

CLIMATE ADAPTATION
FOR VEGETABLE AND FLOWER FARMERS

Hensley's SEED CO. – DENVER · COLORADO –

American Farmland Trust
SAVING THE LAND THAT SUSTAINS US

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OUR PRESENTERS

THE HENSLEY'S TEAM



JULIE FINE

Hensley's SEED CO. DENVER · COLORADO

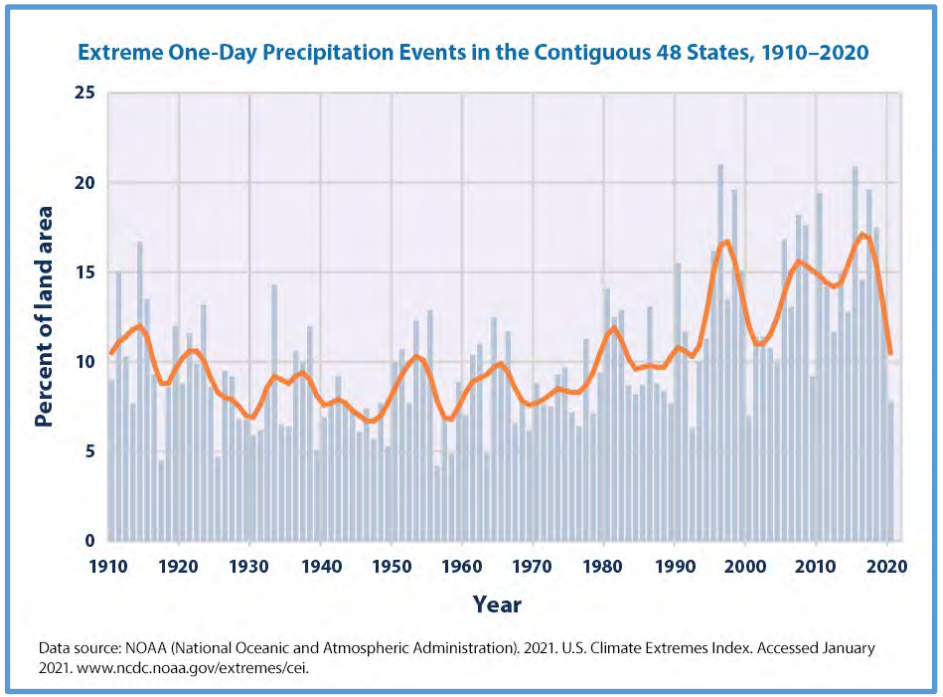
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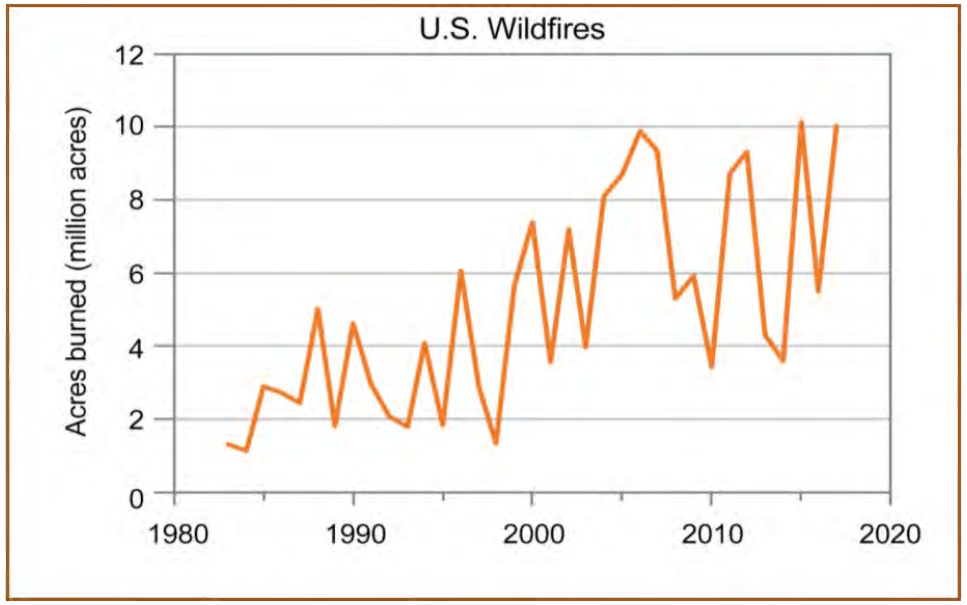
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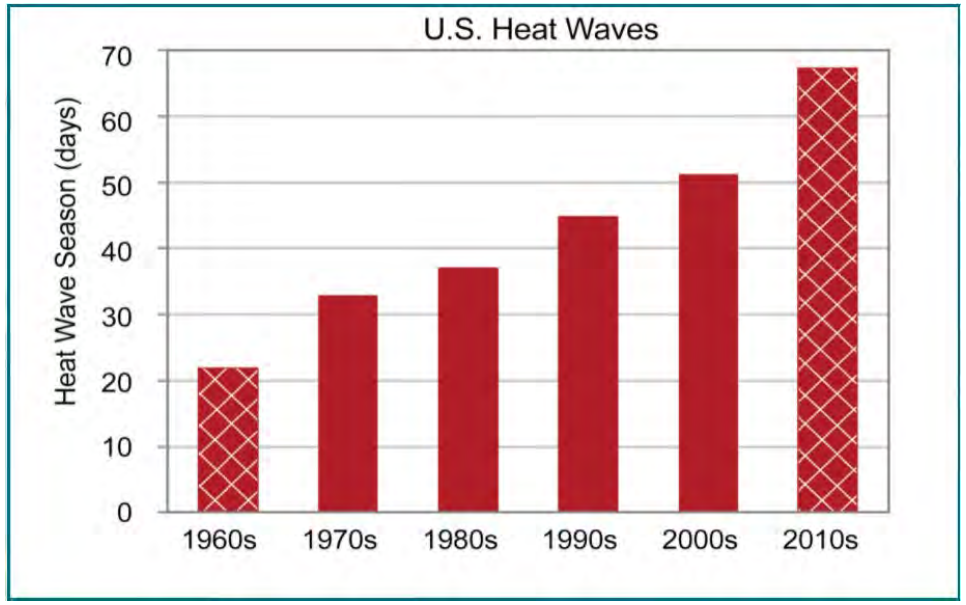

