revenue source. So just restoring the for Black and Indigenous – or this land's first peoples – it's as much about restoring our relationship to the land as everything else (E. O'Gilvie, personal communication, January 15, 2024).

Underscoring this last point, interviewees also spoke about witnessing racism against immigrant farmers and farmers of color within the local farming community and of the history of land dispossession of Black farmers and other farmers of color (I. Ali, personal communication, January 11, 2024; E. O'Gilvie, personal communication, January 15, 2024).

A community of practice and influence

GTC trains its youth participants in organic and sustainable farming, and many return year after year (I. Ali, personal communication, January 11, 2024; E. O'Gilvie, personal communication, January 15, 2024). Among many other

activities, the organization has conducted numerous workshops on topics such as composting from kitchen scraps and milk crate gardens. Members have also been involved in helping to launch school and community gardens ("Briefs," 2018; "Gardening the Community Preps for Plant Sale," 2021; Lowney, 2019).

Elizabeth O'Gilvie, GTC's interim director, spoke about the profound effect the organization has had on her. "GTC is a dream I didn't know I had," she said (Roman, 2016). She was introduced to the program when youth participants knocked on her door as part of an awareness campaign. She soon joined the board and got "bit hard with the ag bug" (E. O'Gilvie, personal communication, January 15, 2024). To learn more about farming, she apprenticed herself to local farmers – "Old white men" (personal communication, January 15, 2024). She established a food forest in her back yard, has advocated for planting fruit crops on city property, and launched a farmers' market (Belmonte & Smith, 2023; E. O'Gilvie, personal communication, January 15, 2024).

Using her background in public policy, she became chair of the Springfield Food Policy Council, joined Massachusetts Food Systems Collaborative and was central to creating Springfield's community gardening ordinance, a farm-to-school program, and the Healthy Incentives Program (HIP) – a statewide program reimbursing SNAP recipients for purchases from participating farmers (Gardening the Community, n.d.; E. O'Gilvie, personal communication, January 15, 2024).

Climate change impacts

GTC has experienced impacts of climate change, including a more unpredictable growing season, hotter temperatures, and more pressure from pests. Despite sewer charges being waived, per the community garden ordinance, it had high city water costs during the drought of 2022. GTC had the greenhouse built partly as a hedge against climate volatility. The current director also pointed to locally grown food as an important source of food security during crises. This was demonstrated during the COVID-19 pandemic, when GTC was an important means for people who lacked transportation options to obtain fresh produce (E. O'Gilvie, personal communication, January 15, 2024).

Springfield's planning documents

In contrast to its previous Open Space and Recreation Plan (OSRP), which made no mention of community gardens or green infrastructure, Springfield's 2015-2022 Open Space and Recreation Plan (OSRP) plan highlights its partnership with Gardening the Community in establishing the food policy council and community gardening ordinance, as well as an ambitious tree-planting project. Among the plan's nine "key elements," it includes "Promote the maturation and continued growth of community gardens and urban agriculture" (City of Springfield, 2015, p. 4).

For environmental justice communities, it states the goals of "planting trees, reducing emissions, restoring water quality and public participation" (City

of Springfield, 2015, p. 8). Among its objectives, it contains two related to urban agriculture: (1) promoting healthier food options through farmers markets and community gardens, and (2) actively facilitating the growth of urban agriculture (City of Springfield, 2015, pp. 52–53). The plan also sets goals install rain gardens and use "organic turf management on city properties" (City of Springfield, 2015, p. 65). The 2022-2027 open space plan contains the same goals, and includes new ones promoting green infrastructure and climate-resilient design on city and private property (City of Springfield, 2022).

Springfield's climate action plan, *Strong, Healthy, and Just* (2017), promotes green infrastructure and nature-based solutions such as rain gardens, bioswales, and increasing the urban tree canopy – including planting fruit trees and shrubs. It refers to Springfield's urban agriculture as an area of strength (2017, p. 40), recommends "allowing urban agriculture in the zoning code" (2017, p. 38), and notes community gardens' role in climate adaptation:

> Additionally, community gardens can be considered a form of green infrastructure (especially those on vacant lots) as they reduce temperatures, infiltrate stormwater, build community cohesion, address local food insecurity, and get rid of impervious surface that worsens the urban heat island effect (City of Springfield, 2017, p. 21).

In 2022, the City of Springfield began work on development plans for neighborhoods that were disproportionately affected by the COVID-19 pandemic, which included all of the neighborhoods of Mason Square-Six Corners. Recommendations from residents included the following related to

urban agriculture (Figure 5), as well as calls for additional community gardens in the neighborhood (City of Springfield and Upper Hill Residents Council, 2024, p. 63)[11].

Housing

1. Create a Mason Square Community Land Trust
2. Hold land for Housing and Urban Ag.
    a. Concerns RE: Gardening The Community lands along Walnut Street.
3. Activate Springfield Land Trust
4. Create a Community Benefits District for the MCDI land to be owned by the trust and farmed by residents.

Figure 5: Recommendations from residents for McKnight Neighborhood Plan. (Pioneer Valley Planning Commission, 2024)

Appendices include handouts about creating an Agricultural Zoning Overlay District, urban orchards, and urban food forests (City of Springfield and Upper Hill Residents Council, 2024).

Analysis

GTC was a catalyst spurring the City of Springfield to recognize the importance of urban agriculture to community health, quality of life, and climate resilience. Since GTC's inception, and in large part due to its advocacy, the city evolved from devaluing community gardens in relation to other kinds of

[11] The Mason Square/Six Corners area was engaged as a whole in the planning process; therefore, the recommendations from participants and the appendices in the Old Hill, Upper Hill, McKnight, Bay, and Maple High/Six Corners are the same.

development to elevating urban agriculture as a key element of its climate action, open space, and neighborhood development plans.

There are several lessons that can be drawn from this case study about how cities can encourage the growth of regenerative urban agricultural projects as nature-based solutions with multiple benefits to community resilience.

1. *Community farms and gardens are important for knowledge creation, transmission, and spread of regenerative and sustainable farming practices.* Urban community farms and gardens are resident-driven enterprises working at the intersection of multiple issues. GTC teaches youth regenerative farming techniques and other skills. It has been a hub of inspiration and knowledge whose participants have become catalysts for policy change supporting wider implementation of sustainable urban agriculture.
2. *Municipal policies and goals are important to enabling and prioritizing regenerative urban agriculture.* The community gardening ordinance was an important step in building legitimacy for community gardening as a community asset and creating a more supportive and predictable environment for community gardens. An urban farming ordinance, such those in Boston and several other Massachusetts municipalities would go yet further (Article 89: Urban Farms, City of Boston Zoning Code, 2013; E. O'Gilvie, personal communication, January 15, 2024).

3. *Municipalities can help organizations gain long-term access to land.* The City of Springfield established minimum five-year licenses for community gardens and helped GTC purchase city land for its farm.
4. *Partnerships between community-based groups and regional non-profits can be fruitful.* GTC began as a project of Mason Square community members and the Northeast Organic Farming Association, a regional organization that promotes organic farming. There is now interest in creating a land trust to permanently protect GTC's farm, and a combined housing-farming land trust has been discussed in neighborhood planning. Land trusts and regional agricultural organizations can bring resources to the community, provide technical support, and help secure land ownership.

5.5 Hadley, Sunderland, and Deerfield, Massachusetts

Enterprise studied: Atlas Farm

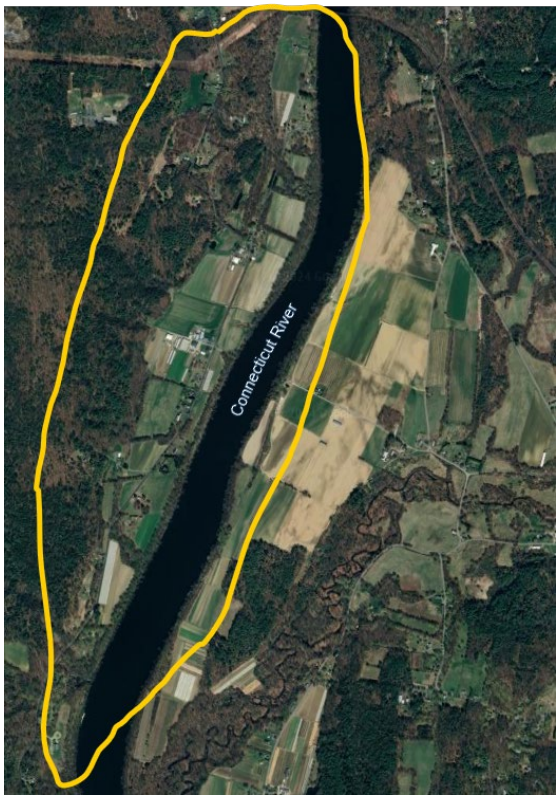

Figure 6: Atlas Farm headquarters, Deerfield, Mass. (Google Earth, n.d.)

Background

Atlas Farm (Figure 6) is a commercial farm growing certified organic, diversified crops year-round, primarily for wholesale. Headquartered in Deerfield, Massachusetts, it farms there and in nearby South Deerfield, Sunderland, and Hadley, occupying a total of 120 acres. When owner Gideon Porth started his farm in 2004, he aspired to "connect people more closely to their food sources, and to be part of the vanguard of sustainable agriculture" (Atlas Farm, n.d.-b). Porth also believes that local food will prove to be more sustainable as climate change progresses, because of the greater commitment of

local farmers to their region and the shorter distances food needs to travel from farm to consumer.

Porth began farming on 2.5 acres he leased in Montague, Massachusetts, later expanding to leased land in Deerfield. The farm now operates on a variety of owned and rented parcels with various lease arrangements. It has 11 year-round employees and about 50 seasonal employees (Atlas Farm, n.d.-b; G. Porth, personal communication, January 30, 2024).

Porth described the effort to gain access to land as a major challenge for beginning farmers. He found the initial parcel through an online tool that helps farmers connect with landowners with land to lease or sell. Since then, his lease agreements and land purchases have largely come through local networks. His first purchase of land was from a neighbor who never listed their property. The first two properties he purchased were enrolled in Massachusetts' Agricultural Preservation Restriction (APR) program,[12] which helped make the land affordable. He now farms on a variety of owned and leased parcels, the latter with varying lease lengths (G. Porth, personal communication, January 30, 2024).

