GC3 Draft Report: Working & Natural Lands Working Group
Agriculture/Soils Working Subgroup
September 2020

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We would also like to thank Governor Ned Lamont for his commitment to and efforts surrounding climate change in Connecticut.

In its 2018 Report, Building a Low Carbon Future for Connecticut: Achieving a 45% GHG Reduction by 2030[1], the Governor's Council on Climate Change (GC3) recognized natural and working lands as important carbon sinks that could help mitigate emissions from the electricity generation, transportation, and building sectors which together produce almost 60% of Connecticut's greenhouse gas emissions. [2]

The GC3 recommended that Connecticut continue to work with non-governmental organizations such as the U.S. Climate Alliance in efforts to regionally develop carbon sequestration and storage practices. The council also recommended that "DEEP should work with land trusts, forest owners, and working lands managers to help adopt carbon accounting methodologies that further support sustainable land-use practices."

In 2018, Connecticut joined with over 25 states in accepting the U.S. Climate Alliances Natural and Working Lands Challenge[3] with a commitment to the following actions:

- Improve inventory methods for land-based carbon flux;
- Identify best practices to reduce GHG emissions and increase resilient carbon sequestration
- Advance programs, policies, and incentives to reduce GHG emissions and enhance resilient carbon sequestration;
- Undertake actions that will support a collective, Alliance-wide goal to maintain natural and working lands as a net sink of carbon and protect and increase carbon storage capacity, while balancing near and long-term sequestration objectives; and
- Integrate priority actions and pathways into state GHG mitigation plans within two years of joining this challenge.

While not yet completed, Connecticut continues to work toward these goals both individually and in partnership with neighboring states, academia, and nonprofit organizations as well as the private sector.

Status of Agriculture/Soils in Connecticut.

This section was drafted with the Support of American Farmland Trust's Planning for Agriculture in Connecticut guide. We would like to thank working group members Chelsea Gazillo, Kip Kolesinskas, and Latha Swamy for contributing to this section, as well as, John Guskowski who is a senior planner from CHA Companies

Connecticut Farm operations account for over 380,000 acres[4], totaling more than 5,500 farms. Despite its small size, Connecticut offers a long growing season with a relatively mild climate. Agriculture contributes over $4 billion to Connecticut's economy each year.

Farms and farmland remain cornerstones of many Connecticut communities, linking the past to the future through a landscape of fields, pastures, stone walls, and weathered barns shaped by

[1] https://portal.ct.gov/-/media/DEEP/climatechange/publications/BuildingaLowCarbonFutureforCTGC3Recommendationspdf.pdf
[2] https://portal.ct.gov/DEEP/Climate-Change/CT-Greenhouse-Gas-Inventory-Reports
[3] U.S. Climate Alliance Natural & Working Lands Challenge: http://www.usclimatealliance.org/nwlchallenge
[4] https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=CONNECTICUT

generations of hard-working farm families and farmworkers. A new generation of farmers, including recent immigrants and beginning farmers, has introduced innovative methods, diverse representation, and new thinking to agriculture in Connecticut. Increased organic production, direct marketing to consumers, community farms that feed neighborhoods, and high-tech greenhouses are examples of their contributions to the renaissance of agriculture in the state.

However, this cherished landscape, and its related farm businesses are often taken for granted. Some of the benefits are easily tangible— the bounty of fresh fruits and vegetables in the spring and summer months; pumpkins, chrysanthemums and Christmas trees in the fall and winter; and milk and dairy products year-round. Other benefits are less apparent but equally important — the local revenue and jobs, the recreational and tourism opportunities, and the wildlife habitats and other environmental benefits. Some benefits are quantifiable; many are not. For example, homeowners who live near farms see their property values increase, benefitting from the beauty and open space that farms provide.

The Impact of Agriculture

● Economic Impact: The agricultural industry in Connecticut between a $3.3 to $4 billion economic impact on the state's economy and generates an estimated 20,000 to 21,000 jobs in the state. [5]

● Environmental Benefits: Connecticut's 381,539 acres of cropland, pasture, and farm woodlands provide food and cover for wildlife, help control flooding, protect wetlands and watersheds, and maintain air quality.

● Fiscal Impact: Our 5521 farms help to stabilize municipal budgets, requiring on average 31 cents in municipal services for each dollar of property tax paid.

● Food Security and Equity: Our state's rich farmland soils, moderate climate, and adequate rainfall ensure the long-term availability of fresh, locally grown food, fiber, and agricultural products. Farms in our cities increase access to healthy foods.

● Tourism: Visitors and residents alike enjoy an exciting calendar of agricultural events throughout the year, including farmers' markets, wineries, pick-your own farms, harvest festivals, and agricultural fairs. Farms are valued for their seasonal events, outdoor activities, as well as their natural beauty and scenic vistas.

● Leveraging Federal Investments: Over $8 to 9 million in federal funds has been leveraged annually via USDA programs that support agriculture and land stewardship. Many of these USDA programs require state programs to administer them and matching state funds for eligibility, including the Agricultural Conservation Easement Program, Farm Loan programs, Energy Conservation Grants, Marketing Grants and research funds.

● Climate Change: Connecticut's farms play a significant role in mitigation, adaptation, and building resiliency to the impacts of climate change. Well managed farms and forests store carbon from the atmosphere in soils and plants, capture and store water from extreme precipitation events, cool cities, create and use renewable energy, and support pathways for species to migrate to new habitats.

Connecticut's agricultural sector is diverse not only in product variety, but also in size. A majority of Connecticut farms (over 69 percent) are fewer than 50 acres. At the same time, there are a number of farms with annual gross revenues in excess of $5 million. There is a growing number of new rural

[5] University of Connecticut - College of Agriculture, Health, and Natural Resources, Economic Impacts of Connecticut's Agricultural
Industry, 2017

and urban farmers in the state, many of whom are seeking to respond to the demand for locally grown products.

Connecticut farms are repositioning to take advantage of several new consumer trends:

● Located along the New York-to-Boston corridor with over 30 million consumers nearby, Connecticut farms are able to respond to the increasing demand for locally grown agricultural products. In fact, Connecticut has the third highest average of per farm direct-to-consumer sales in New England. [6] Other examples of this trend are the number of farmers' markets and Community Supported Agriculture (CSA) farms in the state.
● Agricultural tourism is an important part of the overall Connecticut tourism industry. From 2012 to 2017 the sector grew by more than 75 percent.
● Growing interest in the renewable energy industry has led to proposals that look at the feasibility of wood and other biomass as renewable alternative energy sources.
● Farms are taking advantage of home gardening and landscaping needs by marketing composted soil amendments. By using municipal wastes such as leaves for their composting operations, farmers are reducing the volume of local waste and waste management costs. Dairy farms are joining together to create regional facilities to compost manure. The first such facility was constructed in 2010 on Laurel Brook Farm in East Canaan, Connecticut. Learn more about the compost facility at: www.nativeenergy.com/laurelbrook-farm-compost-project.html.
● Urban agriculture is a growing sector in cities across Connecticut. In New Haven alone, there are over 50 community gardens that produce an estimated 15,000+ pounds of fresh fruits and vegetables each year. In addition, there are seven urban farm sites that together total 65,340 square feet of land and produce roughly 16,500 pounds of organically grown vegetables each year. New Haven, like many other Connecticut cities, is also home to several mobile markets, farm stands, and farmers markets.

The Effects of Climate Change on Connecticut Agriculture

The impacts of climate change are creating both challenges and opportunities for Connecticut agriculture and consumers. The variabilities in rainfall, frost-free periods, temperature, snowfall, and severe weather events are major challenges. The State will have a longer warmer growing season that will favor increased production, especially of specialty crops such as fruits and vegetables. An overall wetter climate, with short term droughts, will make water management a priority. Longer warmer growing seasons and globalization will bring new pests and diseases that will require careful management, and increased research and support from the University of Connecticut and the Connecticut Agricultural Experiment Station. Connecticut, and the Northeast, will be one of the few parts of the U.S. with a climate suitable for both people and agriculture. It will require farmers to continue to innovate in their production methods, infrastructure, marketing, and processing. Consumers will need greater awareness of these challenges, and to appreciate the contributions to local food security and economic diversity that farms bring to the state. This also requires our municipalities to allow the flexibility and resources needed to support them.

This report of the Agriculture/Soils Sub Working Groups aims to discuss climate change in six parts: soils, energy, land use/planning tools, farming and conservation practices,

[6] USDA NASS, 2017 Census of Agriculture - State-Level Data. Table 2: Market Value of Agricultural Products Sold, 2019.

agricultural practices and technology, and sustainable and equitable food systems in Connecticut.

Soils In Connecticut

Submitted by Committee Member: Lilian Ruiz. In collaboration with Emily Cole (AFT), Deb Surabian (NRCS), James Hyde (NRCS)

Scope: Soils under Agricultural Production, Forest, Urban Ag, Lawns/Fields.

"**American agriculture has the potential to become a significant carbon sink and a crucial part of the climate solution.** Climate stewardship practices, such as no- and low-till farming, planting cover crops, diversified crop rotations, rotational grazing, and improved nutrient management, increase carbon sequestration in roots and soils and reduce agricultural greenhouse gas emissions."- **2020 House Select Committee on the Climate Crisis.**

According to Conservation International, **soils hold three times more carbon globally than the atmosphere** and protecting or restoring carbon in soil can provide 3 billion tons of cost-effective climate mitigation per year.[7]

Soil alone cannot fix climate change, but it could be a powerful partner in our efforts (Soil, Land, and Climate Change, EEA, 2019).

The GC3 Report "Building a Low Carbon Future for CT, GHG Reduction Strategies and Recommendations (December 2018)" attributes only 0.6% of the GHG emissions in CT to Agriculture, which steers attention away from the sector as a game changer in achieving the GC3 goal of a 45% GHG REDUCTION BY 2030. However, if the agricultural sector in CT is not a large part of the problem, it can be a crucial part of the solution.

Executive Summary

Changes to our seasonal temperatures and precipitation patterns will have an effect on our local plants and animals. These changes may result in significant economic and health impacts, if actions are not taken to adjust to the observed changes and prepare for the predicted changes. Land Use and Soil Management are two methods readily available and arguably cost effective, when compared to potential long-term effects of changed plant and animal conditions without adequate preparation. Land use conversion from low intensity/high carbon storage systems such as forests, wetlands, or grasslands to high intensity/low carbon storage systems such as highly disturbed areas or capped (impervious) areas is recognized around the world as an immediate loss of soil protecting qualities and greenhouse gas sink or storage. Quickly followed by Land Use is Soil Management and the soils ability to store greenhouse gasses and ameliorate change due to climate. The ability to protect the soils from the range of variables such as larger rainfall storms, longer periods between rain events, and higher average temperatures can be limited or improved with available management practices. Some of the most effective and cost-efficient soil building or erosion protection practices may include:

- Cover crop seeding
- Grass based systems (hay, haylage, pasture)
- Low/No-Till cropping systems
- Double cropping Cover crops for forage harvest
- Grassed/vegetated field alley's
- Strip-Cropping / Contour Farming

[7] https://www.nature.com/articles/s41893-020-0491-z

- Manure/compost/organic based plant nutrients

But all land use and soil building practices take education (time), and money, to effectively create change in an existing economic market – dependent on an existing or known management to bring a product from seed to saleable commodity. Education and Research is a necessity for introducing any new system and optimizing that system for minimum environmental effects and maximum economic yield. Research and education related to:

- soil dynamic properties,
- regenerative or soil building practice effects,
- innovative soil health strategies

to help build plant and animal resiliency to climate changes in all manners of our landscape, including rural and urban agriculture, forested, grazed, and aquatic land uses.

Funding for such necessities as research, education, and implementation is always difficult, but such essential services could be paid by traditional methods such as public support (taxes/fees), private funds, corporate backing, or market demand for regenerative ag products. Or new and innovative markets could be established for commodity trading such as:

- Nutrient credits (likely N & P) for entities who use less fertilizers or recycle manure or similar organic nutrients
- Carbon credits for entities related to reduced fuel consumption, renewable energy, organic matter use or soil organic increases, carbon storage in the soil
- Healthy Soil credits for soil condition goals rather than crop yield, lower inputs per yield unit as measured by reduced fuel consumption, reduced fertilizer use, reduced ag chemical need or use.
- Renewable Energy credits for the generation of energy products such as electricity or renewable natural gas (RNG) from such things as methane digesters or other energy generating technology.

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Introduction

By improving the health of the soil, the effect on reduced emissions and carbon sequestration can be quantified and compared to reducing cars on the road, for example. These effects can be measured using the USDA's Nutrient Tracking Tool and other methodologies.

Soil is one **of the largest *sinks* for atmospheric carbon**, and one that can be managed to mitigate the effects of climate change and decrease the pace of global warming. Improving soil health in agricultural fields, forests, and urban open space (fields, parks, urban gardens, lawns) increases atmospheric carbon sequestration and reduces emissions. Soil health is achieved through practices that prevent erosion, increase water infiltration rate and water holding capacity, increase organic carbon content, nutrient content, biological activity, and biological diversity. Notable soil health conservation practices include cover crops, dairy farm digesters/ nutrient management, and residue and tillage management (no or minimum till).

Soil health is also intimately related to water quality and quantity. Soil erosion causes sediment accumulation in lakes and rivers, and water runoff brings nutrients and chemicals that alter the quality of the water and affects all life that depends on it. Healthy soils can retain more water and make it available to plants in any type of land cover, reducing the need for irrigation. Reducing losses by soil

erosion and runoffs reduces the need to for application of nutrients, which is even more critical with warming waters which are causing algal blooms and depleting wildlife.

The economic benefits of soil health can be measured at the farm gate in the form of increased and stable yields, lower use of inputs and energy, and increased crop resistance to drought due to increased water and nutrient retention in healthy, well managed soils. Beyond the farm gate, the economic benefits of soil health can be measured in the lower cost of maintenance and treatment of water services and natural water systems. Food security is better achieved in healthy soils, decreasing logistical and carbon footprint costs of transportation, as local food production is more sustainable and stable.