Credit: Emily Landeck

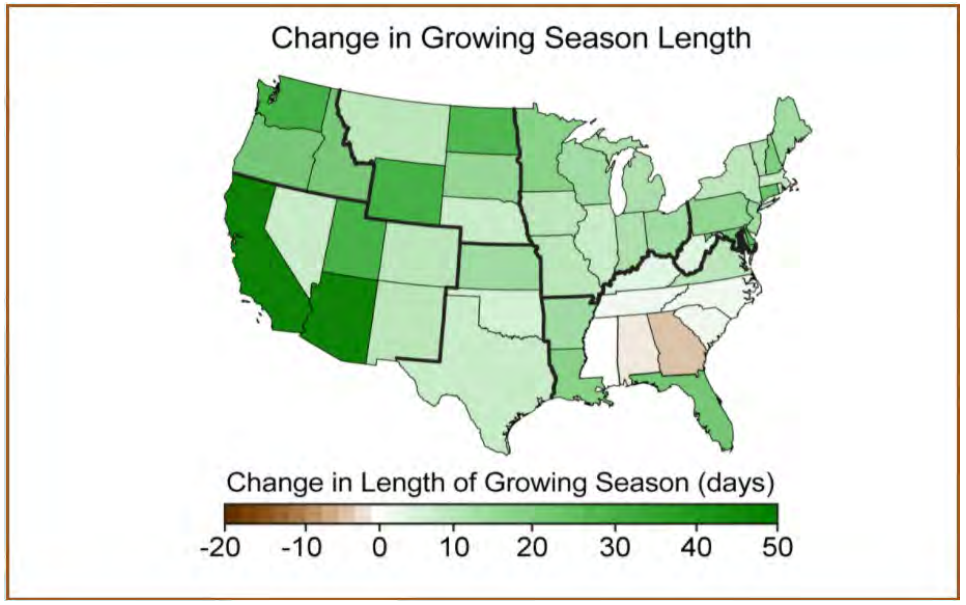
Climate Change Impacts on U.S. Agriculture

- ↑ Increased **water requirements** of crops due to warmer temperatures and changes in precipitation
- ↑ Increased **heat** affecting crops, animals, and humans
- ↑ Increased **soil erosion** from heavy rain
- ↑ Increased **pest and weed** pressure