Length of tenure on a parcel makes a difference in the Porth's choices in how to use the land – including investments in irrigation and regenerative practices such as cover-cropping and allowing fields to lie fallow:

[12] See the Agricultural Preservation Restriction (APR) program (MDAR, n.d.).

> ...[On] land that I own where we'll plan to farm for decades to come, it's very advantageous for us to rest a piece of land and do some soil building for a year where you forfeit crop value, you know you're building your soil asset there. [If] it's a year-to-year or even a couple of year out outlook, it's harder to make those calls (G. Porth, personal communication, January 30, 2024).

Regenerative practices

Atlas Farm employs a number of regenerative practices. These include cover-cropping, crop rotations, and natural soil amendments. Since 2022, it has been participating in the Massachusetts Coordinated Soil Health Program to conduct experiments in soil health and carbon sequestration practices, such as reduced tillage and using various cover crops as living mulch. To help facilitate this, the farm has rented reduced tillage planting equipment, which would otherwise be an expensive investment, from area Conservation Districts. Porth also takes part in a farmer peer-learning group as part of the grant project (Atlas Farm, n.d.-a; Hampden Hampshire Conservation District, 2023; G. Porth, personal communication, January 30, 2024).

Climate change impacts

More extreme and unpredictable weather is the climate change impact most keenly felt by Atlas Farm. Less predictability about when high and low temperatures will occur makes it difficult to plan crops and planting times. Using hoop houses and high tunnels has helped to buffer these extremes. Precipitation is another issue. Porth states that high-quality, well-drained soil is needed to manage both dry and wet conditions; the farm is adding irrigation for drought

resilience. In general, Atlas Farm draws water from the Connecticut River. During dry spells, it has used Deerfield town water. Wet conditions have made it harder for his farmworkers to work in the fields. Atlas Farm also produces much of its own energy through photovoltaics and using biomass for heat; it aims to become 100% energy self-sufficient in 2024. (Atlas Farm, n.d.-a; G. Porth, personal communication, January 30, 2024).

Hadley, Sunderland, and Deerfield planning documents

Deerfield, Hadley, and Sunderland are small (pop. 3,663 – 5,325), majority-white communities. Deerfield and Hadley are affluent; Sunderland is less so, with a poverty rate of 18.8%. While all three towns have strong agricultural sectors and significant land in farms, their planning documents vary greatly in their strategies for climate resiliency and the conceptualization of regenerative agricultural practices as nature-based solutions.

Hadley

The Town of Hadley conducted a Climate Change and Natural Hazard Vulnerability Assessment as part of the Municipal Vulnerability Preparedness (MVP) program in 2020. The report on this assessment, the *Town of Hadley's Community Resilience Draft Summary of Findings,* notes that the MVP program can fund priority action projects for "nature-based solutions for flood protection, drought mitigation, and water quality improvements," as well as for "extreme heat and poor air quality." Participants in MVP workshops identified flooding,

severe storms, and drought as the top hazards confronting Hadley, and identified agriculture as a sector especially vulnerable to drought. The plan notes that agricultural areas often lie in floodplains. However, the report does not propose nature-based solutions as interventions to protect agriculture from these hazards (Town of Hadley, 2020).

In the area of "Air Quality/Dust Issues," the report states that "farmers commonly do not implement cover crops on fallow fields," but does not link this practice to any other environmental issues. It recommends a public education campaign to promote cover cropping. The report also recommends encouraging green infrastructure to reduce algal blooms in a lake, but does not connect this goal to agricultural practices (Town of Hadley, 2020). The town's 2014 Open Space and Recreation Plan (OSRP) contains several actions to promote farmland preservation and sets goals improved irrigation systems on farms (Town of Hadley, 2014).

While Hadley's planning documents reflect limited connections between climate, the environment, and farming practices, Hadley's Climate Change Committee is holding roundtable discussions with farmers on climate change impacts and adaptation (Merzbach, 2024)

Sunderland

Recognition of the intersection of farming and nature-based climate and environmental solutions has undergone a rapid evolution in Sunderland's recent

planning documents; however, concrete goal-setting to promote regenerative practices remains rudimentary. Its 2020 *MVP Resiliency Plan* remarks on the importance of the town's small farms. It notes many of its farms lie in floodplains and are vulnerable to extreme weather, drought, and flooding, and that some farmers have "[lost] arable land because their fields have become too wet (Town of Sunderland, 2020, p. 9). The plan sets a goal to help farmers identify and find funding for "climate resiliency options to protect crops and farm fields," but does not propose any specific nature-based solutions, nor does it characterize farms as potential sources of climate resiliency for the town (Town of Sunderland, 2020). The town's *Hazard Mitigation Plan* (HMP) further articulates climate hazards to farms. The HMP contains a page describing nature-based solutions and commitment to including them in open space and MVP plans, but does not connect nature-based solutions to agriculture (Town of Sunderland, 2021).

Sunderland's Open Space and Recreation Plan (OSRP) articulates a clear connection between farms, farming practices, and climate resilience:

> While farms in town are feeling the effects of climate change on their operations, farmland in Sunderland also plays an important role in mitigating climate change impacts. On-farm conservation practices and improved agricultural practices can increase resiliency to climate change and help mitigate impacts to wildlife, water quality, and other natural resources (Town of Sunderland, 2022, p. 64).

It goes on to mention resources such as the National Resource Conservation Service (NRCS) and the Massachusetts Coordinated Soil Health Program to help

farmers adopt conservation and carbon sequestration practices. The document's 7-Year Action Plan contains several goals to promote farmland preservation. However, it only contains one regarding farming practices: "Promote water conservation practices and healthy soil practices on farms in town" (Town of Sunderland, 2022, p. 131)

Deerfield

As part of a 2022 MVP Implementation Project grant, The Town of Deerfield commissioned the *Deerfield Healthy Soils Report*, conducted by the Regenerative Design Group and Conservation Works – work that won a Sustainability award from the Massachusetts American Planning Association. A member of the Deerfield selectboard, who also is the chair of the Franklin Conservation District and a member of the state working group for the Healthy Soils Action Plan, said that the study "was a step toward other towns in the state conducting similar projects" (Larabee, 2023).

The report studied the location, land-use type, and quality of Deerfield's soils and made recommendations for conservation and restoration, as measured by soil organic carbon, for forest, wetland, agricultural, and turf soils. It includes a section titled "Aligning Land Use Regulations with Soil Health." An appendix features a series of model by-laws: Creative Development; Transfer of Development Rights; Wetlands Protection; a Forest Protection Overlay District; and Significant Trees (Regenerative Design Group & Conservation Works, 2022).

The by-laws concerning agriculture mainly focus on farmland preservation; none speak to on-farm soil management. (Agriculture is exempt from certain proposed by-laws regarding wetlands and site plan reviews (Town of Deerfield, n.d.).) "Strategies," however, include "Incentives for farmers to re-forest riparian corridors" (Regenerative Design Group & Conservation Works, 2022, p. 28).

In contrast, narrative sections of the report contain a wealth of information and recommendations regarding soil health management on farms and examples of initial outreach to involve farmers and other sectors of the community. Regenerative Design Group and Conservation Works conducted several events to share the soil assessment with farmers, large landowners, teachers, students, and town committee members. The Deerfield Climate Change and Energy Committee was identified as the body that would be responsible for implementing the town's soil health initiatives. The consultants engaged teachers and students from the local public high school in in a day of hands-on soil health assessments, and partnered with the local community access television studio to create a video explaining the links between soil health, climate change, and regenerative farming and forestry practices (FCATMedia, 2022; Regenerative Design Group & Conservation Works, 2022).

They conducted outreach to farmers to identify "farmer to farmer soil health mentors" and "ways the Town of Deerfield might support its farmers to

become exceptional soil stewards." They found that farmers consistently "reported requiring longterm financial and technical assistance to adopt soil-smart practices more readily." Several farms, including Atlas Farm, were reported to be participating in the Massachusetts Coordinated Soil Health Program (Regenerative Design Group & Conservation Works, 2022, pp. 5–6).

The soil assessment found that agricultural lands tended to have lower predicted soil organic carbon (SOC) than forest or wetlands but have "High Soil Carbon Regeneration Value." This means that the SOC storage potential is high "if stewarded using smart soil practices" (Regenerative Design Group & Conservation Works, 2022, p. 14). It recommends several approaches promoted by the USDA's National Resource Conservation Service (NRCS) to maximize living roots, soil cover, and biodiversity, while minimizing soil disturbance (p. 21). The most accessible practices with the greatest impact for Deerfield are low/no-till methods on croplands, intensive pasture management, and "hay production that builds organic matter" through biannual grazing and higher cuttings (Regenerative Design Group & Conservation Works, 2022, p. 23). It also recommends protecting flood-prone areas from erosion through wetland restoration and reforesting riparian buffers. Most of these changes require some combination of increased labor, significant equipment costs, and temporary or permanent losses in productivity. The report recommends connecting farmers with funding for these costs, such as through NRCS agricultural conservation

grants and incentive programs, the New England Forests and Rivers Fund, state funding for soil health, and grants from conservation NGOs (Regenerative Design Group & Conservation Works, 2022, pp. 21–23).

Deerfield's Open Space and Recreation Plan (OSRP) 2023-2030 provides an overview of the *Healthy Soils Assessment;* however, it does not contain any recommendations for soil management on farmland. Its Seven-Year Action Plan includes an action step to work with owners of land bordering a specific brook to create "natural buffer strips" (Deerfield Open Space & Recreation Committee, 2023, pp. 137–138). The narrative also notes the recommendation from a 2018 report, *Ecological Resiliency in Deerfield*, "to install and manage riparian buffers and expand floodplain forests along the Deerfield River" (Deerfield Open Space & Recreation Committee, 2023, p. 67). Deerfield adopted a number of Green Infrastructure and Climate Resiliency by-laws in 2020, which appear to be connected with this report.