Soil health is not just an issue impacting agriculture and forestry. It is also related to urban development, particularly in Connecticut with its population density and significant land area intensively dedicated to lawns, fields, parks, and urban agriculture. Consequently, soil health is a concern that needs ample research and education on a variety of land uses and covers including the subaqueous environment. Research initiatives directed specifically at these other soil environments and the BMPs that CT would need to improve soil health would increase the mitigating potential of soil health considerably[8].

Nonetheless, the GC3 Report "Building a Low Carbon Future for CT, GHG Reduction Strategies and Recommendations (December 2018)" **attributes a LOW CO2 Reduction Potential** to "Improved Agricultural Practices"-Practices to reduce GHG emissions and maintain/build soil carbon: organic farming, nutrient reductions, no till agriculture, and improved residue management. One of the arguments is that "Co-benefits[9] can be difficult to quantify, monetize, and monitor" but "when properly valued, co-benefits often help demonstrate that the positive societal and environmental impacts of climate policy actions outweigh the costs."

At present, only one section of the CT General Statues addresses soils- SOIL CONSERVATION (TITLE 22a)- despite its critical importance for the ecology and economy of the state. The General Statutes need to be updated to include *soil health*, not just erosion, and bring the importance of soil as a natural resource to the forefront.

Changes to seasonal temperatures and precipitation patterns will have an effect on plant and animals, which could result in lower yields or loss of income if producers or society is not prepared to deal with the changes at hand.

Erosion can be increased with larger storm events, heat waves, droughts, and rain frequency. The ability to protect the soils from the range of variables can be greatly increased using pro-active management, foresight, and building from past experiences from other regions around the world who have not been actively protecting this vital resource: soil.

[8] US is 2% lawn/turf – so applying that to CT, that is 62,000 acres. If those acres improved organic matter by 1%, which could take 10 years, that would be equivalent to mitigating almost 1.2 million metric tons of CO2.

[9] "cobenefits could consist of improved air and water quality, improved soil and ecosystem health, energy cost savings, sustainable land management, and so on."- GC3 Report "Building a Low Carbon Future for CT, GHG Reduction Strategies and Recommendations (December 2018)".

Land Use and Soil Management are two options readily available and cost effective in terms of reducing risk and increasing resiliency. Grasslands and Forests protect soils and increase soil carbon. Converting to other land use increases the risk of soil loss and reduces the soil carbon potential. Arable lands have a range of potential for both soil loss and carbon storage but are highly dependent on human management decisions and actions. Effective management methods are identified and available, and by comparison to soil or economic loss due to changing climates, is relatively inexpensive to enable. Managing soil nitrogen and carbon within a soil is an effective approach to reducing the rate of change among greenhouse gasses such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). (Pg. 13, (#4 & #5), Climate & Soils, EEA 2008)

The Ag/Soils Subcommittee- SOILS Section recommendations contained in this document provide the necessary tools to set goals, evaluate results and monetize gains for mitigation, resilience, and adaptation to climate change through prioritizing SOIL HEALTH.

Background: Existing Programs and Resources-

Agriculture Resilience Act HR 5861

The Agriculture Resilience Act sets goals to (1) expand adoption of soil health practices (including diverse crop rotations, cover cropping, conservation tillage, perennialization of highly erodible land, agroforestry, composting, biologically based nutrient management, and advanced grazing management, including silvopasture) sufficiently to restore at least a quarter of the soil carbon that has been lost in the last 300 years by not later than 2030 and at least half of lost soil carbon by not later than 2040; (2) increase cover crop acres in the United States to at least 25% of crop acres by not later than 2030 and at least 50% by not later than 2040, with at least 50% of cropland acres covered by crops, cover crops, or residue year-round by not later than 2030, rising to at least 75% by not later than 2040; (3) reduce the rate of conversion in the United States of agricultural land to development, as well as the rate of grassland conversion to cropping, by at least 80% by not later than 2030, and eliminated by not later than 2040; (4) establish advanced grazing management, including management-intensive rotational grazing, on at least 50% of all grazing lands by not later than 2030 and 100% of all grazing land by not later than 2040; and (5) re-integrate livestock and crop production systems at farm, local, and regional levels and increase acreage on individual farms under crop-livestock integrated management by at least 50% over 2017 levels by not later than 2030 and by 100% over 2017 levels by not later than 2040.

USDA COMET-Farm and COMET Planner Tools

The USDA COMET-Farm tool estimates greenhouse gas emissions and sinks on farms using data submitted by farmers about their land and management as well as spatially specific information from geospatial databases on climate and soil conditions. Improved measurement and quantification of conservation programs and practices on carbon sequestration and greenhouse gas emissions reductions will allow USDA to evaluate and utilize that data for potential participation in carbon and environmental markets. It will also create the potential for producer performance-based payments and financial incentives founded on evidence-based carbon sequestration, soil health, and greenhouse gas reduction outcomes. Additionally, tracking the effectiveness of specific practices will allow USDA to prioritize those practices within existing conservation programs.

The USDA COMET-Planner evaluation tool is designed to provide generalized estimates of the greenhouse gas impacts of conservation practices and is intended for **initial planning purposes**.

Site-specific conditions (not evaluated in this tool) are required for more detailed assessments of greenhouse gas dynamics on your farm. It helps with broad scale county and state estimates and relies on state data regarding current land use and practices on farmland.

2020 House Select Committee on the Climate Crisis

Support State Soil Health Initiatives to Increase Adoption of Climate Stewardship Practices States are finding new and innovative ways to help farmers improve soil health and carbon sequestration, reduce greenhouse gas emissions, and make farms more resilient to extreme and unpredictable weather. For example, California's Healthy Soils Program has been successful in helping farmers increase carbon sequestration and Iowa's crop insurance for cover crop initiative has provided farmers with financial benefits for planting cover crops.1041 Rep. Chellie Pingree (D-ME) introduced H.R. 5861, the Agriculture Resilience Act, which would **establish a state soil health grant program to provide states and tribal governments with funding for soil health** and carbon sequestration programs.

Congress should direct **USDA to establish partnerships with state and local governments and provide funding and support to state departments of agriculture** for climate stewardship programs. Congress should also establish a state soil health grant program to provide states and tribes with funding for soil carbon sequestration programs.

Congress should **establish a grant program for state and local governments to develop and implement a strategy to increase climate stewardship practices on land leased** by farmers and owned by non-operator landowners within their communities. This legislation should also direct USDA to develop federal incentives for longer-term leasing contracts and climate stewardship practices on leased land, such as preferred USDA loan rates on infrastructure and equipment for farmers who plant cover crop or practice reduced-till farming.

United States Climate Alliance Report written by AFT[10]

Mitigation Potential- Scenarios

1. Potential GHG reduction if all intensive till adopted no-till

County	Amount of cropland in intensive till (acres)	Remaining GHG potential reduction (MT CO_2e yr^{-1})
HARTFORD	7,487	3,711
LITCHFIELD	2,687	973
NEWLONDON	2,312	844
TOLLAND	2,264	821
NEWHAVEN	1,603	611
WINDHAM	1,486	540
FAIRFIELD	681	252
MIDDLESEX	292	111
Total tonnes CO2e/yr		7,752

2. Potential GHG reduction if non-cover cropped cropland adopted legume cover crops

[10] COMET planner and 2017 NASS AgCensus data.

County	Amount of cropland without cover crops (acres)	Reduction if legume cover crop adopted on all remaining cropland (tonnes CO_2e yr^{-1})
HARTFORD	15,349	3,818
LITCHFIELD	10,588	2,961
NEWLONDON	8,292	2,315
WINDHAM	7,440	2,079
NEWHAVEN	5,045	1,396
TOLLAND	4,672	1,306
FAIRFIELD	2,818	785
MIDDLESEX	2,474	685
	total	15,345

3. Replace 20% synthetic N over a 5-yr period with dairy manure (statewide) 18,679 MTCO2e

4. 100% adoption of combined practices:

Combined Practices: Tillage, Cover Crop, Compost, or Nutrient Management[2]	
Int till to NT/ST+legumeCC+compost25	94,902
Int till to NT/ST+nonlegumeCC+compost25	84,720
Int till to NT/ST+legumeCC	49,227
Int till to NT/ST+nonlegumeCC	39,045
Int till to NT/ST+Red. Syn N 15%	31,505

[1]Estimates with tillage acres includes current adoption levels plus potential from remainining acres in intensive tillage or reduced tillage plus potential from unreported tillage acres (excluding hayland acres).
[2]Combined practices estimates are simply the additive combinations of the single practices. This number does not perfectly align with COMET-Planner estimates to enable adjustments for hayland exclusions for cover cropping and tillage practices.

5. More realistic scenario

Practice Category	Convert from Baseline To:	Tonnes CO_2e yr^{-1}	Equiv to C seq by ## tree seedlings grown for 10 y
Cover Crop[1]	Non-Legume	5,128	84,783
	Legume	9,841	162,721
Tillage[2]	Reduced tillage	3,626	59,949
	No-tillage	12,712	210,198
Nutrient Management[3]	Dairy manure	4,670	77,214
	25:1 compost	11,419	188,808
Potential Mitigation Sum	Lower	13,423	221,947
	Upper	33,972	561,727

[1] Current cover crop adoption plus 25% adoption on remaining acres not in cover crops (excludes hayland acres).
[2] Current no-tillage or reduced adoption plus 75% adoption on remaining acres in intensive
[3] Replacing synthetic fertilizer with dairy manure or 25:1 compost on 25% of cropland acres.

Goals

I. Increase the adoption of soil health conservation practices and easement programs that mitigate the effects of climate change.[11]

[11] The highlighted percentages mirror the national goals proposed on the Ag Resilience Act HR 5861, and need to be set for the state of CT with ample stakeholder input.

a. increase cover crop acres in the state to at least 25% of crop acres by not later than 2030 and at least 50% by not later than 2040, with at least 50% of cropland acres covered by crops, cover crops, or residue year-round by not later than 2030, rising to at least 75% by not later than 2040;
b. increase no-till acres in the state to at least 25% of crop acres by not later than 2030 and at least 50% by not later than 2040, with at least 50% of cropland acres covered by crops, cover crops, or residue year-round by not later than 2030, rising to at least 75% by not later than 2040;
c. increase the use of manure as a replacement to chemical fertilizers to at least 25% of current use by not later than 2030, with at least 30% substitution of current use by not later than 2040;
d. establish advanced grazing management, including management-intensive rotational grazing, on at least 50% of all grazing lands by not later than 2030 and 100% of all grazing land by not later than 2040;

II. Increase easement programs that mitigate the effects of climate change, including but not limited to **high soil carbon capture land uses**, such as forested areas, or the conversion of land from soil deterioration to soil building land uses, or mitigation pools for capped or impervious soil systems.

III. Increase research funding as relates to soil dynamic properties, conservation practice effects for soil building and resiliency, subaqueous soil functions and mapping, soil functions of cropped, urban, forested, grassed, turfed or suburban landscapes, and aquaculture.
a. Mapping of inventory of soil organic carbon in the state, including urban, forested, grazing and aquaculture as well as residential lawns.
b. Mapping of adoption of conservation practices.
c. Determine best soil management practices under climate changes.
d. Demonstrate economic benefit of adoption of conservation practices.
e. Interactive research on new threats and new technologies impacting soil health.

IV. Increase education funding as relates to soil tests, soil health conservation practices, subaqueous soils mapping, and innovative soil health strategies in the agricultural setting which includes cropped, urban, forested, grazing and aquaculture as well as residential lawns.
a. Expand the Soil Science curriculum at UConn.

V. Funding for Implementation from capital based, private equity, socially supported (advertised/purchases), market supported (large purchasers soil/production goals)
a. Help pay for yield loss due to farms learning curve and adopting new systems
b. Purchase low/no-till related equipment for those who want to make changes
c. Incentivize practices deemed most important for soil sustainability (roots in the soil, minimize soil disturbance)
i. Cover crop seeding
ii. Cover crops grown for forage harvest
iii. Grass based systems (hay, haylage, pasture)
d. Minimize Soil Disturbance

i. Manure management systems to allow for proper timing and improved nutrient use
ii. Manure capture, storage, and delivery infrastructure and equipment to allow farms flexibility or low disturbance options to apply fertilizer to growing plants
iii. Barns – Scrape alleys – Pipes – Pumps – Roofs/Covers – Tanks – Tractors – Draglines – No-till manure applicator equipment – supporting equipment to make the systems more successful

e. Maintain Living Roots in the soil
i. Double crop no-till systems appropriate for the region
- Cover Crop forage + Silage
- Vegetable alley covers (living cover or organic mulch cover or similar)

ii. Land Management Plan incentives to educate landowners and develop land use plans with balance of soil building and productivity for turf, forest, urban, or agriculture.

VI. Innovative markets
a. Nutrient shares (N or P)
i. Manure/compost market to offset N and increase organic cycling/biological activity

b. Carbon Shares
i. Fuel Consumption
ii. Renewable Energy generated (Electricity / RNG - renewable natural gas)
iii. Organic Matter
iv. Carbon balance

c. Soil Health shares –
i. Performance of Soil instead of performance of crop,
ii. Lower/lowest Inputs per yield unit
- Fertilizer
- Fuel
- Ag Chemicals (herbicide/pesticide/fungicide)

d. Renewable Energy Generation (Electricity / RNG)

Policy Recommendations

Mitigation, Adaptation and Resiliency

I. Create specific goals for current ag land use types: hay, cropland, pasture. Goals associated with use of practices are translated into tons of carbon.
II. Concentrate on practices that are most impactful for soil health and have the greatest climate change mitigation potential: cover crops, reduced or no till, nutrient management.
III. Dynamic and ongoing research on new threats to soils- As an example, the threat to soil organic matter from invasive earthworms in forested ecosystems.
IV. Map the current baseline: area and land use, % adoption and impact of 25% increase, 50% increase, and full adoption.
V. State will fund the match to federal programs (CSP, EQIP).

VI. Strategies should be geared towards long-term sustainability to help regenerate natural systems, which includes soils, to support agriculture as well as to build resilience for adapting to climate change.