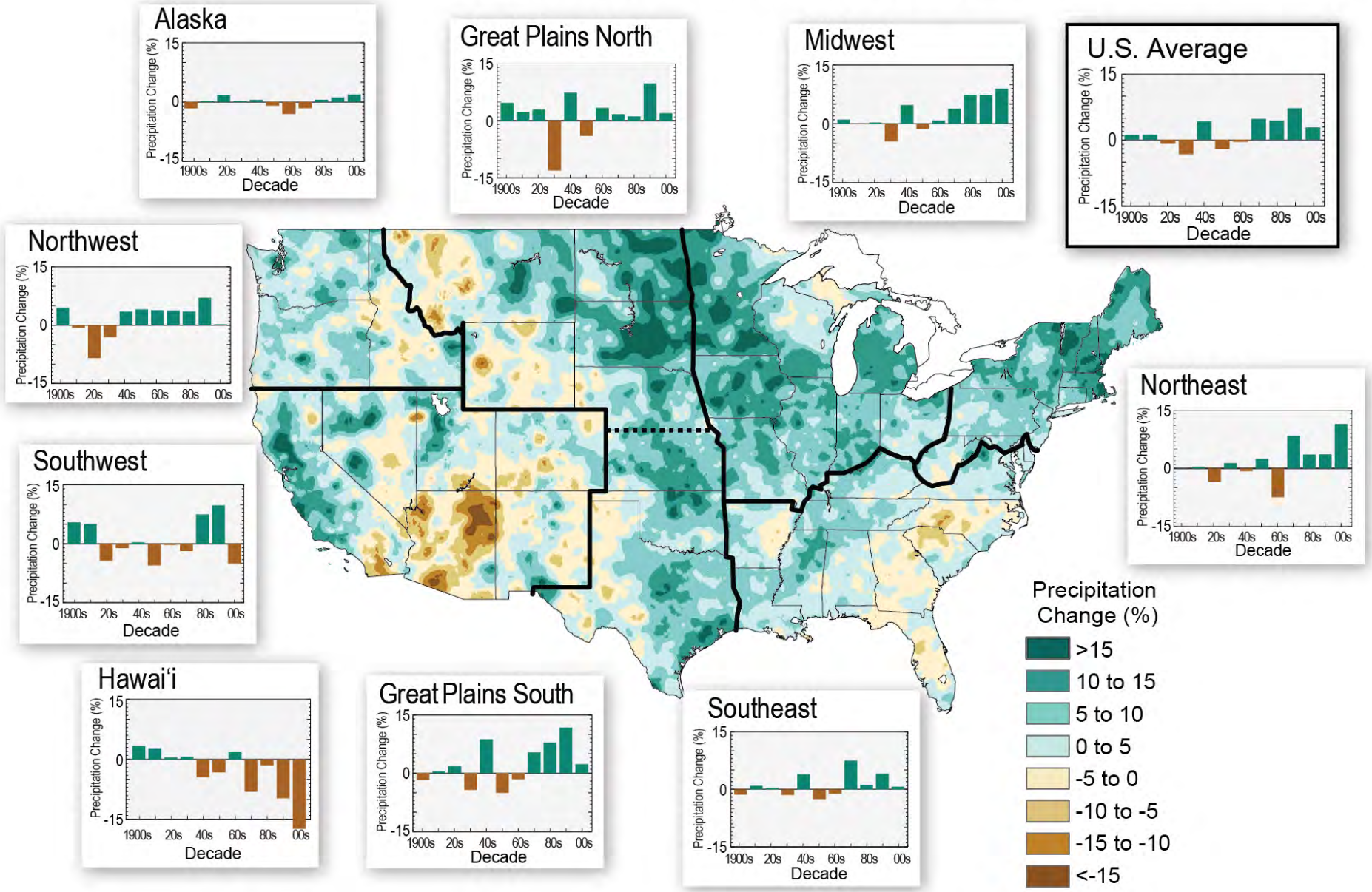






Source: https://nca2018.globalchange.gov/chapter/1/#fig-1-2

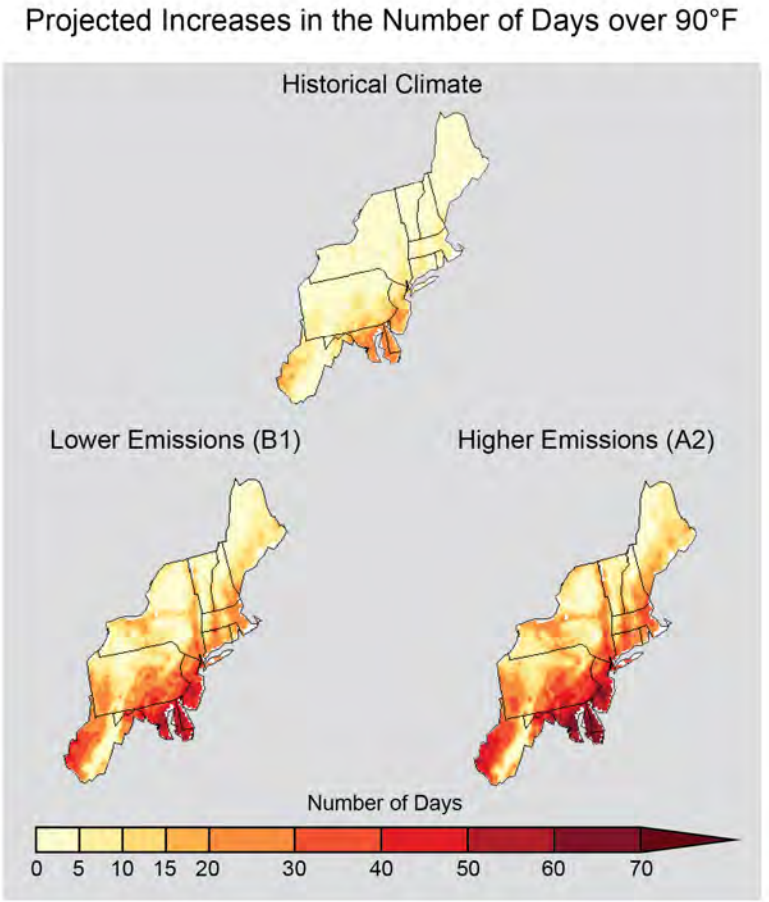
Observed U.S. Precipitation Change



https://data.globalchange.gov/report/nca3/chapter/our-changing-climate/figure/observed-us-precipitation-change

Climate Change Projections for the Northeast and Mid-Atlantic:

- Temperature increases average 4-10°F, with more extreme heat waves