Analysis

Atlas Farm is a successful commercial farm employing regenerative practices in three municipalities with significant agricultural sectors. The founder was motivated to employ organic production methods and other sustainability practices based on personal values of environmental sustainability and connection to the land. He reports little interaction with towns whether in terms of barriers to or assistance with regenerative practices (G. Porth, personal

communication, January 30, 2024). Although he has been farming organically since the farm's founding, recently he has been experimenting with regenerative methods funded by a state grant program coordinated by a non-profit organization. Access to rental of specialized no-till equipment through a local Conservation District has helped make this possible.

The Town of Deerfield included a soil health initiative as part of its MVP grant. The town commissioned a soil health assessment as the basis for this initiative. The study conducted significant community engagement regarding regenerative agriculture and produced several model by-laws for consideration by the town, though none of the by-laws specifically focused on regenerative agriculture.[13]

Deerfield's OSRP, while it references the MVP's healthy soils study, does not include any actions related to farmland soil health. Sunderland's OSRP contains an action to "promote healthy soil practices on farms." The Town of Hadley's MVP connected the lack of cover-cropping to air quality issues, but otherwise does not address regenerative agricultural practices; roundtable farmer discussions of climate impacts, however, are underway.

From this case study, several lessons can be drawn.

[13] None of the new by-laws appear to have been adopted, although a set of by-laws on Green Development Performance Standards, focused on green infrastructure, were adopted in 2021 (Deerfield Site Plan Review with Green Development Performance Standards, 2021; Town of Deerfield, n.d.)

1. *Farmers' connections to other farmers are a significant resource.* This is evidenced in Porth's ability to acquire access to farmland by virtue of community connections, and his participation in the healthy soils peer learning group.
2. *Municipal Vulnerability Plans can be used to assess, conduct outreach, and craft town policy addressing climate impacts, agriculture, and soil health practices.* Although they have not been enacted, the *Deerfield Healthy Soils Report's* model by-laws serve as an example by which town policy can be influenced to support regenerative practices (albeit no by-laws addressed regenerative agriculture).
3. *Open Space and Recreation Plans (OSRPs) are a place where nature-based solutions and agriculture intersect.* While current plans show modest steps toward addressing regenerative practices on farms, OSRPs are a potential place for action.
4. *Flood plains and riparian buffers are a place where farmers' and towns' interests intersect.* Both farms and the towns in which they reside are facing increasing damage from floods, mass erosion events, and a rising water table (FCATMedia, 2022; Larabee, 2023). Restoring riparian forest and stabilizing flood zones with perennial plantings are key to mitigating these harms, but these actions reduce the arable land available to farmers. Municipal outreach to farmers to connect them with technical assistance and funding would be advantageous to both farmers and municipalities.

5. *Connections to regional planning bodies, agencies, state commissions, firms, and NGOs make a difference in knowledge transmission and priority-setting*. In several instances, farmers or towns received crucial information, planning assistance, technical support, funding to help assess, set goals for, or implement actions related to regenerative farming practices from regional or state-level entities.
6. *Town governments can conduct significant public outreach and education on regenerative farming practices.* Funding and support can come from MVP or other climate-related programs. Outreach can include information gathering from farmers. Education can include programs in local schools, farmer-to-farmer mentorships, and digital media created by local media access resources.
7. *Farmers need substantial financial and technical assistance to aid with experimentation and transition to more regenerative practices.* Municipalities can play an important role in reaching out to farmers and connecting them with resources, such as Conservation District equipment rentals and technical assistance, NRCS grant and incentive programs, state funding, Extension services, and NGO grants and technical assistance.
8. *Length of land tenure is important.* Atlas Farm's owner reported reluctance to make trade-offs for longer-term gains from regenerative practices on parcels with shorter leases.

CHAPTER 6

DISCUSSION

6.1 The farmers

The farmers and members of farming organizations interviewed for this thesis were motivated to engage in regenerative farming practices for a variety of reasons, including strengthening community food security in the era of climate change, being good environmental stewards, pushing back against environmental racism, and reconnecting with ancestral ways of farming. All sites foster experiments in regenerative farming techniques and spread knowledge beyond their farms. Through youth- and tenant-farmer trainings and activities, and through participation in a regenerative farming peer learning group, Gardening the Community, Grow Food Northampton, and Atlas Farm all participate in *communities of practice.* The Marin County, Grow Food Northampton, and Gardening the Community case studies also show the influence of farmers and community farming organizations on shaping municipal plans and policies.

6.2 Climate change impacts

When asked about climate change impacts, farmers and food system planners interviewed frequently mentioned more variable and extreme precipitation, leading to both floods and droughts. This has led to increased expenditures on water infrastructure or city water, and at times to major crop

losses. It has caused mass erosion events in riverine areas. Interviewees also consistently discussed more extreme and unpredictable temperatures, leading to greater difficulty in planning crop types and the timing of planting. One mentioned increased pest pressure.

6.3 Municipal plans

Marin County's comprehensive and climate action plans show well-articulated connections between agricultural practices and their functions as nature-based solutions, whether for carbon sequestration or ecosystem services. While the Massachusetts plans and ordinances studied made sporadic connections between regenerative farming practices and nature-based solutions – sometimes using the term *green infrastructure* – the emphasis on them ranges from nominal to significant, depending on the community. Some municipalities, however, had provided support to sustainable agricultural endeavors or had goals or policies that could function to support regenerative practices.

6.4 Findings

The case studies, food system planner interviews, and literature review help answer this study's three research questions:

- What are barriers to farmers' adopting or maintaining regenerative farming practices?
- How have local governments sought to encourage regenerative agricultural practices?

- What can we learn from urban, suburban, and rural farmers about the potential role of municipalities in encouraging regenerative farming?

Findings are described below.

Barriers

Major barriers to adoption of regenerative practices found in this research were (a) lack of long-term access to land, (b) financial risk, and (c) lack of skills and knowledge.

(a) *Long-term land access.* The *Healthy Soils Action Plan* and the Marin County case study indicate that regenerative practices take time to improve soil health. The Gardening the Community and Atlas Farm case studies show that long-term access to land encourages investments in regenerative practices. Owning land or having long-term or rolling leases and licenses allows farmers to make investments in regenerative practices.

(b) *Financial risks.* Interviews with food system planners and reviewed documents (Cole, 2022; Regenerative Design Group & Conservation Works, 2022) indicate that financial risk is a major barrier to changing practices. Adopting new planting methods, new or more diversified crop types, adding cover crops, or reforesting riparian buffers require time and resources and involve risk. Some changes may lead to a temporary or permanent reduction in harvest; others may involve trade-offs or changes in the timing of planting and harvesting. Farmers often have made

investments in equipment and supplies that can tie them to past practices. New practices also often require expensive new equipment, new supplies, additional labor, and may include a period of trial and error. Some nature-based solutions, such as extending riparian buffers or retreating from water-logged and flood-prone fields, mean losses of revenue from crops previously grown in those locations. Financial support would allow farmers to purchase or rent needed equipment, hire additional help, and weather periods of reduced income associated with transitioning to new practices. Atlas Farm and Grow Food Northampton received grants for regenerative practices and nature-based solutions for farm resilience. Nature-based solutions that also provide food crops, such as fruit and nut trees and bushes could help offset losses; the experimental paw-paw plot in Grow Food Northampton provides an example.

(c) *Skills and knowledge.* Food system planner interviews indicated that farmers may not be aware of new practices or the funding and technical support available to help facilitate their adoption. Engaging in new practices requires avenues for acquiring knowledge and a ramp-up period as they learn and implement new skills. They may be reluctant to spend considerable time and money on practices they are unfamiliar with or of which the value appears unproven. Information from agricultural agencies and nonprofits is important. The present study points strongly to the efficacy of peer learning, particularly in the form of informal or formal

communities of practice, for successful promulgation and adoption of new farming practices. Atlas Farm participates in a regenerative farming peer learning group; Gardening the Community and Grow Food Northampton provide training and ongoing communities of practice for their youth and tenant farmers.

Actions taken by local governments

The actions municipalities have taken to promote regenerative agriculture fall into five categories, listed below, with the associated municipalities. Table 1 (p. 122) gives a summary of these actions.

1. Included regenerative farming practices in municipal plans: Hadley, Northampton, and Sunderland.
2. Used Municipal Vulnerability Preparedness (MVP) grants, Community Preservation Act (CPA) funds, or municipal funds: Deerfield, Northampton.
3. Required regenerative practices on city-licensed farms: Northampton.
4. Made city/town lands available for sustainable agriculture: Northampton.
5. Supported community-based farms and gardens: Northampton, Springfield.

Table 1: Municipal actions supporting regenerative and sustainable agriculture.

Municipality	**Actions** *Code: [A]=Specifies regenerative agriculture; [B]=Supports regenerative agriculture; [C]=Could incorporate regenerative agriculture*
Deerfield	• MVP grant: *Healthy Soils Report* (completed); includes recommendations for regenerative farming practices [A] • OSRP goal: Restore riparian buffers and floodplain forests – no reference to agriculture [C]
Hadley	• MVP goal: Public education on cover crops [A] • Climate change committee runs farmer forums (not currently a plan element) [B]
Sunderland	• MVP goal: Help farmers find funding for climate resiliency [B] • OSRP goal: Promote healthy soil practices on farms [A]
Northampton	• Resilience & Regeneration Plan: Vision: Support training in regenerative agriculture; create vocational high school program to plant perennial crops in floodplains [A] • CPA funds used to help establish and expand GFN (completed) [B] • Licenses of city farmland require organic or regenerative practices (in progress) [A]
Springfield	• Helped GTC acquire city land at low cost (completed) [B] • Community gardening ordinance – licenses must be 5 years (in progress) [B] • Established Springfield Food Policy Council (in progress) [B] • OSRP goals: Actively support community gardens and urban agriculture [B] • Climate action plan: Recommends zoning for urban agriculture [B]; recommends planting fruit trees and shrubs [C]; considers community gardens to be vital green infrastructure [B] • Neighborhood plans: Call for expanded urban agriculture [B]

Springfield and Northampton both assisted community-based organic farming organizations with the purchase of land. Springfield has a community gardening ordinance that supports the licensing of city land for community gardens; after the first year, these leases are set for five years, which provides time for regenerative practices to mature. Springfield's climate action plan

describes community gardens as a form of green infrastructure and promotes planting fruit trees as part of its city greening efforts; both of these are compatible with regenerative agriculture approaches.