FORMULA FOR PROGRAMFUNDING:
EXAMPLE- COVER CROP FA PROGRAM:
ADDITIONAL ACRES COVER CROP*COST OF MATCH PER ACRE= COVER CROP PROGRAM COST
ADDITIONAL ACRES COVER CROP*TONS OF CARBON SEQUESTERED/ACRE=TOTAL CARBON MITIGATION ON COVER CROP PROGRAM
COVER CROP PROGRAM COST/ TOTAL CARBON MITIGATION ON COVER CROP PROGRAM= $/TON OF CARBON =>> COMPARABLE WITH OTHER GC3 POLICIES: MITIGATION POTENTIAL @ $/TON

Case Study

Economic Effects of Soil Health Practices on Macauley Farms LLC, NY (2018)

Increases in Net Income

Increase in Income

ITEM	PER ACRE	ACRES	TOTAL
None Identified			$0
Total Increased Income			**$0**

Decrease in Cost

ITEM	PER ACRE	ACRES	TOTAL
Machinery cost savings due to no-till (3 less passes/yr)	$72.28	567	$40,984
Ceased rock picking saving 12 hrs labor/yr	$0.27	567	$153
Weed control by cover crops saves 1 sprayer trip	$12.00	122	$1,464
Soil health practices reduce soil nutrient losses due to .51 tons/ac less erosion	$1.61	567	$914
Total Decreased Cost			**$43,515**
Annual Total Increased Net Income			**$43,515**
Total Acres in this Study Area			**567**
Annual Per Acre Increased Net Income			**$77**

Decreases in Net Income

Decrease in Income

ITEM	PER ACRE	ACRES	TOTAL
None Identified			$0
Total Decreased Income			**$0**

Increase in Cost

ITEM	PER ACRE	ACRES	TOTAL
Increased herbicide cost due to no-till (1 more application)	$23.14	323	$7,475
Cover crop costs	$53.43	122	$6,518
1 day to mix cover seed (8 hrs labor)	$0.83	122	$102
Portable seed mixer & tote box	$0.89	122	$109
Increased machinery cost due to switch from single to split fertilizer	$12.60	254	$3,200
Residue & tillage mgt learning activities (44 hrs/yr)	$1.90	567	$1,074
Total Increased Cost			**$18,479**
Annual Total Decreased Net Income			**$18,479**
Total Acres in this Study Area			**567**
Annual Per Acre Decreased Net Income			**$33**

Annual Change in Total Net Income = $25,036
Annual Change in Per Acre Net Income = $44
Return on Investment = 135%

This table represents costs & benefits attributed to no-till, cover crops, & nutrient management over the 567-acre study area as reported by the farmer. • All values are in 2018 dollars • Prices used: Nitrogen: $.30/lb, Phosphate: $.39/lb, (Estimated Costs of Crop Production in Iowa—2018, ISU). • Sheet & till erosion benefits are based on estimated N & P content of the soil & 2018 fertilizer prices. • Return on Investment is the ratio of Annual Change in Total Net Income to Annual Total Decreased Net Income expressed as a percent (i.e., net profit/cost of investment) • Financial assistance from NRCS was not included in the partial budget analysis as it is not an economic effect of soil health practices themselves. • For study methodology, see https://farmland.org/soilhealthcasestudies. For USDA's Nutrient Tracking Tool, see https://www.cem.usda.gov/nutrient-tracking-tool-ntt. For USDA's COMET-Farm Tool, see http://cometfarm.nrel.colostate.edu. • Rounding errors may result in minor discrepancies in calculated results. • This material is based on work supported by a 2018 USDA NRCS CIG grant: NR183A750008G008.

For more information about this study or to discuss soil health practices, please contact
Aaron Ristow, American Farmland Trust, New York Agricultural Stewardship Program Manager, aristow@farmland.org, 607-745-7165
USDA NRCS Livingston County Office, 11 Megan Drive, Suite 2, Geneseo, NY 14454, 585-243-0030 X 3
To read more case studies, visit farmland.org/soilhealthcasestudies

Economic Effects of Soil Health Practices on Gary Swede Farm, LLC (2018)

Increases in Net Income

Increase in Income

ITEM	PER ACRE	ACRES	TOTAL
Yield Impact Due to Soil Health Practices	$71.95	600	$43,168
Total Increased Income			**$43,168**

Decrease in Cost

ITEM	PER ACRE	ACRES	TOTAL
Reduced Machinery Cost due to Reduced Tillage	$23.43	1,500	$35,152
Nutrient Savings due to Nutrient Mngmnt.	$40.65	600	$24,390
Value of Decreased Erosion due to Soil Health Practices	$2.25	1,500	$3,369
Total Decreased Cost			**$62,911**
Total Increased Net Income			$106,079
Total Acres in the Study Area			1,500
Per Acre Increased Net Income			$71

Decreases in Net Income

Decrease in Income

ITEM	PER ACRE	ACRES	TOTAL
None Identified			$0
Total Decreased Income			**$0**

Increase in Cost

ITEM	PER ACRE	ACRES	TOTAL
Cost of Setting up Planter to Handle Residue	$0.72	600	$432
Cover Crop Costs	$51.00	450	$22,950
Residue and Tillage Mgmt. Learning Activities	$0.07	1,500	$98
Cover Crops Learning Activities	$0.22	450	$98
Nutrient Management Learning Activities	$0.16	1,500	$244
Total Increased Cost			**$23,822**
Annual Total Decreased Net Income			$23,822
Total Acres in this Study Area			1,500
Annual Per Acre Decreased Net Income			$16

Annual Change in Total Net Income = $82,257

Annual Change in Per Acre Net Income = $55

This table represents costs and benefits over the entire study area (1,500 acres) as reported by the farmer.

All values are in 2018 dollars.

Crop prices used in the analysis: Corn: $3.55/Bu, Sweet Corn: $75/Ton. Sources: Crop Values 2018 Summary, USDA, NASS (Corn), Jay Swede (Sweet Corn).

Fertilizer prices used in the analysis: Phosphate: $.39/LB, Potash: $.27/LB. Source: Estimated Costs of Crop Production in Iowa—2018

Sheet and rill erosion benefits are based on estimated nitrogen and phosphorus content of the soil and 2018 fertilizer prices. Source: NRCS Interim Final Benefit-Cost Analysis for the Environmental Quality Incentives Program, 2009.

For information about study methodology, see http://farmland.org/soilhealthcasestudies. For information about USDA's Nutrient Tracking Tool, see https://www.oem.usda.gov/nutrient-tracking-tool-ntt. For information about USDA's COMET-Farm Tool, see http://cometfarm.nrel.colostate.edu/. This material is based on work supported by a USDA NRCS CIG grant: NR183A750008G008.

Jay has been receiving technical and financial assistance through a Conservation Stewardship Program (CSP) contract (2016 to 2020). This support allowed Jay to experiment with new cover crop mixes and new nutrient management split application techniques on a few hundred acres. The CSP income is not included in the analysis given the mismatch in years and acres between the contract and the study. Readers can assume that during the contract years, Jay received additional net income from CSP.

For more information about this study or to discuss soil health practices, please contact

- Aaron Ristow, American Farmland Trust, New York Agriculture Stewardship Program Manager, aristow@farmland.org
- USDA NRCS Wyoming County Office, 36 Center Street, Warsaw, NY 14569, (585) 786-3118

To read more case studies, visit farmland.org/soilhealthcasestudies

Top Energy Goals for the Governor's Council on Climate Change- Agriculture/Soils Sub-Working Group
1. Reduce conversion of Prime and Important Farmland Soils, active agricultural land, forest land, aquaculture important subaqueous soils and other soil landscapes that provide critical ecosystem functions and values/ goods and services such as groundwater recharge/discharge, protection of headwaters of cold water streams, public water supply watersheds, floodplains and riparian areas, wetlands and wetland hydrology, support special habitats and migration corridors for species. From 2001-2016, 23,000 acres of farmland were developed or compromised, the 6th highest % in the nation. Baselines of kinds of farm acreage goals should be established, and goals for reduced conversion, and protection established.
2. Protection of these areas with an emphasis on protection with appropriate easements that allow management consistent with the needs for climate change adaptation, mitigation, and resiliency.
3. Reduce emissions from 1. fossil fuels from equipment, 2. petroleum based fertilizers and pesticides, 3. soil carbon loss and denitrification.
4. Increase perennial and carbon sequestering and storage by vegetation management on all landscapes. Increase the number of native genotypes/species and noninvasive plants growing in the state.
5. Increased stakeholders understanding of climate change impacts, adaptation and/or mitigation strategies
6. Increased adoption of appropriate farm management practices by farmers to enhance climate change adaptation and resilience
7. Increased understanding of challenges and opportunities for agriculture by consumers, policy makers and elected officials
8. Increased knowledge of federal and state programs including risk management and crop insurance tools
9. Increase planning for climate extremes and emergencies
10. Gender and racially diverse shared learning to better understand impacts and develop solutions
11. A resilient, adaptive, economically successful agriculture, forest industry, and food system in every CT community as part of a cohesive regional multistate strategy.

Strategies for mitigation:
1. Reduce conversion of forest and farmland to residential, commercial, industrial
2. Reduce emissions from use of fossil fuels from equipment, petroleum based fertilizers and pesticides.
3. Utilize soil health practices that reduce tillage, increase soil carbon, and reduce denitrification.
4. Utilize methane digesters, manure storage covers, gas collection systems, liquid solid separation, improved manure transfer and distribution to reduce emissions
5. Utilize woody biomass from sustainably harvested sources with clean furnaces for heating and energy production on farms.
6. Increase use of farm based composting of manure, food and yard waste to reduce emissions, store carbon, and reduce petroleum based fertilizer use.
7. Utilize more rotational grazing systems and highly managed forages for all grazing animals.
8. Reduce lawn and turf areas that require frequent mowing, upgrade equipment to mulching and electric mowers
9. Avoid or mitigate loss of Core Forest or Prime Farmland to large scale solar arrays. Plan for co-use with agriculture or utilize certified pollinator friendly vegetation and management.
10. Reduce emissions from animal waste by adjusting diets and adding supplements.

Adaption Strategies- Farm level adjustments that build resistance

1. Focus on Soil Health
• Reduce tillage frequency and intensity, transition to low-till or no-till planting methods to preserve plant residues, where feasible.
• Increase organic matter inputs through cover crops, crop residues, green manure crops, manures, and compost.
• Use diverse winter and summer cover crops between main crops to maximize soil surface protection.
• Use mulches, raised beds to cool and warm soils
• Utilize continual live plant/root to feed the soil food web by building soil heath and organic matter. .
• Develop a rotational plan to maximize the use of perennial crops in the rotation to avoid some or all tillage requirements.
• Reduce soil compaction by minimizing equipment passes over fields. Stay out of fields when soils are wet! Upgrade to low pressure tires on equipment
• Avoid fall tillage and bare winter fallow whenever possible
• Integrate livestock into rotations to convert high carbon crop residue into low carbon organic material

2. Utilize Integrated Crop Management Systems
• Stay abreast of new threats and be aware of life cycles and how pests spread.
• Conduct regular scouting for weeds, insects, and pathogens, and control them with proven strategies.
• Use crop varieties and livestock lineage with resistance to pests and pathogens.
• Implement cultural and biological controls for pests whenever possible.
• Increase the acreage and quality of perennial pollinator and beneficial insect habitat.
• Correctly use appropriate pesticides when pest or pathogens exceed economic thresholds.
• Practice sanitary farming practices (e.g. clean equipment in-between fields) to reduce the spread of pests and pathogens.
• Tests soils and compost regularly. Split applications to avoid loss

3. Diversify Farm Enterprises
• Be open to change. Choose a variety of commodities, farm products and services that insulate against weather, environmental, market, and geopolitical threats.
• Diversify crop production by extending crop rotations and intercropping with multiple species or varieties.
• Select crop varieties based on maturity dates and genetics to match anticipated season length, rainfall and drought patterns, and pest/pathogen pressures.
• Consider controlled environment agriculture to extend the growing season, diversify operations, and decrease weather risks.
• Select livestock breeds and genetics that tolerate temperature extremes
• Diversify the soil resources used to reduce risk. Consider leasing, purchase of land, rotations to manage this.

4. Reduce Livestock Stress for Extreme Temperatures
• Ensure that livestock facilities are well ventilated and have proper cooling mechanisms in place. This includes calf housing, lactating and dry cow facilities.
• Provide access to shade while on pasture.

• Use fans and sprinkler systems controlled with automatic sensors to reduce the risk of heat stress on all animals.
• All animal classes should have access to fresh, clean water.
• Monitor and adjust diets for daily intakes. Rations should be balanced to meet animal needs at a reduced intake during periods of heat stress.
• Consider planting warm season grasses, stockpiling forage, , and silvopasture grazing to maximize quality forages.
• Adopt pastured livestock systems on diversified perennial pasture, rotationally grazed.

5. Engage in Farm Planning and Adaptive Management
• Develop and implement conservation plans
• Develop an adaptation plan to identify your risks and practices to remediate them.
• Conduct a whole-farm energy audit to increase efficiency and opportunities for renewable energy sources.
• Utilize precision farming apps, weather and climate tools (such as climatesmartfarming.org) to make more informed crop production decisions.
• New and renovated farm buildings should be energy efficient and designed to withstand predicted weather conditions, including severe heat, heavy rainfall, wind, and snow loads.
• When purchasing new equipment, select options to maximize fuel efficiency and decrease labor and time constraints.
• Consider purchasing crop insurance to reduce economic risks

6. Efficiently Manage Water Resources& Risks
· Improve irrigation efficiency by using the latest technologies, such as micro-, subsurface, or drip irrigation;
· Install tile drainage, ditches, and waterways in fields to remove excess water and control runoff.
• Expand or improve water supply systems to meet future demand, and increase water storage capacity by constructing deeper wells and ponds, cisterns on structures.
• Time fertilizer and manure applications based on weather forecasts.
• Plant or manage riparian buffers along streams and ponds to capture remaining runoff, reduce erosion and scour
· Integrate agroforestry & permaculture into farming systems to increase water-use efficiency during dry periods and diversify cropping systems.
· Incentivize and increase the use of grey water recycling systems for all water users.