- Warmer, wetter springs with increased variability
- 10-15% increase in yearly precipitation, but more variable precipitation amounts leading to drought
- During heavy precipitation events, rainfall amounts +70%
- 12-14 additional frost-free days
- Warming ocean temperatures



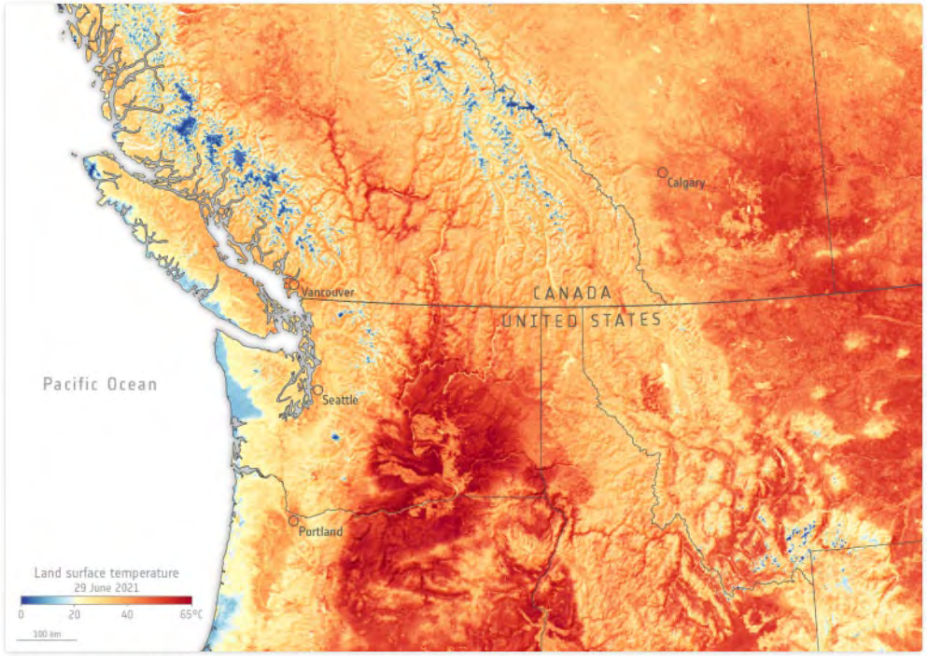
https://nca2014.globalchange.gov/report/regions/northeast#tab2-images