Northampton's comprehensive plan promotes regenerative farming practices as a climate resilience strategy through a number of actions, including working to align city "policy and systems" to promote regenerative farming practices (Northampton Planning Board, 2021). Northampton also requires organic or regenerative practices on the farm parcels it licenses.

Deerfield used a Municipal Vulnerability Preparedness (MVP) grant to commission a healthy soils study, which identified opportunities and barriers to farmers' adoption of regenerative practices; however, the model by-laws for healthy soils the study produced contained just one agriculturally specific strategy. Deerfield's Open Space and Recreation Plan (OSRP) includes restoring floodplain forests and riparian buffers. While it does not mention agriculture, this could potentially include farm-based interventions.

Sunderland's OSRP recognizes farms' vulnerability to climate change and includes an action step to connect farmers to resources to improving climate resiliency through regenerative farming practices.

Hadley's MVP and OSRP make few connections between agricultural practices and climate and environmental resilience; cover cropping education to

reduce dust from farms is included in the MVP. The town's Climate Change Committee, however, has engaged farmers in dialogue about climate adaptation.

Lessons from farmers: Potential roles for municipalities

Case studies and interviews with food system planners indicated four thematic areas that describe leverage points for municipalities in forwarding regenerative agricultural practices (Figure 7). Table 2 (p. 125) shows where they appear in the research.

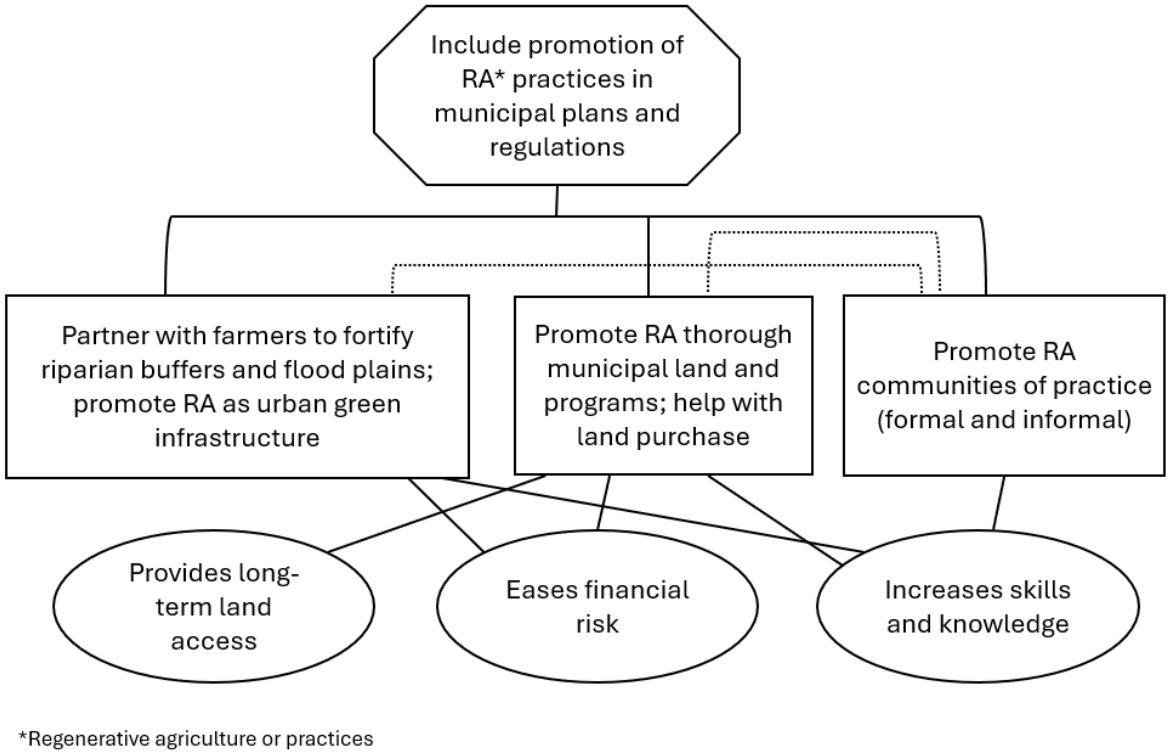

Figure 7: Thematic areas for action and the barriers they address.

Table 2: Thematic areas and associated sources.

Element	Sources
Promote RA communities of practice (formal and informal)	Gardening the Community, Atlas Farm, Grow Food Northampton, Town of Deerfield, Marin County, Town of Hadley, food system planners
Promote RA in municipal plans and regulations	City of Northampton, Town of Deerfield, Marin County, food system planners, literature review
Promote RA through municipal land and programs; help with land purchase	Gardening the Community, Grow Food Northampton, Marin Couty, food system planners, literature review
Partner with farmers to fortify riparian buffers and flood plains; promote RA as urban green infrastructure	City of Northampton, Town of Deerfield, Town of Sunderland, Town of Hadley, City of Springfield, Marin County, food system planners, literature review

Foundational among the themes is *including promotion of regenerative farming practices in municipal plans and regulations*. This is important for mobilizing municipal resources, securing partnerships, and setting the stage for tapping into available funding, such as from the Community Protection Act (CPA), Division of Conservation Services, Municipal Vulnerability Plan (MVP), Massachusetts Department of Agricultural Resources (MDAR), and a variety of federal food system and climate change grant programs. Although it is not a prerequisite for taking action in the other thematic areas, it can situate those actions into an integrated, long-term plan, set concrete goals and benchmarks, help secure funding, and commit municipal resources to them. Municipalities

may also review by-laws, zoning ordinances, and town permitting processes to remove barriers to and create incentive for regenerative agricultural practices.

Partnering with farmers to fortify riparian buffers and flood plains and promoting regenerative agriculture as urban green infrastructure builds upon the most salient areas in which municipalities' and farmers' interests in regenerative practices as nature-based solutions intersect. Much farmland is located alongside rivers and creeks and in flood plains. Farmers have an interest in protecting their crops and topsoil. Municipalities rely on the actions of farmers to stabilize and protect these areas. Urban agriculture is a form of green infrastructure providing urban cooling and other social, health, and environmental benefits. Gardening the Community and others engaging in regenerative practice have installed perennials and natural stormwater features as part of their design. The differential impact of regenerative agriculture as green infrastructure compared to urban farms that do not use these practices merits further investigation. Riparian buffers, flood plains, and urban green infrastructure. In all settings, regenerative practices promise to increase soil organic carbon, sequestering carbon and improving soil health.

Promoting regenerative agricultural practices through municipal land and programs and helping regenerative practitioners with land purchases are ways that municipalities can have direct influence. As seen in Northampton's example, municipalities can make land available for farming through licensing and leasing

and can set terms regarding farming practices. As emphasized earlier, long or rolling leases and licenses are preferred for regenerative agriculture. City-run community gardening programs described in the literature review also set terms for growing practices. Municipalities can also partner with community farms and gardens to assist with land purchases in a variety of ways, as seen in the examples from Gardening the Community and Grow Food Northampton.

Promoting regenerative agriculture communities of practice is an important way that municipalities can encourage their spread and adoption. Communities of practice, defined as "sustained learning partnerships among people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wegner-Traynor & Wegner-Traynor, 2021), showed up in this research as a consistent theme. Gardening the Community and Grow Food Northampton serve as hubs where community members engaged in shared learning, where youth participants or tenant farmers received training and engaged in the ongoing work of farming in community with others. These organizations also conduct community workshops, further spreading these skills and knowledge. The Gardening in the Community case study demonstrated how activism can emerge from such groups, creating systemic change. Atlas Farm also engages in a community of practice in trialing regenerative practices. Farmers are constantly experimenting with approaches to raising successful crops under changing local conditions. Through communities of practice, the

results of these experiments can be rapidly shared, amplified, adapted, and improved. Engaging high school students to learn about and practice soil health and regenerative farming practices has been tried and proposed by Deerfield and Northampton, respectively. Northampton's proposal to deploy students to stabilize flood plains through agroforestry is an example of how these thematic areas can intersect.

Other key actions for municipalities

The Marin County case study, literature review, and several municipal examples showed the importance of planners and other municipal entities as conveners. Municipal planners can forge partnerships among diverse stakeholders, bringing together resources and cross-collaborations. A municipal example of this is the Springfield Food Policy Council. In doing so, it is important that planners understand and tap into existing networks and their existing plans and partnerships – and seek to build on these rather than needlessly duplicate them. Municipalities can also serve as conduits to resources and information, such as grants, equipment rentals, and technical assistance, for farmers and community farming and gardening groups. A municipal point person and webpage offering information, as shown in Marin County's example, could be considered.

CHAPTER 7

CONCLUSION

The municipalities studied had significant agricultural areas vulnerable to environmental hazards, placing both farms and the community's environment at risk, as well as agricultural projects providing significant green infrastructure. Yet despite the recognition of the link between farming practices and nature-based solutions in international and federal planning, a review of municipal plans suggests that Massachusetts cities and towns still view agriculture and nature-based solutions as separate. Goals to address local hazards through green infrastructure and goals concerning agriculture are often scattered throughout various municipal plans, such as OSRPs and MVPs, and lack a coordinated approach. Where language concerning regenerative farming practices as nature-based solutions appears, it is often not connected with action steps and commitments.

Case study farms, municipal documents, and the literature review indicate spheres in which municipalities have direct control. These include municipally owned land on which towns and cities can set the terms of licenses to farmers; municipally run community gardens and farms, for which a regenerative approach can be mandated; and green infrastructure installed by the city which can incorporate food crop trees and bushes. Municipalities can also facilitate the acquisition of land by organizations focused on sustainable or

regenerative farming, whether through sales of city land or partnerships with nonprofits and land trusts.