Policy Recommendations and Actions
1. Establish dedicated staff at UConn, Ag Experiment Station, CT Dept of Agriculture, Conservation Districts to provide technical assistance on tillage practices/equipment, soil health practices, grazing/forage management
2. Contact Congressional Delegation and USDA about the need for additional NRCS staff and technical assistance for conservation planning and implementation.
3. Modify CT Dept of Agriculture programs such as EAP, Farm Transition, Farm Reinvestment Program, and Farmland Restoration Program to create an integrated Climate Program for producers similar to the Massachusetts Climate Smart Agriculture Program. Would have continuous signup, expand to cover equipment, vegetative conservation practices, soil health practices, and offer ability to leverage Federal program funds to 90-100% of the costs.

4. Accelerate and streamline CT Dept of Ag Farmland and OSWA easement programs to close in 2yrs or less, with 2x the number of easements closed with 4 yrs. Additional staffing, partners, reduce barriers such as SBRB, pursue alternative appraisal processes, drop/reduce cost share requirement from project partners.
5. Modify existing State Agency Grant programs (including DEEP and DoAg) ranking criteria to include climate mitigation, adaptation, resiliency elements.
6. Develop stronger Farmland Protection and mitigation regulation to prevent loss of farmland from state funded projects.
7. Contact Congressional delegation to strengthen federal Farmland Protection Policy Act (FPPA) to reduce conversion of farmland
8. Modify and update Urban Green and Community Garden Program to include CT Dept of Ag as a sponsor or partner, with a Climate smart practices and food system focus. Remove the match requirement.
9. Submit proposals to USDA NRCS RCPP Program, Conservation Innovation Grants (CIG) Grants to accelerate protection and management of parcels in public water supply areas, important habitats, flood prone areas, recharge and discharge areas.
10. Create incentives for the livestock (emphasis on dairy) industry to utilize more grazing, perennial forage based systems.
11. Create incentives/funding to utilize methane digesters, manure storage covers, gas collection systems, liquid solid separation, backed bedding barns, improved manure transfer and distribution, and adjustments/supplements in animal feed to reduce emissions from animal agriculture and food waste.
12. Evaluate and modify composting and food/yard waste standards to accelerate farm based composting and utilization on private lands.
13. Create additional State funding and program incentives for municipal participation in Sustainable CT initiative.
14. Develop and fund Statewide a Pollinators Pathway program initiative based on CT NOFA initiative. Some 63 Towns have initiatives with over 5,000 households.
15. Develop tax incentives and outreach strategy to reduce lawn/turf in urban suburban areas. Increase the principles of organic lawn care, IPM, nutrient management, composting, upgrade equipment to mulching and electric mowers.
16. Expand Broadband access to urban and rural communities to accelerate the use of precision agriculture and apps tools to improve implementation of conservation practices.
17. Support increased funding and research by UConn, Ag Experiment Station, Yale School of Forestry in new and adapted crops/breeds, IPM, soil health, Agroforestry, forest management, grazing systems, water management, controlled environment agriculture, and other production systems.
18. Increase training, technical assistance, and outreach on the programs, tools, techniques, and applied research needed to implement mitigation and adaptation practices. Virtual trainings should be an important component.
19. Establish a New England Center for Climate Controlled Agricultural Excellence to research and implement conservation practices and production techniques.
20. Fund the installation of additional weather stations to better capture CT's microclimates, and utilize Cornell's Climate Smart Weather Tools.
21. Develop payment system for ecosystem services, or tax incentives, for private landowners /farmers/foresters who implement climate mitigation and adaptation practices.
22. Implement actions from the Commissioner of Agriculture's Farmland Access Report. This will create pathways to land security (ownership, long term leases), with an emphasis on beginning

farmers and farmers of color. Secure land improves implementation of conservation practices, brings food security, green infrastructure and land management to new communities.
23. Increase technical assistance to CT municipalities on updating Planning and Zoning rules and regulations and techniques to prevent farmland loss, protect special soil landscapes and improve soil health and water management.
24. Develop and require adoption of model municipal regulations that improve protection of ecosystem services and landscapes with techniques such as conservation subdivisions, low impact development.
25. Provide funding and technical assistance to support the CTNOFA Ecotype Project as a statewide initiative, to save and produce seed/plant materials from native species for commercial production and sale. Expand to include indigenous food, herb, and fiber crops.
26. Continue to avoid or mitigate loss of Core Forest or Prime Farmland to large scale solar arrays. Plan for co-use with agriculture or utilize (adopt a standard) certified pollinator/wildlife friendly vegetation, infrastructure and management plan.
27. Develop a Statewide strategy for farmland protection and farmland access, based on a projection of food system goals, soil resources, infrastructure, social and environmental justice, nutritional needs, and habitats in a changing climate. It would be part of a regional initiative such as implementing the New England Food Vision and Wildlands and Woodlands Initiative.
28. Update CT E&S and Stormwater Manuals to include improved soil health and water management practices that better reflect climate change, science and technology.
29. Develop key messages and outreach strategies for policy makers, elected officials, and the general public on the importance of these practices, and the values of agriculture's contributions to mitigation, adaptation, and resiliency.

Relevant websites and references: www.farmland.org/farmsunderthreat
: https://www.pollinator-pathway.org/
: https://www.pollinator-pathway.org/connecticut
http://ctnofa.org/Documents/book_FINAL_OPT.pdf
https://www.nytimes.com/2009/09/24/garden/24garden.html?pagewanted=all
: https://ctnofa.org/ecotypeproject/
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Energy

Submitted by Working Group Member Amanda Fargo-Johnson with assistance from Thomas Morgart, Amanda Freund, Dina Brewster, Kimberly Stoner, Kip Kolesinskas

Based off Governor's Council on Climate Change 2011 Report- section on Agriculture

Planning for Connecticut agriculture climate change adaptation is critical, and energy plays an important role. While there is a variety of agriculture here in the state, they all have one thing in common, the cost of energy to run their businesses is high. Historically Connecticut ranks number two in the country for electric costs. With dairy and greenhouse operations bringing the biggest economic value to the state they also are the largest consumer groups within the agriculture sector to consume energy. With federal, state, and non-profit programs in place to provide funding and technical assistance to farms seeking to offset on-farm energy costs and usage more is still needed to be done in order to reach a higher level of sustainability.

Part of climate change adaptation includes strategies that will have positive effects economically and environmentally for agriculture operations. Future adaptation strategies should build upon the current infrastructure, reduction in on-farm energy usage, while allowing for new, innovative opportunities for growth in ways farms can produce renewable energy supplies to help reach state energy goals while reducing emissions. Farms in the state are interested in alternative resources, research, assistance and funding which are important to helping them make the right decisions. Connecticut Gov. Ned Lamont in 2019 signed Executive Order No. 3 which requires DEEP to analyze pathways and recommend strategies for achieving a 100 percent zero carbon target for the electric sector by 2040. The agriculture community with the correct strategies in place could assist with these long-term sustainability goals.

Within the CT Climate Preparedness Plan in 2011, based on stakeholder input and the experience and knowledge of its members, the Agriculture Workgroup recommended following specific principles and adaptation strategies. In order to support Connecticut agriculture and provide for economic growth and future job creation, there needs to be a vision for the future of Connecticut agriculture that includes strategies with regards to energy. Assisting farms with reducing their energy costs and usage which ultimately allows them to adapt to climate change, reduce the carbon footprint, all while providing food security for the State.

From 2013 Governor's Council on Climate Change Report:

Creation of a future vision for Connecticut agriculture should be developed through a stakeholder process and should be expansive and iterative. The vision should build upon strengths, seize opportunities, address risks and maintain an unwavering focus on sustainability and resilience. Create a framework for continued dialogue with the agricultural community to engage stakeholders in creating a shared vision for building resilience and sustainability in Connecticut agriculture Adaptation is an iterative process that requires continued dialogue with stakeholders in order to assess adaptation implementation strategies and their likely success. New research, on both climate change projections and new technologies that could help Connecticut agriculture adapt, should be incorporated into planning on an on-going basis. This effort should be led by a partnership of government agencies, agriculture non-profits and educational institutions and stakeholders from

each of Connecticut's agriculture sectors within a framework that engages stakeholders in creating a shared vision for building resilience and promoting sustainability in Connecticut agriculture.

Government agencies, agricultural non-profits and academic institutions can support the implementation of energy efficiency measures and renewable energy projects on Connecticut farms by providing funding and developing training in these sustainable practices.

CT Climate Preparedness Plan 2011

Align policies and funding to support resilient agriculture in Connecticut policies and grant funding that support resilient agriculture in Connecticut will be important to ensure that agricultural systems are able to adapt to climate change. Provisions that encourage climate change adaptation can be incorporated into existing policies, rules, regulations, standards, outreach and funding programs. Policies and funding programs should have the ultimate goal of managing the sustainable use of natural resources by all user groups. Funding for agriculture climate change research should be prioritized. Encourage new agricultural technology and infrastructure that minimizes additional greenhouse gas emissions and impacts to natural resources Consideration of the impact that new agricultural technology and infrastructure might have on greenhouse gas emissions and natural resources such as water, that will be most impacted by climate change, should be considered before adoption or investment in such. An analysis of the best available research, latest technology, generally accepted agricultural practices and public policies should be conducted to determine this impact. Provide integrated education and support to farmers and consumers to facilitate the implementation of agricultural adaptation strategies Entities such as agricultural non-profits, CT Department of Agriculture and educational institutions should incorporate climate change adaptation into their curricula in order to facilitate the implementation of agricultural adaptation strategies.

Public funding and other incentives will be needed to assist with infrastructure improvements necessary to help Connecticut agriculture adapt to climate change. Infrastructure improvements include, but are not limited to, passive and active cooling technologies for dairy facilities postharvest cooling methods for shellfish, efficient irrigation systems for greenhouses, nurseries, orchards and row crops, frost protection systems for fruits and warm weather crops, and greenhouse cooling technologies. Public funding for agriculture infrastructure improvements is considered to be of high urgency, with relatively low to medium resource needs and little room for regret in the near term by the Agriculture Workgroup.

Energy conservation and efficiency through the reduction of a farm's energy load is the first and most important step to achieving both farm and climate resiliency. Currently offered programs include energy efficiency incentives by USDA NRCS and REAP grants and loans through USDA Rural Development. At the state level Energize CT programs for business are available to farms who are Eversource or UIL customers. Those who are eligible can receive retrofit assistance thru the Small Business Energy Advantage Program. Also, through the Energize CT programs is a new construction program, the only incentive of its kind available to farms seeking to install new equipment not already in place on their farm or construct a new structure with energy efficiency measures. More funding is needed for new EE construction to leverage these dollars to help farms viably install energy efficient equipment at the onset of their projects. If farms are not able to access the appropriate incentive for new energy efficient equipment upfront, then they may opt for less

expensive in turn less energy efficient options. An increase in supporting programs would offer a way to help lower startup costs for new and beginning farmers along with farmers looking to expand their operation by helping to offset the costs of equipment while supporting a green Connecticut. Controlled environmental agriculture will play an important role in the future of food production in our state. These closed looped systems require large energy inputs for lighting and heating. Connecticut also has an emerging Hemp industry that is not only growing outdoors but indoors as well. Ensuring greenhouses and farm structures are constructed efficiently is key.

For farms seeking to install renewable energy measures, current Connecticut programs include net metering, virtual net metering (VNM) and the LREC/ZREC program. While net metering and the REC programs are currently slated to expire in coming years it will be important to ensure that the new energy tariff to take the place of the two programs is comparable in incentive. A comparable incentive will encourage and facilitate on-farm energy installation of such renewable energy as solar installations. Even with an increase in the VNM cap in 2019 available to agriculture customer hosts, the Eversource percentage of cap has already exceeded its capacity among the shared pool with state and municipal hosts. It's important to ensure that these credits are being used appropriately within the legislative intent to support farms seeking to use the VNM program and not just those installing systems on farmland. On a federal level renewable energy support is available to eligible producers from USDA Rural Development through the Renewable Energy of America Program (REAP). In addition, there is a federal tax credit to those who are eligible, currently decreasing over the next few years from 30% to 10% for commercial installations. Some farms may be eligible for financing of energy projects through the Connecticut Green Bank's C-Pace program.

CT RC&D a non-profit organization who through its CT Farm Energy Program has been able to provide technical assistance in the securing of over $4.3 million dollars in USDA REAP grants which when leveraged equates to over $17 million dollars in energy projects implemented on CT farms and agriculturally based rural small businesses since 2010. However, farms do not always meet eligibility requirements for such federal programs such as REAP or do not have enough money to leverage such grants on their own. Connecticut should seek ways to provide more support for on-farm energy implementation. As part of the one of the 2020 GC3 Agriculture and Soils Working Group stakeholder meetings guest speakers from the Departments of Agriculture in both Massachusetts and Vermont who have dedicated staff working on farm energy programs spoke about the ways they provide direct support to farms with implementation of energy projects. An example Connecticut could benefit looking further into is MDAR's Climate Smart Agriculture Program (CSAP). CSAP has two parts, Adaptation & Mitigation and Energy and farms can apply to one or both portions of the program. Within CSAP is the Agricultural Energy Program (ENER) which helps farms improve their sustainability through implementing energy efficiency and renewable energy projects; also contributes towards state: food plan, energy efficiency/clean energy and greenhouse gas reduction goals. While these grants help fund traditional projects they also allow for more creative and out of the box thinking to go from idea to implementation with support from the CSAP. Allowing farms to be creative with energy solutions specific to their operation will ensure their sustainability while leading to climate resiliency.

The most common renewable energy projects on farms in Connecticut have been historically solar installations. There is some interest in geothermal although cost can be a prohibitive factor for retrofitting systems. Hydroelectric and wind tend to not be as viable of an option for farms in the state. Biomass is a viable option for heating greenhouses or using manure from dairy and poultry

farms to create electricity and heat. An example of an innovative option is to consider Compost Aeration and Heat Recovery units which are modular and service medium to large farms, commercial and institutional compost operations.