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Climate Change Projections for the Northwest:

- Temperature increases average 3-10°F, largest change in summer
- Summer precipitation to decline by as much as 30%, with less frequent but heavier downpours
- Declining snowpack and reduced streamflow, causing a strain on summer water supply
- Forests becoming warmer and drier, greater frequency of fires and insect outbreaks
- Increased water temperatures and sea level rise

Land surface temperatures (°C) in June 2021 exceeded scientists' predictions of extreme heat in the Northwest

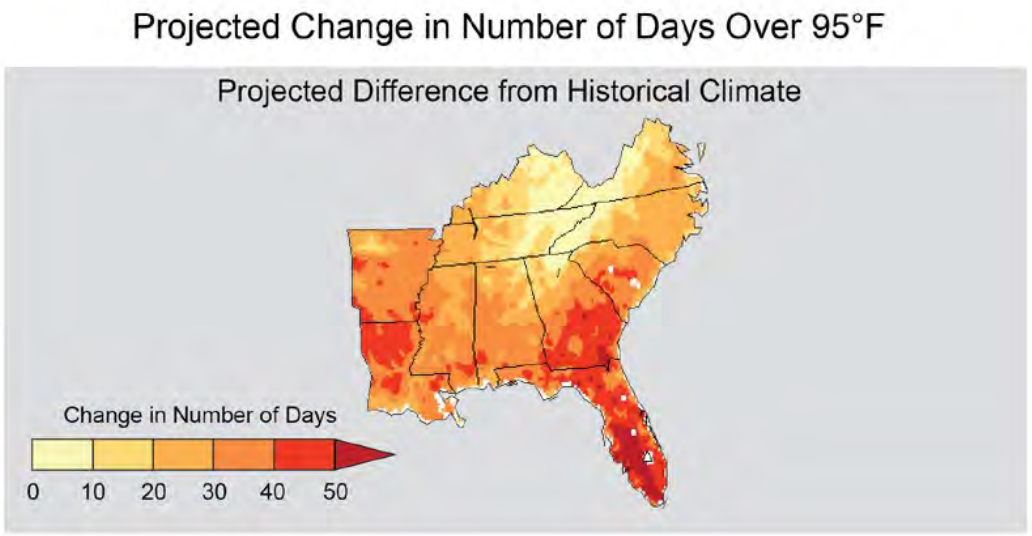


The heat wave in June 2021 is one example of an event that is both outside the range of what we expect and where scientists have quantified the extent to which climate change contributed to the event. Image: European Space Agency under CC BY-SA 2.0.

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Climate Change Projections for the Southeast:

- Temperature increases average 4-8°F
- More predicted days over 95°F and fewer freezing events
- Inland areas are projected to warm more than coasts
- Increased frequency of heavy downpours
- Periods of extreme drying and reduced freshwater availability
- Substantial increase in the intensity, frequency, duration, and strength of Atlantic hurricane activity
- Sea level rise effecting shorelines, wetlands, coastal areas



https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-southeast_.html

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Intensity & frequency of rainfall



- Flooding
- Topsoil loss
- Unpredictable irrigation
- Nutrient loss
- Soil damage

Changes in temperature



- Temperature fluctuations
- Plant stress
- Irrigation demands
- Dangerous heat
- Yield losses

Shifting seasons



- Pest & disease incidence
- Delayed planting or harvest
- Plant stress
- Fluctuations in temperature