Influencing practices on private, commercial farms is more complicated for municipalities, and therefore more rarely seen in the municipal plans and case studies in this paper. Such farms are often eligible for federal, state, and nonprofit funding and technical assistance for transitioning to regenerative practices. In spite of these resources, regenerative practices are not widely practiced on Massachusetts farms. Particularly in communities with large or sensitive areas in agricultural use, such as river-adjacent land and flood plains, farms represent significant areas of vulnerability to climate change hazards – as well as significant potential for carbon sequestration and adaptive ecosystem services.

These shared vulnerabilities provide a priority focus for municipalities in relation to farms. Municipalities can have a productive role by conducting outreach to farmers to work with them on strengthening their farms' resilience. This can include making plans and timelines with farmers; connecting them to federal, state, and private financial and technical resources such as grants, access to equipment, expertise, and learning cohorts; and forging partnerships with educational, workforce development, or conservation groups to assist farmers with planting.

Municipal action to strengthen floodplain and riparian zone resilience is urgent as flooding becomes more common and river-adjacent lands become more waterlogged. Such actions will require partnerships with the farmers who own and work the land, and coordination among different municipal bodies, including agricultural commissions, departments of public works, and, if the municipality has them, offices of climate change and resilience. The Massachusetts Wetland Protection Act gives agricultural activities a fair amount of latitude (310 CMR 10.00: Wetlands Protection, n.d.); the role of conservation commissions in interfacing with farmers regarding activities in these zones was not explored in this research and merits further investigation.

Municipalities' potential actions to encourage regenerative practices would be aided by creating long-range community-wide plans for climate-resilient agriculture. Such plans would recognize the importance of local agriculture, both commercial and community-based, in many dimensions of community resiliency, including food security, community connectedness, local character, flood protection, and ecosystem services. Thus, efforts to increase the resilience of this sector through regenerative farming practices and to increase the resilience of the community's natural environment through this sector's nature-based services, would be aligned. These plans would also include commitments to agricultural land preservation, expanded urban agriculture, and farm licenses on municipally owned land.

Climate-resilient agriculture should be an element of municipal climate action plans. To create and implement such a plan would require the participation of diverse stakeholders, including farmers; community gardening and community farm organizations; relevant municipal offices, departments, and commissions; high schools and workforce development programs; agricultural, environmental, and conservation NGOs; food security, food justice, and Indigenous Land Back advocates; and institutions and agencies such as university extension services and conservation districts. Any existing entities or networks, such as local and regional food policy councils, may already include several of these stakeholders – and have existing priorities and recommendations to be incorporated into plans for climate-resilient agriculture. Other plans, such as OSRPs and comprehensive plans, should be updated to align with the climate-resilient agriculture plan, and the climate-resilient agriculture plan should be used to guide future plans and grant applications, such as MVPs and grants connected to the Inflation Reduction Act.

This thesis's research focused closely on specific actions municipalities can take. However, because of the interconnected nature of food systems, ecosystems, and economies, the ideal plan for agriculture would likely be a regional one. Food systems research has been done on the level of "food shed," which has been defined as a geographical area extending a certain number of "food miles" (the distance food must travel) from a population area (Kurtz et al.,

2020). Callahan's concept of planning on the level of bioregion – "Unique biogeographical areas sharing cultural, economic and historic characteristics, distinguished by interdependent and interconnected ecological resources" (Callahan, 1993, p. 3) – could be useful here. Bioregional planning, possibly organized at the level of watershed, could take into account the interconnected nature of the farms, communities, infrastructure, habitats, and water systems in a given region (Callahan, 1993).

In states with county governments, planning on the county level, as in the Marin County example, could be a fruitful path. In states which, like Massachusetts, lack county governments, regional planning is conducted by regional planning agencies and councils of government. These entities, however, have no power to enact any measures; any such actions ensuing from their plans must be carried out by their participating municipalities.

Even with this limitation, however, regional planning bodies are a logical locus for creating coherent regional plans that include land use, local food needs, resources, and linkages between urban and rural food producers and consumers, and which can convene member municipalities and diverse stakeholders. Food policy councils already bring together many of these constituencies; where they exist, planners should build upon their existing plans, networks, and expertise.

Engaging Conservation Districts as lead organizations for regional planning and implementation is worth consideration. Conservation Districts are

regional organizations charged, under state law, with developing and implementing plans, research, and education on "the conservation and development of natural resources," such as for erosion prevention and control, including "methods of cultivation, growing of vegetation, cropping programs, tillage practices, and changes in use of land…." (Division of Conservation Services, n.d.). They also are empowered to distribute funds and purchase and make available equipment to land-users to carry out these practices (Division of Conservation Services, n.d.). In Massachusetts, they report to the state's Division of Conservation Services and work in partnership with nonprofit organizations and federal and state agencies such as the USDA's Natural Resources Conservation Service (NRCS) and the state's Office of Energy and Environmental Affairs (EEA), Department of Environmental Protection (MassDEP), and Department of Agricultural Resources (MDAR) (MACD, n.d.).

7.1 Relevance and applicability of findings

This thesis' findings are generally applicable to the Northeast United States, and may also be applicable to the upper Midwest, which is facing similar climate change impacts (Janowiak et al., 2016). They would likely also be relevant to other regions of the United States that have smaller farms. Planning in Massachusetts is shaped by being a home-rule state without county governments; thus, this research could be particularly relevant to states with similar systems.

7.2 Limitations of research

This thesis had several limitations. The local case studies encompassed very different operations: Gardening the Community operates as a nonprofit food justice organization in the urban core of an industrial city, while Atlas Farm is a commercial farm with parcels in rural areas. (Interestingly, Grow Northampton shares features with Gardening the Community in terms of mission and community role, while sharing with Atlas Farm a more rural location and similar acreage). It was difficult to analyze and make general recommendations for such differently situated agricultural operations. In addition, a great deal of planning has been developed for urban agriculture. It was beyond the scope of the thesis to connect its findings to this body of work, but perhaps it can be a contribution toward it.

Another limitation was that only organic farms were included as case studies. They were chosen because they were engaged in regenerative practices. However, an investigation of conventional farms, both those that engage in regenerative practices, such as cover cropping and reduced tillage, and those that do not, would help further illuminate factors that frustrate or support their adoption.

It was easier in this in this research to understand how regenerative agricultural practices could serve as nature-based solutions in more rural settings, where farms border natural features such as forests and rivers, than in

city centers, where they exist within a highly built environment, with different environmental exposures and ecosystem connections. In urban contexts, it is clear that farms and community gardens serve as green infrastructure (Cabral et al., 2017). The impact of regenerative practices such as reduced tillage, residue mulching, and cover cropping in urban settings is less clear, and worthy of further research. Urban food forests, which add to urban tree canopy as well as produce food, may hold particular promise as nature-based solutions (Riolo, 2019).

Although the literature reviewed and some interviewees suggested payments to farmers for ecosystem credits or carbon credits, this thesis did not analyze the feasibility of these options for municipalities. Given the limited financial resources of many municipalities, advocacy to create state ecosystem services or carbon credit programs could be considered. The Vermont Farmers Ecosystem Stewardship Program is one example (Agency of Agriculture Food and Markets, n.d.).

In the course of this research issues of land access for Black, Indigenous, and other people of color and for immigrant and refugee groups frequently arose. Interviewees recounted experiences of racism against farmers of color in the studied communities. A local program connecting immigrant and refugee farmers played a role in one case study. The Indigenous Land Back movement (Nelson, 2024), efforts to restore land to Black farmers (Philpott, 2021), and

immigrant and refugee farming projects (All Farmers, 2022a; Massachusetts Department of Agricultural Resources (MDAR), 2023) all are important areas for further research in connection to regenerative agricultural practices.

7.3 Personal statement

As climate change intensifies, I believe that local communities and regions must mobilize to strengthen their capacity to withstand global and local stresses and shocks, which are already becoming stronger and more frequent. In my view, disruptions to local food supplies during the first year of the COVID-19 pandemic were a small preview of the disruptions that will likely ensue as the climate destabilizes. Currently, the beautiful and productive agricultural lands that contribute so much to the Northeast U.S.'s character are not enough to provide food security for the region's population if more distant supplies fail (Peters et al., 2023). In addition to the vital work of supporting and strengthening local farms, expanding home-based gardens, agroforestry, and a variety of innovative practices could help us grow food in new ways and in new places while preserving natural lands and habitat.

This is also important to relieving the environmental and human exploitation inherent to our global food system. Carried by fossil fuels, food comes to our stores from distant regions, stripped of its connections to the places and people that produced it. In the highly urbanized Northeast U.S., our consumption of this food is not just a matter of price and convenience – we are

utterly dependent on it. As William E. Reese put it, we are living on "appropriated carrying capacity" – oblivious to our food's ecological footprint and its consequences. The current abundance of imported food "makes people less averse to the risks associated with urban growth spreading over locally limited agricultural land" (Rees, 1992, pp. 122–126).

While municipal and regional plans increasingly address food security and farmland preservation, integration of local plans with a vision for increased regional food self-sufficiency is lacking. Planning and engagement to develop local agriculture is needed at all levels – and this agriculture must be built to be sustainable and beneficial to our region's ecosystems. This thesis is a small step toward that goal.