An option for renewable energy on CT dairy farms is anerobic digesters. In general, anaerobic digester facilities use microorganisms to break down organic matter (e.g., food waste or animal manure) to produce a biogas that can be used as fuel to generate electricity or heat. The anaerobic digestion process also produces a byproduct ("digestate") that can be used as fertilizer for crops, and bedding among other things. Farms seeking to install anaerobic digesters on their dairy farm have seen an increase in options at the state level over recent years. With the passing of legislation that includes:

- exempt certain anaerobic digestion facilities from a requirement to obtain a solid waste facility permit from the Department of Energy and Environmental Protection (DEEP);
- Establish a process in which the DEEP commissioner may direct the electric distribution companies (EDCs, i.e., Eversource and United Illuminating) to enter into long-term agreements to purchase power from anaerobic digestion facilities;
- Require the Public Utilities Regulatory Authority (PURA) to develop standards for interconnecting and injecting biogas into the state's natural gas distribution system; and
- Increase the amount of virtual net metering credits available to agricultural customers with anaerobic digestion facilities;
- Anaerobic digestion is now eligible for the LREC program. In combination with these new State polices, farms may be able to access tipping fees and/or eligible for a USDA REAP grant.

While it appears that farms are now better suited to consider anerobic digesters, there are still barriers to implementation for those seeking to install such costly systems. Further support could be modeled around the Massachusetts thermal credit program, in MA their thermal incentive (a REC) for the renewable biogas that generates electricity; it's an AEC (Alternative Energy Credit) for the thermal component of heat generated by the engine set if the AD is a combined heat & power operation and meets minimum overall electric + thermal efficiency; also applies if the generated AD biogas is made utility grade and piped directly into a main gas pipeline under the new APS Thermal. Consideration of a direct incentive for farms installing AD that have phosphorus removal equipment attached to the system should be given considering the phosphorus requirements farms are being held to and the cost barriers they present. AD provides benefits including substantial odor reduction, production of a renewable energy source (biogas), reduction of greenhouse gas (GHG) emissions, potential pathogen reduction, minimization of solid waste for disposal, and enhanced nutrient management (Borowitzka 1999). Through the GC3 working group stakeholder meeting we see that 5 dairy farms in Vermont are moving forward with smaller models of AD systems that would be well suited to smaller dairy herds like we have here in Connecticut. Further support for this model should be investigated.

Within the topic of agriculture and energy lies siting large solar fields on prime and important farmland soils and core forest. With the passing of PA 17-218, which requires the CT Siting Council to consider input from the Department of Energy and Environmental Protection (DEEP) commissioner and Connecticut Department of Agriculture Commissioner on the impact of certain proposed energy-related projects on the environment, prime farmland or forest land, or agriculture,

before allowing them to proceed. There is a balance between reaching energy goals and ensuring affordable and productive farmland is available and accessible to Connecticut farmers. As a state we should pursue the idea of dual use, whether it be for pollinators, animals or crops grown in conjunction with large solar fields as a way to keep the land in production, support is needed in this area of exploration. We see where other Northeast states and beyond have been working on such systems. An additional option that could support farms economically, while helping those not able to install their own renewable energy systems is to explore the role farms could play in Connecticut's Community Solar program. Where feasible some farms have land that is not prime for farming and would be ideal for siting such systems.)

Farmers in Connecticut face barriers when considering energy projects. Some are intimidated by the number of programs or requirements it takes to install a project. While others who do work to implement such projects have experienced issues with permitting, interconnection, utility line upgrades, fees as well as financing such systems upfront. While current incentives may be useful for some, other farmers including new and beginning farmers with extended credit and no capital budgets, find it hard to invest in innovation even with positive ROIs due to upfront investment costs.

Links and Resources

Farm energy assistance available in CT (CT partner agencies brochure): http://ctfarmenergy.org/wp-content/uploads/2018/11/CTFarm_Energy_Brochure.pdf

3rd Edition of the CT Farm Energy BMP Guide: https://ctfarmenergy.org/wp-content/uploads/2019/07/CT_BMP_July17_WEB-1.pdf

On Farm Energy Fact Sheet (CFEP, USDA & UConn):

http://ctfarmenergy.org/wp-content/uploads/2018/11/On_Farm_Energy-facts-print.pdf CT Farm Energy Geothermal brochure: http://ctfarmenergy.org/wp-content/uploads/2018/11/CT-Geothermal-Brochure-2018-1.pdf

CT Farm Energy Survey (2014):

http://ctfarmenergy.org/wp-content/uploads/2018/11/2014_CT_Farm_Energy_Survey.pdf

Agricultural good practice guidance for solar farms:

https://solargrazing.org/wp-content/uploads/2019/06/Agricultural-Good-Practice-Guidance-for-Solar-Farms-UK.pdf

UMass Dual-Use: Agriculture and Solar Photovoltaics Fact Sheet: https://ag.umass.edu/sites/ag.umass.edu/files/fact-sheets/pdf/dual-use_012419.pdf

Vermont's Guide to Farming Friendly Solar: https://www.uvm.edu/sites/default/files/media/solar_on_farms_report_2017.pdf

EE case studies with Eversource and UIL: White Flower Farm:

http://ctfarmenergy.org/wp-content/uploads/2018/11/ECT-WhiteFlowerFarm-Case_Study.pdf

Gilbertie's Herb Farm:

https://www.energizect.com/organic-farm-raises-bar-responsible-practices-efficiency-upgrades-and-expertise-provided-ui%20

Bishop's Orchards Solar Project Fact Sheet:

http://ctfarmenergy.org/wp-content/uploads/2018/11/Bishops-Orchards-Solar-Project-Fact-Sheet.pdf

Prides Corner Farms Solar Project Fact Sheet:

http://ctfarmenergy.org/wp-content/uploads/2018/11/Prides-Corner-Farms-Solar-Project-Fact-Sheet.pdf

Land Use Planning Tools

Submitted by Working Group member Joan Nichols in collaboration with working group members Kip Kolesinskas and Chelsea Gazillo from American Farmland Trust

Connecticut farmland is a finite, non-renewable, and threatened resource that has sustained farm family businesses, local economies, local food systems, and natural resources for nearly 300 years. Working farmland demands little of state and local financial resources[12] yet contributes ten-fold to quality of life, food security, and environmental protection for all of Connecticut's citizens. Working farmland and the natural resources associated with this fragile land base should be looked at as a contributing solution to addressing the impact of climate change and resiliency.

The impact of climate change has far reaching consequences for Connecticut agriculture in terms of soil health, food production, farm profitability and the sustainability and growth of existing and yet to be established farm businesses. Land use planning on both the state and local level must take into consideration the wise use and protection of farmland in rural, suburban and urban communities. A regulatory framework that allows for diversification and innovation will ensure that Connecticut farmers have the necessary tools to sustain their businesses and combat the challenges associated with climate change.

Land Use Planning

It all begins and ends with wise land use planning. Land use planning in Connecticut takes place on both the state and local level.

State Level:

The Office of Policy and Management prepares a state plan of conservation and development (State C&D Plan, also known as the state POCD), every five years in accordance with Section 16a-27 of the Connecticut General Statutes. A Draft 2018-2023 State C&D Plan is under consideration by the General Assembly in the 2020 legislative session.[13] Agriculture is considered in limited context in three of the six Growth Management Principles: Principles 1, 4 and 5. Attachment "A" of this draft document provides a Directory of Plans Prepared by State Agencies. There is no statewide plan for agriculture listed in this directory.

Renewable energy projects are a critical component to mitigating the impact of climate change. Renewable energy projects help Connecticut farms offset farm energy costs and larger projects can provide additional revenue to the farm. The loss of productive farmland to large scale, ground-mounted solar projects should be fully vetted before any project is approved.

Recommendations:

1. Require a statewide comprehensive plan for Connecticut Agriculture. The existing statutory framework in which to develop and guide this plan would be the Governor's Council for Agricultural Development[14] Addressing adaptation and mitigation strategies to address climate change should be incorporated into this statewide plan for agriculture. These adaptation and

[12] https://s30428.pcdn.co/wpcontent/uploads/sites/2/2019/09/Cost_of_Community_Services_Studies_AFT_FIC_201609.pdf

[13] https://portal.ct.gov/OPM/IGPP-MAIN/Responsible-Growth/Conservation-and-Development-Policies-Plan/Conservation-and-Development-Policies-Plan

[14] https://portal.ct.gov/DOAG/Boards/Boards/Governors-Council-for-Agricultural-Development

mitigation strategies for agriculture would then be integrated into energy, food security, forest, wildlife, water, and other statewide plans.

2. Disincentivize location of solar projects on farmland. Incentivize multiple-use projects that allow for solar and agricultural production to co-exist on the same footprint when there are no other prudent and feasible alternatives, and as needed, as part of the farm business and/or succession plan. Maintaining soil health needs to be a critical component of the planning and installation of solar arrays.

3. Amend the Connecticut Siting Council membership to include someone who represents the interest of agriculture.

4. Incentivize Community Energy Projects that provide energy to the farm and the surrounding community while mitigating any impact to productive farmland.

5. Support additional research to understand how state and local land use planning laws relate to the trends in Urban and Highly-Developed (UHD) and Low-Density (LDR) conversion across New England and how that translates to wise use planning for agriculture in Connecticut.

Local Level:

In Connecticut, land use planning is conducted at the local municipal level. 169 sets of land use regulations have a direct impact on the growth and sustainability of Connecticut farms. Publications such as Planning for Agriculture – A Guide for Connecticut Municipalities[15] provides guidance and recommendations on how municipalities can support local agriculture.

Connecticut is a small state. Agriculture would benefit from a more regional planning approach. This would help mitigate the impact of climate change by taking a more wholistic approach to land use planning with consideration for transportation, smart use and protection of available farmland, smart use and sharing of available infrastructure, and marketing opportunities.

Innovation and technology are fundamental to mitigating the impact of climate change on Connecticut agriculture and local food production.

The average size of Connecticut's farms continues to decline[16]. Small farms and new farmers embrace innovation and technology that allow for food production on smaller acreages utilizing innovations in soil health practices, water conservation and indoor, controlled environment production. Larger farmers are seeking to diversify and extend their growing season while buffering themselves against the challenges of climate change. Connecticut farmers are embracing technology to help feed Connecticut.

Farmers often need to travel to centralized food processing centers to have their produce processed and packaged for added-value products. Livestock producers continue to travel across multiple state

[15] https://workinglandsalliance.org/wp-content/uploads/2016/06/AFT_Planning-For-Agriculture-CT-Guide_2016_Final.pdf

[16]https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_State_Level/Connecticut/st09_1_0001_0001.pdf

lines to have their animals processed in a USDA facility. The number of available USDA meat processing facilities in Connecticut cannot meet the demand for fresh, local protein. In addition to the capital cost to construct and operate a USDA meat processing facility, many Connecticut municipal zoning regulations prohibit slaughter facilities within their municipal boundaries. This adds additional cost to both the farmer and consumer for local protein and requires unnecessary burning of fossil fuels to transport the animal to the processing facility and then transport the processed product back to the Connecticut marketplace.

Municipal Plans of Conservation and Development (POCDs) are the foundation by which municipalities develop and amend planning and zoning regulations. Municipal sub-division regulations do not always account for the wise use and protection of farmland.

Suburban and urban communities often have unused publicly owned parcels of land that can be utilized for the growing of food by the shared community. SustainableCT[17] has recognized those communities that embrace smart growth, planning for agriculture, and community gardens.

Recommendations:
1. Encourage conservation sub-divisions where agricultural land can be set aside in perpetuity for agricultural production.

2. Eliminate minimum acreages for farms in municipal zoning regulations.

3. Encourage the use of unused publicly owned land in suburban and urban communities for local food production.

4. Encourage repurposing of abandoned commercial and industrial sites for the processing of agricultural products including meat processing facilities.

5. Recognize that farm and food production will look different in the future due to climate change. Large, indoor greenhouses for food production could become the new norm and should be embraced.

6. Reduce regulatory and permitting obstacles to the construction and repurposing of infrastructure to allow local food processing centers and on-farm food processing.

7. Consider adoption of Regional Agricultural Councils such as the Lower CT River Valley Regional Agriculture Council that can take a more regional approach to supporting and planning for Connecticut agriculture.[18]

8. Reduce any local regulatory hurdles that deter on-farm energy projects including anaerobic digesters.

9. Reduce any local regulatory hurdles that deter on-farm composting facilities, even if they include food waste.

[17] https://sustainablect.org/
[18] https://rivercog.org/commissions-and-committees/regional-agriculture-council/

10. Offer incentives and opportunities for year-round farmers' markets in either repurposed and/or multiple use existing facilities or new structures that are easily accessible and based on analysis from the Statewide Agriculture Plan.

Tax Programs and Incentives

Connecticut has many tax programs that help Connecticut farmers. Farms are businesses and like any other business enterprise, need to be profitable. Without farm profitability, there are no farms. Farm businesses should be eligible for any funding aimed at economic development either at the state or local level, just like any other business enterprise.

Recommendations:

1. Strength PA 490 – Connecticut's Current Use Assessment Law for Farmland, Forest Land, Open Space and Maritime Heritage Land by providing state determination over decisions of municipal assessors that do not abide by the intent of the law.

2. Provide a tax abatement for investment in agricultural land and infrastructure.

3. Adopt an investment tax credit for investment in agricultural land and infrastructure.

4. Assess all permanently protected farmland at PA 490 value in perpetuity.

5. Allow urban, commercial/industrial properties that are utilized solely for agriculture to benefit from a reduced land use tax assessment.

Farmland Preservation

Connecticut's Farmland Preservation Program was established in 1978. As of July 2019, the program has preserved more than 44,500 acres on 370 farms. The long-term goal is to preserve 130,000 acres.[19] Funding and manpower to support this program often is a collaborative effort between the state of Connecticut, federal agencies such as the USDA

Natural Resources Conservation Service (NRCS), local land trusts, and technical support from non-profits such as Connecticut Farmland Trust. Permanently protecting farmland is critical to protecting Connecticut's food supply, mitigating climate change, and providing a long-term source of available farmland for future generations. The choice for a farmland owner to permanently protect this invaluable asset is often a difficult and emotional one. Farmland owners need to balance family dynamics, a sense of heritage, financial needs and obligations, often within the context of farm transition planning. At its best, the process from start to finish can be lengthy.