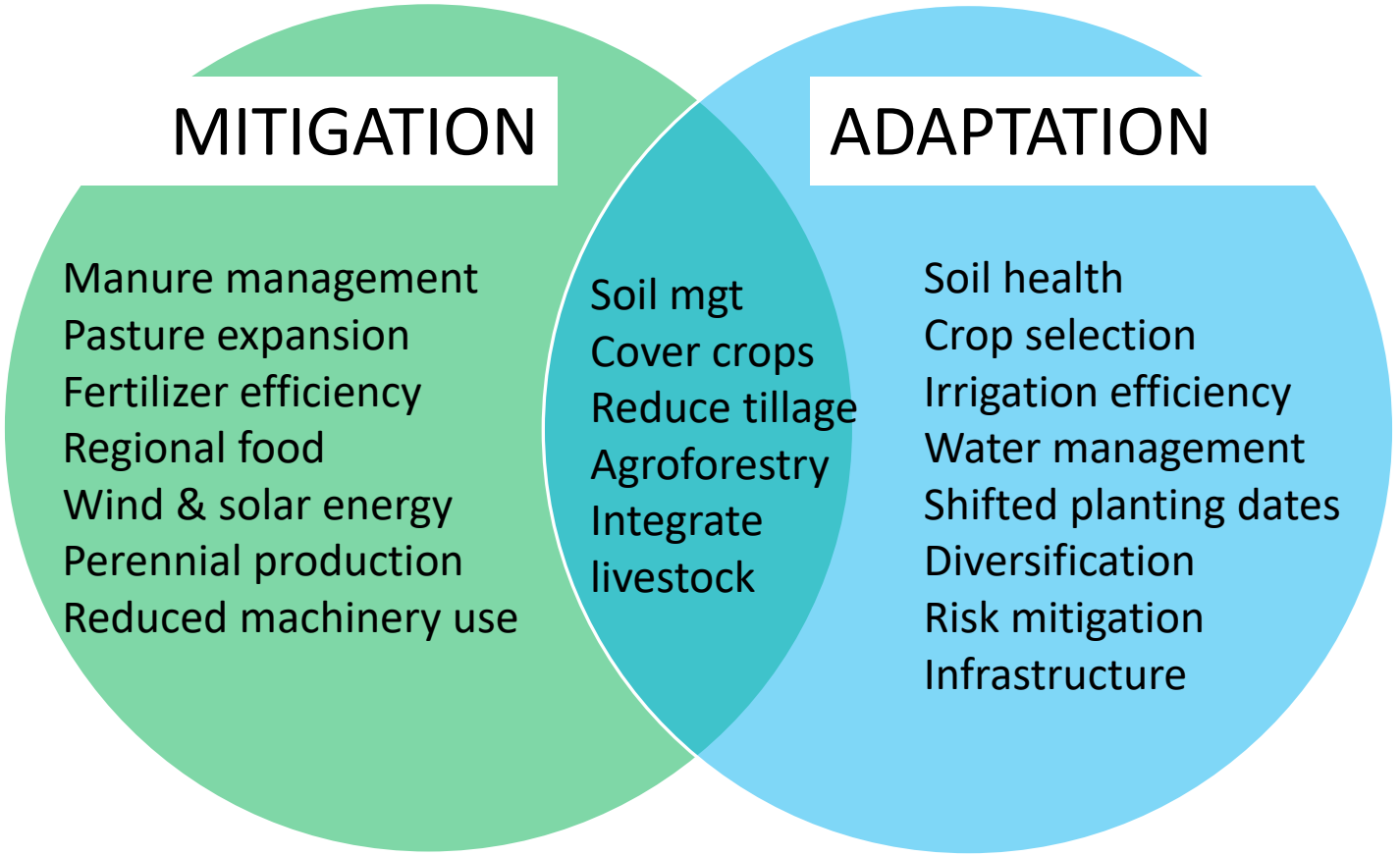
Extreme weather



- Infrastructure damage
- Drought
- Wildfires & smoke
- Erosion

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Climate Adaptation Can Reduce Risks and Increase Resilience



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Healthy Soil is a Universal Adaptation



Cover the Soil
- Physical protection
- Mulch, cover crops
- Leave crop residue

Feed the Soil
- Organic matter
- Living roots

Reduce tillage
- Conserve soil carbon
- Save aggregates

Cultivate diversity
- Crop rotation
- Border rows
- Pollinators

Animals & Perennials
- Integrate livestock
- Maintain perennial roots
- Grasslands, trees