WORKS CITED

7 U.S. Code Chapter 94 – ORGANIC CERTIFICATION. (n.d.). LII / Legal Information Institute. https://www.law.cornell.edu/uscode/text/7/chapter-94

310 CMR 10.00: Wetlands Protection.

A timeline of Grow Food Northampton's history. (n.d.). Grow Food Northampton. https://www.growfoodnorthampton.org/history/

About. (2020). Marin Organic. https://marinorganic.org/a914/index.php/about

About MCP – Marin Carbon Project. (n.d.). https://marincarbonproject.org/about-mcp/#mission-and-vision

About NACD. (2016, June 3). NACD - National Association of Conservation Districts. https://www.nacdnet.org/about-nacd/

About: What Is the Pioneer Valley Planning Commission? (n.d.). PVPC. https://www.pvpc.org/about

Agency of Agriculture Food and Markets. (n.d.). *Vermont Farmers Ecosystem Stewardship Program*. State of Vermont. https://agriculture.vermont.gov/CSP-Assist

AIM. (2022). *Campaign for the Center for Food and Agriculture*. Agricultural Institute of Marin (AIM). https://issuu.com/aim./docs/aim_donor_packet_digital_2022

Alexanderson, M. S., Luke, H., & Lloyd, D. J. (2023). Regenerative farming as climate action. *Journal of Environmental Management*, *347*, 119063. https://doi.org/10.1016/j.jenvman.2023.119063

All Farmers. (2022a, January 12). *Farmers*. All Farmers. https://www.allfarmers.world/home-2

All Farmers. (2022b, January 12). *How We Work*. All Farmers. https://www.allfarmers.world/how-we-work

Almaraz, M., Simmonds, M., Boudinot, F. G., Di Vittorio, A. V., Bingham, N., Khalsa, S. D. S., Ostoja, S., Scow, K., Jones, A., Holzer, I., Manaigo, E., Geoghegan, E., Goertzen, H., & Silver, W. L. (2023). Soil carbon sequestration in global working lands as a gateway for negative emission technologies. *Global Change Biology*, *29*(21), 5988–5998. https://doi.org/10.1111/gcb.16884

Altieri, M., Funes-Monzote, F., & Petersen, P. (2012). Agroecologically efficient agricultural systems for smallholder farmers: Contributions to food sovereignty. *Agron. Sustain. Dev.*, *32*, 1–13. DOI 10.1007/s13593-011-0065-6

Amending Title 7, Chapter 7.70 of the Revised Ordinances of the City of Springfield, 1986, As Amended, by Inserting a New Chapter 7.70 - Community Gardens, Pub. L. No. Chapter 7.70 (2012). https://www.springfield-ma.gov/planning/fileadmin/Planning_files/Community_Gardens2-FINAL__2_x.pdf

American Farmland Trust – Saving the land that sustains us since 1980. (n.d.). American Farmland Trust. https://farmland.org/

American Planning Association. (2007). *Policy Guide on Community and Regional Food Planning*. American Planning Association.

Anderson, T., & O'Connor, B. (2022). *The Massachusetts Healthy Soils Action Plan*. Massachusetts Executive Office of Energy and Environmental Affairs. https://www.mass.gov/doc/healthy-soils-action-plan-2023/download

APA Policy Guide on Agricultural Land Preservation. (1999, April 26). American Planning Association. https://www.planning.org/policy/guides/adopted/agricultural.htm

Article 89: Urban Farms, City of Boston Zoning Code (2013). https://www.bostonplans.org/getattachment/a573190c-9305-45a5-83b1-735c0801e73e

Atlas Farm. (n.d.-a). *Our Commitment to Sustainable Practices*. Atlas Farm. https://www.atlasfarm.com/sustainability

Atlas Farm. (n.d.-b). *The Seeds of Atlas Farm*. Atlas Farm. https://www.atlasfarm.com/story

Belmonte, M., & Smith, K. (Directors). (2023, November 17). In Springfield, Liz O'Gilvie takes on food deserts—And food swamps—Through policy and gardening. In *New England Public Media*. https://www.nepm.org/regional-news/2023-11-17/in-springfield-liz-ogilvie-takes-on-food-deserts-and-food-swamps-through-policy-and-gardening

Bless, A., Davila, F., & Plant, R. (2023). A genealogy of sustainable agriculture narratives: Implications for the transformative potential of regenerative

agriculture. *Agriculture and Human Values*, *40*(4), 1379–1397. https://doi.org/10.1007/s10460-023-10444-4

Bolster, C., Mitchell, R., Campbell, A., Cosh, M., Farrigan, T., Franzeluebbers, A., Hoover, D., Jin, V., Peck, D., Schmer, M., & Smith, M. (2023). *Chapter 11: Agriculture, Food Systems, and Rural Communities. Fifth National Climate Assessment*. U.S. Global Change Research Program. https://doi.org/10.7930/NCA5.2023.CH11

Briefs. (2018). *Republican, The (Springfield, MA)*, A006.

Cabral, I., Costa, S., Weiland, U., & Bonn, A. (2017). Urban Gardens as Multifunctional Nature-Based Solutions for Societal Goals in a Changing Climate. In N. Kabisch, H. Korn, J. Stadler, & A. Bonn (Eds.), *Nature-Based Solutions to Climate Change Adaptation in Urban Areas: Linkages between Science, Policy and Practice* (pp. 237–253). Springer International Publishing. https://doi.org/10.1007/978-3-319-56091-5_14

Callahan, K. (1993). Bioregionalism: Wiser Planning for the Environment. *Land Use Law & Zoning Digest*, *45*(8), 3–9.

Campbell, B. M., Beare, D. J., Bennett, E. M., Hall-Spencer, J. M., Ingram, J. S. I., Jaramillo, F., Ortiz, R., Ramankutty, N., Sayer, J. A., & Shindell, D. (2017). Agriculture production as a major driver of the Earth system exceeding planetary boundaries. *Ecology and Society*, *22*(4). https://www.jstor.org/stable/26798991

Campbell, L. K. (2017). *City of Forests, City of Farms: Sustainability Planning for New York City's Nature*. Cornell University Press. https://www.jstor.org/stable/10.7591/j.ctt1vjqq40

Carlisle, L. (2022). *Healing Grounds: Climate, justice, and the deep roots of regenerative farming*. Island Press.

City of Northampton. (n.d.). *Greenway Working Lands*. https://www.northamptonma.gov/1419/Greenway-Working-Lands

City of Northampton. (1999). *Northampton Vision 2020 Vision and Consistency Analysis: A Blueprint for the Northampton Vision 202 Comprehensive Plan*.

City of Northampton. (2001). *Executive Summary: Greenhouse Gas Emissions Inventory: Summer Internship, 2001, Cities for Climate Protection Campaign*.

City of Springfield. (2015). *Open Space & Recreation Plan 2015-2022*. https://www.springfield-

ma.gov/planning/fileadmin/Planning_files/Open_Space_Plan/OpenSpace_FINAL_2015.pdf

City of Springfield. (2017). *Strong, Healthy & Just: Springfield's Climate Action & Resilience Plan*. Springfield Office of Community Development. https://www.springfield-ma.gov/dr/fileadmin/community_dev/DR/CARP_FINAL_REV_2017.pdf

City of Springfield. (2022). *Open Space and Recreation Plan 2022-2027*. https://www.springfield-ma.gov/park/fileadmin/Laura_Walsh/COS_OpenSpace___Recreation_Plan_DRAFT_2022_rd.pdf

City of Springfield and Upper Hill Residents Council. (2024). *Upper Hill Neighborhood Investment Plan 2024-2034*.

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (Eds.). (2016). *Nature-based solutions to address global societal challenges*. IUCN International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2016.13.en

Cole, E. (2022). *Regenerative Agriculture for New England: Sustaining Farmland Productivity in a Changing Climate*. American Farmland Trust. https://farmlandinfo.org/wp-content/uploads/sites/2/2022/08/Regenerative-Ag-for-NE_AFT-CLF.pdf

Commonwealth of Massachusetts. (2021). *HB 5250: An Act Enabling Partnerships for Growth*.

Council on Environmental Quality. (n.d.). *Climate and Economic Justice Screening Tool (CEJST)*. Climate and Economic Justice Screening Tool. https://screeningtool.geoplatform.gov

County of Marin. (2022). *Agriculture, Weights and Measures*. Official County of Marin Websites. https://www.marincounty.org/depts/ag

Deerfield Open Space & Recreation Committee. (2023). *Deerfield Open Space and Recreation Plan 2023-2030*. Town of Deerfield. https://www.deerfieldma.us/DocumentCenter/View/1744/Deerfield-Open-Space-Recreation-Plan-2023-2030?bidId=

Deerfield Site Plan Review with Green Development Performance Standards (2021).

Division of Conservation Services, Pub. L. No. Part I, Title II, Chapter 21, Section 18. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter21/Section18

Donahue, B., Burke, J., Anderson, M., Beal, A., Kelly, T., Lapping, M., Ramer, H., Russell, L., & Berlin, L. (2014). *A New England Food Vision*. Food Solutions New England, Durham, NH, University of New Hampshire. https://foodsolutionsne.org/wp-content/uploads/2014/07/LowResNEFV_0.pdf

Donvan, M. (2020, January 23). What is conservation agriculture? *CIMMYT*. https://www.cimmyt.org/news/what-is-conservation-agriculture/

Eggermont, H., Balian, E., Azevedo, J. M. N., Beumer, V., Brodin, T., Claudet, J., Fady, B., Grube, M., Keune, H., Lamarque, P., Reuter, K., Smith, M., Van Ham, C., Weisser, W. W., & Le Roux, X. (2015). Nature-based Solutions: New Influence for Environmental Management and Research in Europe. *GAIA - Ecological Perspectives for Science and Society*, *24*(4), 243–248. https://doi.org/10.14512/gaia.24.4.9

Executive Office of Energy & Environmental Affairs (EEA). (2023). *The Resilient Lands Initiative: Expanding Nature's Benefits Across the Commonwealth – A Vision and Strategy*. Commonwealth of Massachusetts. https://www.mass.gov/doc/the-resilient-lands-initiative-2023/download

FAO. (2017). *Climate Smart Agriculture Sourcebook* (Second). United Nations. https://www.fao.org/climate-smart-agriculture-sourcebook/en/

FAO, United Nations. (n.d.-a). *10 elements of agroecology*. Agroecology Knowledge Hub. http://www.fao.org/agroecology/overview/overview10elements/en/

FAO, United Nations. (n.d.-b). *Sustainable Food and Agriculture*. Food and Agriculture Organization of the United Nations. http://www.fao.org/sustainability/background/en/

FAO, United Nations. (n.d.). *What is Conservation Agriculture? | Conservation Agriculture | Food and Agriculture Organization of the United Nations*. https://www.fao.org/conservation-agriculture/overview/what-is-conservation-agriculture/en/

FCATMedia (Director). (2022, May 10). *Deerfield Climate Forum Video Presentation: Keith Zaltzberg - Soil and Climate Change*. https://www.youtube.com/watch?v=uhjO-MLubf8

FEMA. (2021). *Building Community Resilience with Nature-Based Solutions: A Guide for Local Communities*. https://www.fema.gov/sites/default/files/documents/fema_riskmap-nature-based-solutions-guide_2021.pdf

Gardening the Community. (n.d.). *GTC Staff & Board of Directors*. Gardening the Community. https://www.gardeningthe.org/staff--board.html

Gardening the Community preps for plant sale. (2021, April 18). *Republican, The (Springfield, MA)*.