This is exasperated by pressure from non-farming interests such as residential and commercial development who are all vying for a finite resource of available land. American Farmland Trust recently released a report: *Farms Under Threat – The State of the States*[20] According to this report, Connecticut scored among the top states for policies and programs that address the threat of conversion. On the flip side, Connecticut scored among the top states for the conversion of agricultural land to urban and highly developed and low-density residential uses. Demographically, the average Connecticut farmer is nearing 60 years old. Over the next 10 – 20 years a significant amount of Connecticut farmland will transition out of farming or to a new owner. Connecticut is at

[19] https://portal.ct.gov/DOAG/ADaRC/ADaRC/Farmland-Preservation
[20] https://farmlandinfo.org/publications/farms-under-threat-the-state-of-the-states/

a critical juncture in terms of farmland preservation. Smart planning for the protection of Connecticut farmland needs to happen now.

As has been previously noted, farmland and working farms have a positive impact in mitigating climate change and contribute to Connecticut's resiliency. The rate at which willing farmland owners can permanently their land should not be hampered in any way by state government or burdensome bureaucracy.

Recommendations:
1. Identify and eliminate any unnecessary regulatory roadblocks to the closing of agricultural conservation easements.

2. Prioritize full funding for the farmland preservation program through both the Community Investment Act (CIA) dollars and lump sum bonding. This is urgently needed to protect farms and reduce fragmentation.

3. Prioritize utilizing "buy-protect-farm" mechanism to expedite farmland preservation process and create farmland access opportunities for the next generation of farmers.

4. Seat and reinstate a fully functioning Farmland Preservation Advisory Board.[21]

5. Recognize changes in farming practices and provide for infrastructure that will accommodate indoor propagation.

6. Prioritize and fund the Community Farms Program for the protection of smaller farms in more urban and suburban communities.

7. Review and revise the Farmland Preservation Program and Community Farms Preservation Program regulations criteria to increase the pace of farmland preservation to more adequately reflect the current and future needs of Connecticut agriculture for farms of all sizes and types of farming.

8. Provide a tax incentive for new and beginning farmers and underserved populations to be able to purchase permanently protected farms at farmland value.

9. Continue to fund and maintain a robust FarmLink program as a valuable tool to connect farmland owners with farmland seekers.

10. Consider allowing provisions in agriculture conservation easements that allow for appropriate new technologies, such as dual-solar, that can help mitigate climate change while protecting soil health.

11. Consider the environmental role of forestland in agricultural easements and require forest management plans for any agricultural easement that includes forestland.

[21] https://portal.ct.gov/DOAG/Boards/Boards/Farmland-Preservation-Advisory-Board

Farming and Conservation Practices
Submitted by working group member Kip Kolesinskas.

What programs/policies exist to advance these practices?
Land protection and planning to reduce conversion and protect/restore landscape ecosystem functions

· CT Department of Agriculture Farmland Protection Program & Community Farms Program
· CT Department of Agriculture Farmlink Program
· CT Department of Energy and Environmental Protection Open Space and Watershed Land Acquisition (OSWA) Program
· CT Department of Energy and Environmental Protection Urban Green and Community Garden Program
· Municipal Land Protection Programs
· CT Green Plan- CT's Comprehensive Open Space Acquisition Strategy
· CT Forest Action Plan
· CT Wildlife Action Plan
· Municipal Plans of Conservation & Development
· State Plan of Conservation & Development
· Department of Energy and Environmental Protection Recreation and Natural Heritage Trust Program
· CT Inland Wetlands and Watercourses Act
· NPS Land & Water Conservation Fund
· USFS Forest Legacy Program
· National Fish & Wildlife Foundation
· USDA Natural Resources Conservation Service (NRCS) Agricultural Conservation Easement Programs; ALE, WEP, HFRP
· USDA NRCS Emergency Watershed Floodplain Easement Program (EWP-FPE)
· USDA Farm Service Agency (FSA) Conservation Reserve Program
· Private Non Profit Conservation and Land Trust Organizations
· PA 490 Tax Use Value Assessment Programs
· 10 Mill Program
· CT PA 17-218, Review of impacts on core forest and prime farmland from energy development
· Chapter 466, CT General Statutes Section 22-6, review of State funded projects that impact 25+ acres of prime farmland soils
· Federal Farmland Policy Protection Act (FPPA)

Conservation Practices on Agricultural, Forest and other lands
· CT Department of Agriculture Farm Transition Grant
· CT Department of Agriculture Farm Viability Grant
· CT Department of Agriculture Farmland Restoration Program
· CT Department of Agriculture Shellfish Sanitation Program
· CT Department of Agriculture technical assistance
· CT DEEP Service Forestry Program
· CT DEEP Urban Forestry Program
· CT Agricultural Experiment Station technical assistance
· CT Agricultural Experiment Station IPM assistance
· CT Agricultural Experiment Station Soil testing and nutrient management assistance

· UConn Extension Master Gardeners assistance
· UConn Soils Testing lab and nutrient management assistance
· UConn Extension Specialist assistance on Forestry, IPM, Greenhouse, nursery, turf, livestock, fruit, vegetable production
· USDA NRCS Conservation Technical Assistance (CTA)
· USDA NRCS Environmental Quality Incentives Program (EQIP), Agricultural Management Assistance Program (AMA), Conservation Stewardship Program (CSP),
· USDA Specialty Crop Block Grant Program
· CT's Five Conservation Districts technical assistance

Top Goals for This Group

1. Reduce Conversion of Prime and Important Farmland Soils, active agricultural land, forest land, aquaculture important subaqueous soils and other soil landscapes that provide critical ecosystem functions and values/ goods and services such as groundwater recharge/discharge, protection of headwaters of cold water streams, public water supply watersheds, floodplains and riparian areas, wetlands and wetland hydrology, support special habitats and migration corridors for species.

2. Protection of these areas with an emphasis on protection with appropriate easements that allow management consistent with the needs for climate change adaptation, mitigation, and resiliency.

3. Reduce emissions from use of fossil fuels from equipment, petroleum-based fertilizers and pesticides, loss of soil carbon and denitrification.

4. Increase perennial and carbon sequestering and storage by vegetation management on all landscapes. Utilize native genotypes/species and noninvasive when possible.

5. Increased stakeholders understanding of climate change impacts, adaptation and/or mitigation strategies

6. Increased adoption of appropriate farm management practices by farmers to enhance climate change adaptation &resilience

7. Increased understanding of challenges and opportunities for agriculture by consumers, policy makers and elected officials

8. Increased knowledge of Federal and State Programs and Risk Management and Crop Insurance Tools

9. Increase planning for climate extremes and emergencies

10. Gender and racially diverse shared learning to better understand impacts and develop solutions

11. A resilient, adaptive, economically successful agriculture, forest industry, and food system in every CT community as part of a cohesive regional multistate strategy.

Strategies for mitigation:

1. Reduce conversion of forest and farmland to residential, commercial, industrial

2. Reduce emissions from use of fossil fuels from equipment, petroleum based fertilizers and pesticides.

3. Utilize soil health practices that reduce tillage, increase soil carbon, and reduce denitrification.

4. Utilize methane digesters, manure storage covers, gas collection systems, liquid solid separation, improved manure transfer and distribution to reduce emissions

5. Utilize woody biomass from sustainably harvested sources with clean furnaces for heating and energy production on farms.

6. Increase use of farm based composting of manure, food and yard waste to reduce emissions, store carbon, and reduce petroleum based fertilizer use.

7. Utilize more rotational grazing systems and highly managed forages for all grazing animals.

8. Reduce lawn and turf areas that require frequent mowing, upgrade equipment to mulching and electric mowers

9. Avoid or mitigate loss of Core Forest or Prime Farmland to large scale solar arrays. Plan for co-use with agriculture, or utilize certified pollinator friendly vegetation and management.

How can farmers and landowners adapt to climate change and build resiliency?

1. Risk Assessment
2. Diversification
3. Improvement of soil health
4. Use of conservation practices
5. Newly adopted production systems

Adaptation Strategies- Farm level adjustments that build resilience

1. Focus on Soil Health
2. Utilize Integrated Crop Management Systems
3. Diversify Farm Enterprises
4. Efficiently Manage Water Resources & Risks
5. Reduce Livestock Stress From Extreme Temperatures
6. Engage in Farm Planning and Adaptive Management
7. Efficiently Manage Water Resources& Risks
8. Establish land access for a diverse group of beginning farmers and land managers on all landscapes

1. Focus on Soil Health

• Reduce tillage frequency and intensity, transition to low-till or no-till planting methods where feasible.
• Increase organic matter inputs through cover crops, crop residues, green manure crops, manures, and compost.
• Use winter and summer cover crops between main crops to maximize soil surface protection.
• Use mulches, raised beds to cool and warm soils

• Use tillage methods which preserve plant residues. The goal is to minimize time with no plants covering the field.
• Develop a rotational plan to maximize the use of perennial crops in the rotation to avoid some or all tillage requirements.
• Reduce soil compaction by minimizing equipment passes over fields. Stay out of fields when soils are wet! Upgrade to low pressure tires on equipment
• Avoid fall tillage and bare winter fallow whenever possible

2. Utilize Integrated Crop Management Systems
• Stay abreast of new threats and be aware of life cycles and how pests spread.
• Conduct regular scouting for weeds, insects, and pathogens, and control them with proven strategies.
• Use crop varieties and livestock lineage with resistance to pests and pathogens.
• Implement cultural and biological controls for pests whenever possible.
• Correctly use appropriate pesticides when pest or pathogens exceed economic thresholds.
• Practice sanitary farming practices (e.g. clean equipment in-between fields) to reduce the spread of pests and pathogens.
• Tests soils and compost regularly. Split applications to avoid loss

3. Diversify Farm Enterprises
• Be open to change. Choose a variety of commodities, farm products and services that insulate against weather, environmental, market, and geopolitical threats.
• Diversify crop production by extending crop rotations and intercropping with multiple species or varieties.
• Select crop varieties based on maturity dates and genetics to match anticipated season length, rainfall and drought patterns, and pest/pathogen pressures.
• Consider controlled environment agriculture to extend the growing season, diversify operations, and decrease weather risks.
• Select livestock breeds and genetics that tolerate temperature extremes
• Diversify the soil resources used to reduce risk. Consider leasing, purchase of land, rotations to manage this.

4. Reduce Livestock Stress for Extreme Temperatures
• Ensure that livestock facilities are well ventilated and have proper cooling mechanisms in place. This includes calf housing, lactating and dry cow facilities.
• Provide access to shade while on pasture.
• Use fans and sprinkler systems controlled with automatic sensors to reduce the risk of heat stress on all animals.
• All animal classes should have access to fresh, clean water.
• Monitor and adjust diets for daily intakes. Rations should be balanced to meet animal needs at a reduced intake during periods of heat stress.
• Consider planting warm season grasses, stockpiling forage, rotational grazing to maximize quality forages.

5. Engage in Farm Planning and Adaptive Management
• Develop and implement a conservation plan
• Develop an adaptation plan to identify your risks and practices to remediate them.

• Conduct a whole-farm energy audit to increase efficiency and opportunities for renewable energy sources.
• Utilize precision farming apps, weather and climate tools (such as climatesmartfarming.org) to make more informed crop production decisions.
• New and renovated farm buildings should be energy efficient and designed to withstand predicted weather conditions, including severe heat, heavy rainfall, wind, and snow loads.
• When purchasing new equipment, select options to maximize fuel efficiency and decrease labor and time constraints.
• Consider purchasing crop insurance to reduce economic risks

6. Efficiently Manage Water Resources& Risks

· Improve irrigation efficiency by using the latest technologies, such as micro-, subsurface, or drip irrigation;
· Install tile drainage, ditches, and waterways in fields to remove excess water and control runoff.
• Expand or improve water supply systems to meet future demand, and increase water storage capacity by constructing deeper wells and ponds, cisterns on structures.
• Time fertilizer and manure applications based on weather forecasts.
• Plant or manage riparian buffers along streams and ponds to capture remaining runoff, reduce erosion and scour
· Integrate agroforestry & permaculture into farming systems to increase water-use efficiency during dry periods and diversify cropping systems.

Policy Recommendations and Actions

1. Establish dedicated staff at UConn, Ag Experiment Station, CT Dept of Agriculture, Conservation Districts to provide technical assistance on tillage practices/equipment, soil health practices, grazing/forage management

2. Contact Congressional Delegation and USDA about the need for additional NRCS staff and technical assistance for conservation planning and implementation.

3. Modify CT Dept of Agriculture programs such as EAP, Farm Transition, Farm Reinvestment Program to create an integrated Climate Program for producers similar to the Massachusetts Climate Smart Agriculture Program. Would have continuous signup, expand to cover equipment, vegetative conservation practices, soil health practices, and offer ability to leverage Federal program funds to 90-100% of the costs.

4. Accelerate and streamline CT Dept of Ag Farmland and OSWA easement programs to close in 2yrs or less, with 2x the number of easements closed with 4 yrs. Additional staffing, partners, reduce barriers such as SBRB, pursue alternative appraisal processes, drop/reduce cost share requirement from project partners.

5. Modify existing State Agency Grant programs (including DEEP and DoAg) ranking criteria to include climate mitigation, adaptation, resiliency elements.

6. Develop stronger Farmland Protection and mitigation regulation to prevent loss of farmland from state funded projects.

7. Contact Congressional delegation to strengthen federal FPPA to reduce conversion of farmland

8. Modify and update Urban Green and Community Garden Program to include CT Dept of Ag as a sponsor or partner, with a Climate smart practices and food system focus. Remove the match requirement.

9. Submit proposals to USDA NRCS RCPP Program, CIG Grants to accelerate protection and management of parcels in public water supply areas, important habitats, flood prone areas, recharge and discharge areas.

10. Create incentives for the dairy industry to utilize more grazing, perennial forage based systems.

11. Create incentives/funding to utilize methane digesters, manure storage covers, gas collection systems, liquid solid separation, backed bedding barns, improved manure transfer and distribution to reduce emissions from animal agriculture and food waste.

12. Evaluate and modify composting and food/yard waste standards to accelerate farm based composting and utilization on private lands.

13. Create additional State funding and program incentives for municipal participation in Sustainable CT initiative.

14. Develop and fund Statewide a Pollinators Pathway program initiative based on CT NOFA initiative. Some 63 Towns have initiatives with over 5,000 households.

15. Develop tax incentives and outreach strategy to reduce lawn/turf in urban suburban areas. Increase the principles of organic lawn care, IPM, nutrient management, composting, upgrade equipment to mulching and electric mowers.