Gardening The Community Urban Farm—Springfield, MA. (n.d.). *Regenerative Design Group*. https://www.regenerativedesigngroup.com/projects/education-farm/

Garth, H. (2020). The Violence of Racial Capitalism and South Los Angeles's Obesity "Epidemic." *American Anthropologist*, *122*(3), 653–654. https://doi.org/10.1111/aman.13444

Gerten, D., Heck, V., Jägermeyr, J., Bodirsky, B. L., Fetzer, I., Jalava, M., Kummu, M., Lucht, W., Rockström, J., Schaphoff, S., & Schellnhuber, H. J. (2020). Feeding ten billion people is possible within four terrestrial planetary boundaries. *Nature Sustainability*, *3*(3), 200–208. https://doi.org/10.1038/s41893-019-0465-1

Grow Food Northampton. (2020). *Reflections 2020*. https://www.growfoodnorthampton.org/wp-content/uploads/2020/12/GrowFoodNorthampton_2020Reflections-3.pdf

Grow Food Northampton. (2021). *Grow Food Northampton Strategic Plan FY21-FY24*. https://www.growfoodnorthampton.org/wp-content/uploads/2022/04/FINAL-Strategic-Plan-2021-2024.pdf

Grow Food Northampton. (2022a). *2021 Impact Report*.

Grow Food Northampton. (2022b). 2022 Impact Report. *Grow Food Northampton*. https://www.growfoodnorthampton.org/2022-impact/

Grow Food Northampton. (2023). *Community Farm Land Use and Access Frameworks*. https://www.growfoodnorthampton.org/wp-

content/uploads/2024/01/Community-Farm-Land-Use-and-Access-frameworks.pdf

Grow Food Northampton. (2024a). *Events List*. Grow Food Northampton. https://www.growfoodnorthampton.org/events/

Grow Food Northampton. (2024b). *Farmland Lease Request for Applications 2024*. https://www.growfoodnorthampton.org/wp-content/uploads/2024/01/Farmland-Lease-Request-for-Applications-2024.pdf

Growing Food Connections. (n.d.). *Database*. https://growingfoodconnections.org/?s=green+infrastructure&submit=Search

Guthman, J. (2014). Conventionalizing Organic: From Social Movement to Industry via Regulation. In *Agrarian Dreams: The Paradox of Organic Farming in California* (Second). University of California Press.

Hampden, Hampshire & Franklin Deeds. (2014, July 27). *The Republican (Springfield)*, F009.

Hampden Hampshire Conservation District. (2023, May 26). *Equipment Rentals*. Hampden Hampshire Conservation District. https://hampdenhampshireconservation.org/equipment-rental/

Harvard Forest. (2017). *Wildlands and Woodlands, Farmlands and Communities: Broadening the Vision for New England*. Harvard University Press. https://www.wildlandsandwoodlands.org/sites/default/files/Wildlands%20and%20Woodlands%202017%20Report.pdf

Home Page. (n.d.). Community Involved in Sustaining Agriculture. https://www.buylocalfood.org/

Irby, E. (2021, April 26). *American Farmland Trust to Partner on Largest Soil Health Project in New England History*. American Farmland Trust. https://farmland.org/aft-rcpp-new-england/

IUCN. (2020). *IUCN Global Standard for Nature-based Solutions: A user-friendly framework for the verification, design and scaling up of NbS* (First Edition). International Union for Conservation of Nature (IUCN). https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf

Janowiak, M. K., Dostie, D. N., Wilson, M. A., Kucera, M. J., Skinner, R. H., Hatfield, J. L., Hollinger, D., & Swanston, C. W. (2016). *Adaptation Resources for Agriculture: Responding to Climate Variability and Change in the Midwest and Northeast. Technical Bulletin 1944.* U.S. Department of Agriculture. https://www.climatehubs.usda.gov/sites/default/files/adaptation_resources_workbook_ne_mw.pdf

Kurtz, J. E., Woodbury, P. B., Ahmed, Z. U., & Peters, C. J. (2020). Mapping U.S. Food System Localization Potential: The Impact of Diet on Foodsheds. *Environmental Science & Technology*, *54*(19), 12434–12446. https://doi.org/10.1021/acs.est.9b07582

Lal, R. (2020). Regenerative agriculture for food and climate. *Journal of Soil and Water Conservation*, *75*(5), 123A-124A. https://doi.org/10.2489/jswc.2020.0620A

Larabee, C. (2023, January 4). Award-winning soil study strengthens Deerfield's climate resiliency efforts. *Greenfield Recorder*. https://www.recorder.com//Award-winning-soil-study-strengthens-Deerfield-s-climate-resiliency-efforts-48842920

Lessieter. (n.d.). *Timeline of the No-Till Revolution*. https://www.no-tillfarmer.com/articles/11095-timeline-of-the-no-till-revolution

Lowney, M. E. (2019). Harvest time at Riverview Apartments—Republican, The (Springfield, MA)—November 6, 2019—Page 010. *Republican, The (Springfield, MA)*, 010.

MACD. (n.d.). *About*. Massachusetts Association of Conservation Districts. https://massacd.org/about/

Marin Carbon Project. (2024). *Carbon Farming*. Marin Carbon Project. https://marincarbonproject.org/what-is-carbon-farming/#what-is-carbon-farming

Marin County. (2020). *Marin County Unincorporated Area Climate Action Plan 2030*. County of Marin Community Development Agency. https://www.marincounty.org/-/media/files/departments/cd/planning/sustainability/climate-and-adaptation/cap-2030_12082020final.pdf

Marin County: 195 Years of Family Farming. (2013). University of California Cooperative Extension. https://growninmarin.org/files/238940.pdf

Marin County Community Development Agency. (2023). *Marin Countywide Plan: 2023 Update* (pp. 253-). https://www.marincounty.org/userdata/cda/planning/cwp2023.pdf

Marin County Parks. (2014). *Marin County Parks Annual Report 2013-14*. https://www.parks.marincounty.org/-/media/files/sites/marin-county-parks/about-us/measure-a/fy-13-14/measurea_141217_mcp_measurea_ar_art3_web.pdf?la=en

Marin County Parks. (2023). *Food, Agriculture, and Resilient Ecosystems Grants (FARE)*. https://www.parks.marincounty.org/about-us/fare-grants

MarinMap Map Viewer. (n.d.). MarinMap: A Geographic Information System for Marin County, California. https://www.marinmap.org/Html5Viewer/Index.html?viewer=smmdataviewer

Massachusetts Coordinated Soil Health Program. (n.d.). American Farmland Trust. https://farmland.org/ma-soil-health-program/

Massachusetts Department of Agricultural Resources (MDAR). (2023). *Massachusetts Farmland Action Plan 2023-2050*. Commonwealth of Massachusetts. https://www.mass.gov/doc/massachusetts-farmland-action-plan/download

Massachusetts Executive Office of Energy and Environmental Affairs. (2020). *Massachusetts 2050 Decarbonization Roadmap*. Commonwealth of Massachusetts. https://www.mass.gov/doc/ma-2050-decarbonization-roadmap/download

Massachusetts Executive Office of Energy and Environmental Affairs. (2022). *Massachusetts Clean Energy and Climate Plan for 2025 and 2030*. Commonwealth of Massachusetts. https://www.mass.gov/doc/clean-energy-and-climate-plan-for-2025-and-2030/download

Massachusetts Food Policy Council. (2015a). *Massachusetts Loal Action Food Plan*. https://mafoodsystem.org/wp-content/uploads/2021/09/MLFSPFull.pdf

Massachusetts Food Policy Council. (2015b). *Massachusetts Local Food Action Plan*. https://mafoodsystem.org/wp-content/uploads/2021/09/MLFSPFull.pdf

Massachusetts General Law – Part I, Title VII, Chapter 40, Section 8L. (n.d.). https://malegislature.gov/Laws/GeneralLaws/PartI/TitleVII/Chapter40/Section8L

Mass.gov. (n.d.). *Flood Zone Mapping Tool*. Massachusetts Environmental Public Health Tracking (MEPHT). https://matracking.ehs.state.ma.us/planning_and_tools/flood-zones/flood-zones-tool.html

Mbow, C., Rosenzweig, C., Gustavo Barioni, L., Benton, T., Herrero, M., Krishnapillai, M., Liwenga, E., Pradhan, P., Rivera-Ferre, M., Sapkota, T., Tubiello, F., & Xu, Y. (2019). *Chapter 5: Food Security* (Special Report on Climate Change and Land). IPCC. https://www.ipcc.ch/srccl/chapter/chapter-5/

McLennon, E., Dari, B., Jha, G., Sihi, D., & Kankarla, V. (2021). Regenerative agriculture and integrative permaculture for sustainable and technology driven global food production and security. *Agronomy Journal*, *113*(6), 4541–4559. https://doi.org/10.1002/agj2.20814

MDAR. (n.d.). *Agricultural Preservation Restriction (APR) Program*. https://www.mass.gov/agricultural-preservation-restriction-apr-program

Measure B: Marin County Civic Center (2014).

Merzbach, S. (2024, March 18). *Hadley's climate change panel to hold farmers' roundtable*. Daily Hampshire Gazette. https://www.gazettenet.com/Farmers-to-discuss-climate-issues-at-Hadley-roundtable-54396707

MVP. (n.d.). *MVP Toolkit: Nature-Based Solutions*. https://www.mass.gov/doc/mvp-nature-based-solutions-toolkit/download

Nature-Based Solutions | FEMA.gov. (2023, October 13). https://www.fema.gov/emergency-managers/risk-management/climate-resilience/nature-based-solutions

Nelson, K. (2024, February 20). The Land Back movement isn't just focused on ancestral grounds—it's fighting to preserve and restore foodways too. *Eater*. https://www.eater.com/2024/2/20/24073976/Indigenous-peoples-land-back-movement-native-foodways

Nerds for Earth. (2024, January 18). *Massachusetts Soil Health Policy: Legislative Status Update*. Nerds for Earth. https://nerdsforearth.com/massachusetts-soil-health-policy/

Northampton Agricultural Commission – Agenda. (2024).

Northampton Planning Board. (2021). *Sustainable Northampton Comprehensive Plan (2021)*. City of Northampton. https://www.northamptonma.gov/DocumentCenter/View/18591/Sustainable-Northampton-Comprehensive-Plan-November-2021

NRCS, USDA. (2023). *NRCS Climate-Smart Mitigation Activities*. National Resources Conservation Service. https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/climate/climate-smart-mitigation-activities

Oberč, B. P., & Arroyo Schnell, A. (2020). *Approaches to sustainable agriculture*. IUCN. https://doi.org/10.2305/IUCN.CH.2020.07.en

Ordinance No. 3760: An Ordinance of the County of Marin, State of California, Re-Implementing a One-Quarter of One Percent Transactions and Use Tax to Be Administered by the California Department of Tax and Fee Administration for Parks, Open Space, and Sustainable Agriculture, Ordinance No. 3760 (2022). https://www.parks.marincounty.org/-/media/files/sites/marin-county-parks/about-us/measure-a/ordinance_no_3760.pdf?la=en

Organic no-till is elusive, but study shows promise. (n.d.). https://www.farmprogress.com/crops/organic-no-till-is-elusive-but-study-shows-promise

Paine, D. (2005, October 28). Youth protest sale of garden site. *The Republican (Springfield)*, B2b.

Peters, C., McCarthy, A., Barley, L., Schumann, S., Borges-Mendez, R., Donahue, B., & von Wettenberg, E. (2023). Volume 2: Estimating production for 30%

regional self-reliance. In S. Sawyer & E. Kahler (Eds.), *New England Feeding New England*. New England Food Systems Planners Partnership. https://nefoodsystemplanners.org/wp-content/uploads/NEFNE_Volume-2_Estimating-Production-for-30_-Regional-Self-Reliance.pdf

Philpott, T. (n.d.). After a century of dispossession, Black farmers are fighting to get back to the land. *Mother Jones*. https://www.motherjones.com/food/2021/04/black-land-matters-farmers-justice-leah-penniman-fannie-lou-hamer-cory-booker-land-tenure/

Pioneer Valley Planning Commission. (2014). *Pioneer Valley Food Security Plan*. https://www.pvpc.org/sites/default/files/PVPC%20Food%20Security%20Plan%20FINAL%202014.pdf

Pioneer Valley Planning Commission. (2024). *McKnight Neighborhood Investment Plan 2024-2034 (Draft)*. https://www.pvpc.org/spfld-nbhd-plans

Raja, S., Born, B., & Russell, J. K. (2008). A Planners Guide to Community and Regional Food Planning: Transforming Food Environments, Facilitating Healthy Eating. *Planning Advisory Service Report*. https://www.planning.org/publications/report/9026878/

Rees, W. (1992). Ecological Footprints and Appropriated Carrying Capacity: What Urban Economics Leaves Out. *Environment and Urbanization*, *4*(2).

Regenerative Design Group, & Conservation Works. (2022, June 30). *Deerfield Healthy Soils Report: MVP Implementation Project 2022*. https://www.deerfieldma.us/DocumentCenter/View/1044/Deerfield-Healthy-Soils-Report

Regenerative Design Group – Greenfield, Massachusetts. (n.d.). Regenerative Design Group. https://www.regenerativedesigngroup.com/

Reid, S., & Weinstein, A. (2023). Unearthing the legacy of Black farmers. *Green America.* https://www.greenamerica.org/communities-frontlines-climate-crisis/unearthing-legacy-black-farmers

Riolo, F. (2019). The social and environmental value of public urban food forests: The case study of the Picasso Food Forest in Parma, Italy. *Urban Forestry & Urban Greening*, *45*. https://doi.org/10.1016/j.ufug.2018.10.002

Roman, E. (2016, May 5). Gardening inspires teens to grow, eat, fresh. *The Republican (Springfield)*, C001.

Schlesinger, W. H. (2022). Biogeochemical constraints on climate change mitigation through regenerative farming. *Biogeochemistry (Dordrecht)*, *161*(1), 9–17. https://doi.org/10.1007/s10533-022-00942-8

Slaff, J., Freedman, S., & Grist, D. (2018). *Ecological Resilience in Deerfield: Trees as Living Infrastructure*. The Conway School.

Smith College. (n.d.). *Piyush Labhsetwar*. People. https://www.smith.edu/people/piyush-labhsetwar

Smith, P. (2013). Delivering food security without increasing pressure on land. *Global Food Security*, *2*(1), 18–23. https://doi.org/10.1016/j.gfs.2012.11.008

Springfield Planning and Economic Development. (2019). *Springfield and Its Neighborhoods: A Statistical Profile for Springfield, Massachusetts*.

Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B. L., Lassaletta, L., de Vries, W., Vermeulen, S. J., Herrero, M., Carlson, K. M., Jonell, M., Troell, M., DeClerck, F., Gordon, L. J., Zurayk, R., Scarborough, P., Rayner, M., Loken, B., Fanzo, J., … Willett, W. (2018). Options for keeping the food system within environmental limits. *Nature*, *562*(7728), 519–525. https://doi.org/10.1038/s41586-018-0594-0

Sustainable Agriculture Research & Education (SARE). (2020). *What is Sustainable Agriculture?* National Institute of Food and Agriculture (USDA).

Swan, A., Toureene, C., Easter, M., Chambers, A., Brown, K., Williams, S. A., Creque, J., Wick, J., & Paustian, K. (2023). *COMET Planner: Carbon and greenhouse gas evaluation for NRCS conservation planning. A companion report to www.comet-planner.com* (Version 3.1). National Resources Conservation Service, U.S. Department of Agriculture. https://storage.googleapis.com/comet-planner-public-assets/fiftyStates/pdfs/COMET-PlannerReport.pdf

Tittonell, P. (2023). *A Systems Approach to Agroecology* (Mount Holyoke College eBooks Online E-Book; 1st ed. 2023.). Springer Nature Switzerland.

Toensmeier, E. (2016). *The Carbon Farming Solution: A Global Toolkit of Perennial Crops and Regenerative Agriculture Practices for Climate Change Mitigation and Food Security*. Chelsea Green Publishing.

Town of Deerfield. (n.d.). *Chapter 179: Zoning*.

Town of Hadley. (2014). *Hadley Open Space & Recreation Plan Update 2014*. https://www.hadleyma.org/sites/g/files/vyhlif651/f/uploads/chpt_9_action_plan_2014_draft.pdf

Town of Hadley. (2020). *Community Resilience Building Workshop Summary of Findings (Draft)*. https://www.hadleyma.org/sites/g/files/vyhlif651/f/uploads/hadley_mvp_final_draft_report_02.14.2020_withappendices_0.pdf

Town of Harvard. (2020). *Harvard's Agricultural Climate Action Plan 2020* (p. 64). https://www.harvard-ma.gov/sites/g/files/vyhlif676/f/uploads/harvard_agricultural_climate_action_plan_final_0.pdf

Town of Sunderland. (2020). *MVP Resiliency Plan*. https://www.townofsunderland.us/sites/g/files/vyhlif3891/f/pages/sunderland_mvp_report_september_2020_final.pdf

Town of Sunderland. (2021). *Town of Sunderland Hazard Mitigation Plan*. https://www.townofsunderland.us/sites/g/files/vyhlif3891/f/uploads/hazmit_final_jan2021_sunderland.pdf

Town of Sunderland. (2022, January 14). *Town of Sunderland Open Space and Recreation Plan 2021 Update*. https://www.townofsunderland.us/sites/g/files/vyhlif3891/f/uploads/openspacerecreationplan2022_2029.pdf

University of California, Division of Agriculture and Natural Resources. (2024). *Grown in Marin*. https://growninmarin.org/For_Farmers_and_Ranchers/

Urban Agriculture Incentive Zones Act – California State Board of Equalization. (n.d.). https://www.boe.ca.gov/proptaxes/uaincentivezone.htm

U.S. Census Bureau. (2020). *U.S. Census*.

U.S. Census Bureau. (2022). *American Community Survey*.

U.S. Department of Agriculture (USDA). (n.d.). *Food Access Research Atlas*. Economic Research Service (ERS). https://www.ers.usda.gov/data-products/food-access-research-atlas/

USDA. (n.d.). *The role of Climate-Smart Agriculture in climate adaptation and mitigation in the Northeast*. Northeast Climate Hub. https://www.climatehubs.usda.gov/hubs/northeast/topic/role-climate-smart-agriculture-climate-adaptation-and-mitigation-northeast

USDA NASS. (2017). *State Profile – Massachusetts* (2017 Census of Agriculture, U.S. Summary and State Data). U.S. Department of Agriculture. https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Massachusetts/cp99025.pdf

USDA NASS. (2022). *Table 47. Land Use Practices: 2022 and 2017* (2022 Census of Agriculture - State Data). U.S. Department of Agriculture, National Agricultural Statistic Service. https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_1_State_Level/Massachusetts/st25_1_047_047.pdf

Velasquez-Manoff, M. (2018, April 18). Can Dirt Save the Earth? *New York Times Magazine*. https://www.nytimes.com/2018/04/18/magazine/dirt-save-earth-carbon-farming-climate-change.html

Wegner-Traynor, E., & Wegner-Traynor, B. (2021, July 15). *Communities of practice: Sustained learning partnerships*. https://www.wenger-trayner.com/communities-of-practice/

Wheeler, T., & von Braun, J. (2013). Climate Change Impacts on Global Food Security. *Science*, *341*(6145), 508–513. https://doi.org/10.1126/science.1239402

White House Council on Environmental Quality, White House Office of Science and Technology Policy, & White House Office of Domestic Climate Policy. (2022). *Nature-Based Solutions Resource Guide*. https://www.whitehouse.gov/wp-content/uploads/2022/11/Nature-Based-Solutions-Resource-Guide-2022.pdf