16. Expand Broadband access to urban and rural communities to accelerate the use of precision agriculture and apps tools to improve implementation of conservation practices.

17. Support increased funding and research by UConn, Ag Experiment Station, Yale School of Forestry in new and adapted crops/breeds, IPM, soil health, Agroforestry, forest management, grazing systems, water management, controlled environment agriculture, and other production systems.

18. Establish a New England Center for Climate Controlled Agricultural Excellence to research and implement conservation practices and production techniques.

19. Fund the installation of additional weather stations to better capture CT's microclimates, and utilize Cornell's Climate Smart Weather Tools.

20. Develop payment system for ecosystem services, or tax incentives, for private landowners /farmers/foresters who implement climate mitigation and adaptation practices.

21. Implement actions from the Commissioner of Agriculture's Farmland Access Report. This will create pathways to land security (ownership, long term leases), with an emphasis on beginning

farmers and farmers of color. Secure land improves implementation of conservation practices, brings food security, green infrastructure and land management to new communities.

22. Increase technical assistance to CT municipalities on updating Planning and Zoning rules and regulations and techniques to prevent farmland loss, protect special soil landscapes and improve soil health and water management.

23. Develop and require adoption of model municipal regulations that improve protection of ecosystem services and landscapes with techniques such as conservation subdivisions, low impact development.

24. Provide funding and technical assistance to support the CTNOFA Ecotype Project as a statewide initiative, to save and produce seed/plant materials from native species for commercial production and sale. Expand to include indigenous food, herb, and fiber crops.

25. Continue to avoid or mitigate loss of Core Forest or Prime Farmland to large scale solar arrays. Plan for co-use with agriculture, or utilize (adopt a standard) certified pollinator/wildlife friendly vegetation, infrastructure and management plan.

26. Develop a Statewide strategy for farmland protection and farmland access, based on a projection of food system goals, soil resources, infrastructure, social and environmental justice, nutritional needs, and habitats in a changing climate. It would be part of a regional initiative such as implementing the New England Food Vision and Wildlands and Woodlands Initiative.

27. Update CT E&S and Stormwater Manuals to include improved soil health and water management practices that better reflect climate change, science and technology

Agricultural Practices and Technology-

Submitted by UConn College of Agriculture, Heath and Natural Resources committee members Indrajeet Chaubey and Bonnie Burr as well as faculty members Rich McAvoy, Rich Meinert and Rosa Raudales. Dairy producers Ben Freund, Amanda Freund, Seth Bahler with greenhouse expertise offered by Joe Geremia and Kevin Sullivan.

Climate change offers tremendous opportunity to the agricultural sector to create a systems approach to farming. This needs to be done while addressing how innovation and research can improve food and plant production with a myriad of other needs society has as it struggles with climate change. Agriculture's need to feed the world's 9 billion people in a climate that shifts and seems increasingly volatile and extreme. Costs affiliated with addressing climate change combined with volatile profit margins leave agricultural producers at a loss for self-funding newer more innovative production practices. Adding behavioral sciences to agriculture practices will be necessary to lead implementation of innovative new practices to deal with shifting climatic trends. Research has shown that promoting best intervention practices without understanding their socio-cultural relationships reduces adoption rates of new technologies.

In 2019, the National Academies of Sciences, Engineering, and Medicine released *Science Breakthroughs to Advance Food and Agricultural Research by 2030*. In this report, they shared "To achieve the major goals of efficiency, resiliency, and sustainability, improvements are needed to address the most challenging issues across food and plant systems. The key research challenges identified by the committee include (1) increasing nutrient use efficiency in crop production systems, (2) reducing soil loss and degradation, (3) mobilizing genetic diversity for crop improvement, (4) optimizing water use in agriculture, (5) improving food animal genetics, (6) developing precision livestock production systems, (7) early and rapid detection and prevention of plant and animal diseases, (8) early and rapid detection of foodborne pathogens, and (9) reducing food loss and waste throughout the supply chain." All of these challenges fall squarely on how we create a systematic response to climate change.

For the purposes of this subcommittee report on innovation, there are three targeted areas: soils, controlled environment agriculture and nutrient management of livestock operations.

Policy recommendations for sustaining environmental and soil health - There are a variety of innovations that can be utilized to improve environmental and soil health. These include but are not limited to:

- Create programs to financially support programs on how agriculture contributes to carbon sequestration

- Applying nanotechnology-based sensors into plants and soils to monitor plant productivity, including schematic representation of real-time continuous monitoring of soil, crops, water, and livestock via microelectromechanical and biodegradable sensors.

- Utilize sensor data for modeling and for predictive and prescriptive agriculture. Precipitation alerts let farmers know which fields may be too wet or too windy to apply pesticides so they can avoid costly treatments and unnecessary fossil fuel use.

• Reducing tillage - With better weed-control solutions, farmers reduce the need to till, decreasing tractor passes over the field and allowing for less soil disruption. This not only curbs greenhouse gas emissions and fossil fuel use, but when soil is left untilled it is better able to store carbon, as well as nutrients and water.

• Increasing efficiency - Satellites and drones provide real-time field health images that enable farmers to identify areas of crop stress or pest infestations faster so action can be taken more quickly.

• Optimizing nutrients - Utilize microbes to enhance crop production and enrich crops by helping plants harness and use nutrients and water more efficiently.

• Use of metagenomics (Biteen et al 2016) to leverage development of new microbial products that may be more resilient to stress and as components of targeted biofertilizer and biocontrol formulations.

• The Internet of things (IoT) - addresses the adoption of beneficial data-driven technologies to enable seamless data collection from various sensors, cameras, and drones and are the foundation for intelligent systems, such as precision agriculture and spans the entire food system (Wolfert et al., 2017).

• Create a common infrastructure or platform with open access and unified data sharing for ecosystems and physical, chemical and biological soils data to support the 5R approach to precision agriculture (right inputs, right time, right place, right amount, right manner (Khosla 2010)

• Increase water-use efficiency through the application of multiple technologies, improved data analytics, and better biophysical-based integrated systems models.

• Increase use of nutrient efficacy practices through use of sensing technologies, data analytics, precision plant breeding, and land management practices. Utilize field level carbon measurements, digital management records, remote sensing, predictive analytics, in a connected platform that producers control- Yale F&ES is working on this

• Accelerate innovation by creating a digital infrastructure that holds and provides FAIR (findable, accessible, interoperable, and reusable) and open access to agri-food datasets from planting to food waste. Develop strategies for data science in food and agricultural research, and nurture the emerging area of agri-food informatics by adopting and influencing new developments in data science and information technology in food and agricultural research.

• Identify ways to reuse Phosphorus in addition to precision application methods of fertilizer and manure management. Identify new ways to improve bio-availability of nutrients, new mechanisms to recycle nutrients, improve fertilizer use efficiency.

• Use of synthetic biological approaches for custom design of rhizosphere microbiomes that could enhance productivity of specific crops Given soil types and climate (Busby et al 2017)

• Create more productive and sustainable crop production systems by identifying and utilizing soil microbiomes capability to produce nutrients, increase nutrient bioavailability and improve plant and

crop resilience to stress and disease. Address the roles of soil microbiomes and plant traits in controlling water-use efficiency

• Conduct research on the metaphenome of the soil microbiomes

• Increase research on the biochemical pathways involved with SOC decomposition and greenhouse gas emissions

• Greater utilization of pest-exclusion nets to create barriers to protect specialty crops against pests and diseases. The nets serve as floating row covers to control temperature, light, relative humidity and soil moisture for plant production.

• Utilize concepts of dry chain - drying products and maintaining their dryness with hermetic storage that prevents mold growth after harvest and during storage, reducing food waste and exposure to mycotoxins such as aflatoxin.

• Soil solarization - reduces heat-sensitive weeds, pests, and diseases without chemicals. Facilitated solarization reduces the time needed by covering clear solarizing plastic with an insulating layer at night to reduce the heat lost during cool nights then remove insulation as the sun comes up in the morning

• Improve capturing data on the precise use of water in agriculture, using spatially resolved data on plant health, soil properties, nutrient concentrations, water quality parameters and water quantity to develop accurate prediction models for water use efficiency.

• Collect data at a higher spatial and temporal resolution to connect to satellite imagery to support ecohydrology based approaches to water management.

• Identify efficient methods to increase soil carbon content to improve water-holding capacity of soils.

• Increase use of solar pumps for irrigation

• Increased efficiency will also be achieved through an ability to select from a number of genetic varieties of plants based on relevant weather and seasonal climate forecasts. Plants can be selected for varieties that are salt or drought tolerant in dry years when alternative impaired sources of water are used for irrigation.

Controlled Environment Agriculture

Controlled environment agriculture is already a major contributor to Connecticut's $3.5 billion agricultural economy with significant growth potential. With limited land resources, unpredictable growing seasons and the need to increase efficient use of water resources, controlled environment production will be instrumental in addressing climate change. There is currently untapped consumer demand for Connecticut grown products, particularly locally grown food. With controlled environment agriculture, food will be produced year-round in urban, suburban or rural settings, contributing significantly to local food production and local employment. It will overcome

limitations of land availability and the impacts of our traditional seasonal growing patterns. Successful models in Europe, Canada and Mexico illustrate how indoor and controlled environment agriculture contributes significantly to local food and plant production, economic development and job growth. Connecticut's established nursery and greenhouse industry gives our state a competitive advantage if we are able to use the latest innovations in controlled environment agriculture and help to create new business ventures. Innovation should focus on food and plant production systems, energy efficiency, environmental sustainability, and environmental control management.

Policy Recommendations for Controlled Environment Agriculture

• For food production systems the research emphasis will be on increasing productivity, developing production recommendations for new crops, enhancing the nutritional value of crops, and improving sustainable production practices.

• Energy related inputs will emphasize energy conservation, alternative energy sources, improved efficiency and technology transfer to enable commercialization.

• Environmental impacts focus on improved water and fertilizer efficiency especially in closed systems, innovative pest and disease management, and reducing the waste stream. Special emphasis on the intersection of plant production, energy, and water utilization in the greenhouse environment.

• Water savings in CEA are proven, but more innovation is needed to understand how recirculating water affects and can improve overall system sustainability. Continue focusing on water management and water purity, incentivizing innovative computer aided water distribution techniques.

• Continue researching environmental control management impacts for energy efficiency, crop response and productivity as well as bio-control dynamics so greater optimization of management systems is achieved.

• CEA systems are energy intensive so better energy management strategies are needed. Optimal approaches for lighting and cooling systems, temperature control, feed, disease management, still need to be determined to make these systems scalable, economically viable, and sustainable.

• Innovations and advancement in techniques associated with propagation of tissue culture such as protoplast fusion, cell fusion, hybridization and genetic engineering allow for minimizing growing space yet controlling the inputs necessary for accelerated plant growth.

• Utilize plant breeding programs to increase availability of native plants for soil stabilization and enhanced pollination resources. Breeding programs will also design plants to perform with substantially less irrigation and crop protection products.

• Continue researching challenges with coupling CEA systems to the other elements of the built environment to close the loop on nutrient and water use including adding aquaculture and fish production to these systems.

• Alternative sources of water and controlled environments can improve water-use efficiency and water productivity. Determine what alternative water sources and system-level management practices are available for agriculture.

• Incentivize systems that apply grey water recycling.

• Additional innovation needs to focus on how CEA can be designed to lower water use and increase water productivity. Increasing water-use efficiency by implementing multiple water saving technologies across integrated systems by using prescriptive analytics for water management will be useful.

• Need to adopt more resilient growing systems that rely on less single use plastic.

• Innovative educational programs need to be created for consumer education that promotes responsible site management, lawn reduction and habitat restoration to promotes soil health and water quality and sound water quantity usage.

Nutrient Management

Nutrient (manure) management, especially on dairy farms wishing to utilize anaerobic digesters (AD) has been very difficult and little progress has been made since 2011. While surrounding states are moving ahead with AD projects (MA, NY, VT), CT has had little success so far. The proformas do not cash flow on CT farms due to increased costs, and stricter phosphorus restrictions. CT farms must work within the parameters of their Comprehensive Nutrient Management Plans (CNMP) to protect soils and state waterways and ground water from excess nutrients, particularly phosphorus. These CNMP's are reasonable and serve as guardrails as we deal with renewable energy opportunities. Dairy farms offer tremendous potential to contribute to two important CT priorities including renewable base load power production and reduction and or recycling food waste. Management practices including anaerobic digesters (AD), aerating manure, storing manure at low temperatures (below ground) and removal of methane using biological filters or, trapping and burning methane as a fuel can help reduce and offset fossil fuel otherwise needed. Improving practices that can reduce nitrous oxide emissions from farms may include greater use of legumes as a nitrogen source and adjusting tillage intensity.

Policy Recommendations for Nutrient Management

• Research must be updated to address and assign the full eco-system value of ag related programs versus other renewable energy sources. DEEP, PURA and DOAG should set up a program to encourage the development of these agricultural projects that includes working with agriculture to streamline the entire regulatory process and allocate necessary financial incentives. Cross cutting agency workgroups must be utilized and driven towards solutions by the Governor and executives from agency teams. Public utilities must be included as they have historically blocked these viable projects both with timeliness of response and their designated rules of engagement.

• Project assessment must utilize local values where appropriate that can be uniquely assigned to provide greater transparency in evaluating projects by applicable state agencies.

• Eco-system assessment with more detailed and comprehensive data should be attributed to dairy farms. Economic shifts in the dairy industry increased the consolidation in farm operations so producers could attain economic sustainability. Federal regulations of milk marketing create very tight and often negative financial impacts and should be considered creating climate change policies.

• UConn College of Agriculture Health and Natural Resources studies have played a critical role in decision making processes. These should be regularly updated illustrating how agriculture impacts the economic vitality of the state as well as local communities. This is the first step towards showing the climate benefits of agriculture and open space versus permanently covered surfaces such as roads, highways, parking lots, commercial space and homes.

• Apply innovation to create compost which can be prescriptive by testing compost for nitrogen, phosphorus and potassium before selling to home owners and commercial users. End users should be encouraged to test soil where compost is added to ensure overapplication of nutrients does not occur.

• DEEP composting regulations should be changed to ensure manure is considered manure and not categorized differently when farms co-mingle manures to create compost materials.

• Anaerobic Digesters (AD) projects on dairy farms need to identify funding options to help projects become viable. CT should identify and incentivize innovative technologies that can separate out and reduce nutrients, especially phosphorus from our organic materials before they are applied to agricultural lands.

• Anaerobic Digesters (AD) create a nutrient rich digestate by-product and it's critical to develop markets for off farm use. Regular soil testing of farm fields will highlight which nutrients found in manure are required while others are not. Assistance in carrying out proper market research is necessary as well as business development assistance to create a new value added agricultural product for the market. If it's not packaged and marketed properly the material has no destination besides farmland.

• Unlike renewable technologies such as wind and solar, AD is a net reduction (of emissions) technology. Innovation is required to increase energy derived from AD's which is up to 25X more beneficial (based on methane destruction alone) to the environment than simple offsetting technologies such as solar and wind.

• Herd size is a key component of developing AD projects. While this technology is very successfully incorporated on European farms with less than 200 cows, that has not happened here in the US due to regulatory and cost constraints. CT farms need to be able to co-mingle manures in a regional approach to meet size efficiencies usually found beginning at 3000-4000 cow numbers. The other option is creating incentives for smaller herds to install AD's if co-mingling becomes an issue.

• Increase capture of methane emissions by installing equipment, or purchasing precision application equipment needed to manage this gas. Dairy cooperatives such as AgriMark have initiatives to satisfy consumer concerns about methane emissions tied to rumination. Additional research is needed on the efficacy of feed additives to optimize efficiency of production while reducing emissions.

• Use of new and emerging technologies should be refined as food waste is combined with manures. Separation and removal of nutrients which are trending towards saturation on some fields in this state needs to be addressed. The incentive provided for taking food waste/scraps must cover the added cost of transporting increased volume of digestate. Scale must be considered in economic formulas.

• Incentivizing and increasing farm waste to be channeled into LPG such as propane will offer more clean energy fuel options and should be explored further.

• Increase utilization of ag waste for Virtual Net Metering (VNM) allowing farmers to sell off excess energy to other farmers, consumers or municipalities. Programs found such as Vermont CowPower and the Optima KV project at Duke Energy in North Carolina are examples of how dairy/livestock farms can partner with energy companies.

• Applying VNM in large scale solar projects on prime and important agricultural soils should be heavily monitored. Research is required to see how soil and land productivity are affected when solar panels are no longer efficient, or in use and solar infrastructure needs to be removed.

Our state must prioritize its investment in agricultural innovation as well as research to ensure we balance a healthy agricultural economy with a healthy environment and healthy consumers.

Building a Sustainable and Equitable Food System for Connecticut

Submitted by working group member Chelsea Gazillo with support from working group members Latha Swamy, Dina Brewster, and Kip Kolesinskas. Special thanks to Jiff Martin (UConn - Extension), Bonnie Burr (UConn - Extension), and Meg Hourigan (CT Food System Alliance).

Findings from 2011 Connecticut Climate Change Preparedness Plan as relates to Market Opportunities/ Building a Sustainable and Equitable Food System for Connecticut

1. Create a vision for the future of Connecticut agriculture Connecticut agriculture contributes $3.5 to 4 billion to the State's economy, and accounts for more than 20,000 jobs (Lopez et al. 2017).

Its strength may be attributed to many factors, such as a close, densely populated customer base, farm and farm product diversification and a highly educated population that values local agriculture and rural character. In order to support Connecticut agriculture and provide for economic growth and future job creation, there needs to be a vision for the future of Connecticut agriculture that includes strategies to reduce stressors and adapt to climate change, with the ultimate goal of promoting food security for the State. Creation of a future vision for Connecticut agriculture should be developed through a stakeholder process and should be expansive and iterative. The vision should build upon strengths, seize opportunities, address risks and maintain an unwavering focus on sustainability and resilience.

2. Create a framework for continued dialogue with the agricultural community to engage stakeholders in creating a shared vision for building resilience and sustainability in Connecticut agriculture.

Adaptation is an iterative process that requires continued dialogue with stakeholders in order to assess adaptation implementation strategies and their likely success. New research, on both climate change projections and new technologies that could help Connecticut agriculture adapt, should be incorporated into planning on an on-going basis. This effort should be led by a partnership of government agencies, agriculture non-profits and educational institutions and stakeholders from each of Connecticut's agriculture sectors within a framework that engages stakeholders in creating a shared vision for building resilience and promoting sustainability in Connecticut agriculture.

3. Align policies and funding to support resilient agriculture in Connecticut

Policies and grant funding that support resilient agriculture in Connecticut will be important to ensure that agricultural systems are able to adapt to climate change. Provisions that encourage climate change adaptation can be incorporated into existing policies, rules, regulations, standards, outreach and funding programs. Policies and funding programs should have the ultimate goal of managing the sustainable use of natural resources by all user groups. Funding for agriculture climate change research should be prioritized

4. Provide integrated education and support to farmers and consumers to facilitate the implementation of agricultural adaptation strategies

Entities such as agricultural non-profits, CT DOAG, UConn Extension and other educational institutions should incorporate climate change adaptation into their curricula in order to facilitate the implementation of agricultural adaptation strategies. Education directed at farmers should include

strategies to conserve water and suggestions of new crops and animals that would be more suitable to changing climatic conditions. These farmer-oriented educational activities could be best delivered in vocational or higher learning institutions or by agricultural extension programs. Education directed at the consumer should include information about new crops available in stores and at local farmers‘ markets, and strategies to sustain local agriculture, such as ―buy local‖ campaigns.

Building a Sustainable and Equitable Food System for Connecticut

1. Planning/Coordination
    a. Review and the update structure, membership, and duties of CT Food Policy Council to promote food security, strengthen food systems, and mitigate/adapt the impacts of climate change.
    b. Support and fund food system planner at the municipal level. This would include replicating the city of New Haven's Food System Policy Director position in municipalities across the state.
    c. Support CT Food System Alliance's plan to develop a Statewide Food Plan
    d. Develop a statewide agricultural plan that outlines a timeline and objectives for the state to have every resident in the state purchasing 5 percent of their groceries from local producers by 2030.
    e. Support planning for urban agriculture initiatives including urban agriculture master plans at the local level.
    f. Encourage municipalities to adopt urban agriculture ordinances/change zoning codes.
    g. Support feasibility study to determine best practices/use for state funds to be expended on urban farming and community gardens land acquisition needs - including revisiting the application requirements for the Community Farms Preservation Program.
2. Infrastructure/Marketing Channels
    a. Support UConn Extension efforts to pull together a needs assessment for the meat producers/ industry to have success in Connecticut. This will include looking at the feasibility of a USDA certified mobile slaughter unit.
    b. Work with Connecticut Regional Development Authority to revitalize the Hartford Regional Market to include a multifaceted facility that would include a 365 farmers market, farm to table restaurants, a centralized processing and storage facility, and affordable housing opportunities and garden space for residents. The facility needs to identify/repurpose a parking lot that can be used for an overflow farmers market during the height of the Connecticut growing season.
    c. Encourage more food cooperatives/ online ordering collectives/ home delivery ventures. An example of this is The Modern MilkMan, Mountain Dairy and The Sunderland Food Collaborative in Massachusetts.
    d. Increase support for a potential incubator program with commercial kitchen storage space (including refrigeration, freezer, and general storage space for supplies) and that supports dozens of food and agriculture companies across the state. Tenants would include but are not limited to specialty food product makers, artisanal bakers, caterers, food trucks, personal chefs, fishman, seaweed, and sea vegetable producers. An example of this is Hope and Main in Rhode Island.

e. Increase food hubs across the state.
f. Prioritize Ag. Viability grant applications that will lead to the development of more regional food hubs that are equipped for refrigeration, freezing, storage, and processing.
g. Fortify the Department of Agriculture's existing Connecticut Grown marketing efforts to provide additional resources to both farmers and consumers

3. Farm to School & Farm to Institution
    a. Expand and grow opportunities for Farm To School such that, by 2032, 100% of Early Childhood Education Centers (ECE) and K-12 schools are able to connect education, agriculture and nutrition, where at least 25% of food served in CT ECE Centers & K12 Schools is sourced locally, and all students enrolled in CT ECE Centers and K-12 schools have access to meaningful, empowering experiences with the local food system in their classrooms, cafeterias and outdoor learning spaces. [See CT Farm to School Collaborative]
    b. Encourage public institutions, hospitals, schools, municipalities, and corporate leaders to pledge to campaigns that guide food service purchasing and support sustainable food systems, such as: Good Food Purchasing Program, Menus for Change, Real Food Challenge, Health Care Without Harm, and Put Local On Your Tray
4. Next Generation of Connecticut's Farmers
    a. Provide support for beginning, young, and socially disadvantaged farmers and incorporate climate-smart agriculture into Department of Agriculture grant programs
    b. Coordinate with tribal nations and ensure they receive full financial and technical assistance to implement climate stewardship practices
    c. Engage with and Support Environmental Justice Communities on Climate Stewardship Practices, Programs, and Policies to Create a Fair and Equitable Food System
    d. Support a state funded incubator farm that is managed in partnership with a non-profit organization for the next generation of farmers to learn climate-smart agriculture practices
    e. Support recommendations from CT Department of Agriculture Farmland Access Working Group
    f. Support land access opportunities for Black, Indigenous, Farmers of Color
    g. Pass a "Farmer Equity Act" to increase state support to the growing number of socially disadvantaged farmers throughout Connecticut. This would require that the CT Department of Agriculture draft a report that outlines the history of racism in food and agricultural systems across Connecticut and draft recommendations outlining how the CT Department of Agriculture will rectify the harm that systemic racism inflicted on BIPOC farmers in accessing farmland and other agricultural resources.
    h. This would be similar to the 'The Farmer Equity Act' in California that led to the CA Department of Agriculture publishing The Farmer Equity Report. California was the first state to enact farmer equity legislation and as a result, lessons were learned.

This legislation must include a detailed account of racism in Connecticut's food and agricultural system; a definition of racial equity; detailed steps the agency will take to be inclusive of Black,

Indigenous, and People of Color in the report writing process and implementation of recommendations; a clear outline as to how the state can provide direct support to BIPOC farmers and BIPOC food and agriculture nonprofits; and the need to hire a staff person at CT DoAg. that will focus on writing the report with consultation of a coalition of BIPOC organizations and farmers that will also aid in advancing the recommendations outlined within the report. In addition, the agency should solicit thorough input from BIPOC led and other stakeholder organizations that have demonstrated a record in advancing racial equity in food and agricultural systems work in CT.

The report should also clear specificity or actionable and prioritized recommendations in the implementation process. These provisions must include but are not limited to the following:

- How the state can build organizational capacity with the CT Department of Agriculture to work towards racial equity by including staff at all levels of hierarchy throughout the state government. This process should involve the Commissioner of Agriculture or his appointee and the Governor or an appointee in the drafting and implementation of the recommendations outlined within the final report.

- Aim to achieve true consultation in stakeholder engagement that goes beyond dissemination of information and asking for input to allowing BIPOC led organizations in the state to influence decision making at the CT Department of Agriculture.

- Design outreach efforts to reach diverse demographics with different communication needs.

- Coordinate farmer equity efforts across state, federal and local government and nonprofits to have collective impact to advance equity and inclusion.

- Improve data collection to inform decision making and evaluate.

    i. Enhance educational/training programs and Cooperative Extension for Connecticut agricultural producers

    j. Review and revise Community Farms Preservation Program regulations criteria to increase the pace of small farms preservation and reflect the current and future needs of agriculture

5. Urban Agriculture

    a. Expand the state definition of agriculture to be more encompassing of urban farming and community gardens.
    b. Strengthen outreach within the CT Department of Agriculture to urban agriculture organizations and urban communities on the Department's various grants and programs
    c. Strengthen DEEP's Urban Greens and Community Gardens program to expand and increase state funding for urban agriculture projects. This grant program would be made available to municipalities; nonprofits 501 © (3) organizations, public or non-profit educational or public institutions; established urban farmers with more than

three (3) years of commercial urban farming experience. The grant program will promote improving soil quality in urban environments, accommodate proposals for land acquisition, support equipment needed to increase market opportunities and year round production, encourage urban composting, support for farmers to transition to organic practices, incentivizes innovative growing technologies and practices, and encourages the marketing, distribution, and transportation of locally grown products from farm to consumer. This could be similar to Massachusetts Urban Agriculture Grant Program Develop a Memorandum of Understanding between the CT DEEP (Forestry, Wildlife, Land Acquisition, Parks) and the CT Department of Agriculture to accelerate identification of parcels, assist with leases/permits or development of farm-friendly conservation easements, manage stewardship of farmed parcels, outreach to the agricultural community and complete utilization of the CT Urban Greens and Community Garden program. This would allow Urban Greens and Community Garden program participants to benefit from other DoAg. grant programs that may be of relevance to their operation/programs including the farm transition grant and the farm viability grant.

6. Ecological Resource Management
    a. Address selling compost to remove excess compost that are nutrient dense and increase opportunities to sell to homeowners. This could be done by allowing the co-mingling of various types of compost.
    b. Increase support and investments to reduce food waste at the consumer level, on the farm, in the grocery stores and restaurants, in schools, throughout government, and in landfills.
    c. Streamline implementation of the federal Food Safety Modernization Act by designating the Connecticut Department of Agriculture as the lead agency in the state responsible for regulating food production, processing, handling, and transport.
    d. Develop more cooperatives and coordinated food transportation and distribution systems that build efficiencies in the transportation of agricultural products to markets which would further alleviate the use of fossil fuels
7. Food Security and Agriculture
    a. Allow for Senior Farmers Market Vouchers to be utilized with online purchasing platforms
    b. Implement a healthy incentive program (similar to the Massachusetts Healthy Incentive Program) that increases local food access to urban areas and streamlines the federal GUSNip program within the state
    c. Strengthen regulations that allow mobile markets in the state to utilize SNAP terminals

Resources to reference that will inform this section Growing Connecticut Farms - Developed as part of the Governor's Council on Agriculture Development City of Santa Cruz Climate Adaptation Plan Food Solutions New England 20/20 Vision House of Representatives Climate Change Action Plan HEAL Food Alliance - Platform for Real Food.