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Climate Adaptation Planning



Credit: Julie Fine

Adaptation Practices

- **Cover crops and/or mulch to protect soil**
- **Reduced tillage**
- **Find carbon sources for soil**
- **Adjust nutrient application timing**
- **Manage water to prevent ponding, run off, erosion**
- **Diversify crops (livestock breeds, perennials, mixtures)**
- **Adjust crop plan, trial new varieties, etc**
- **Conservation buffer strips**
- **Convert marginal cropland to riparian buffer or perennial zone**
- **Improve or expand pasture**



Credit: Julie Fine

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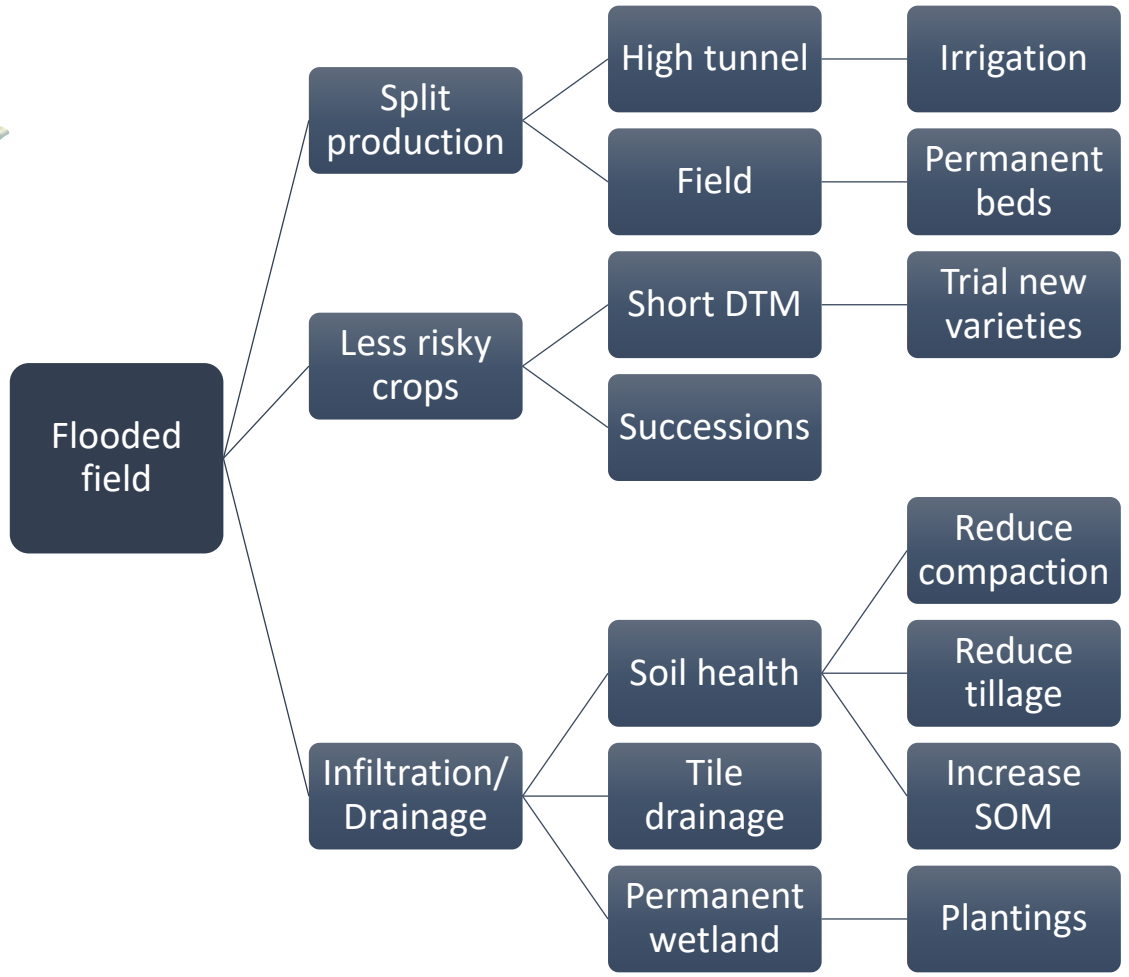
Infrastructure

- Greenhouses/ high tunnels
- Increase irrigation capacity
- Tile drainage
- Water storage
- Post-harvest cooling
- Climate controlled storage
- Shade for employees & animals
- Create pollinator habitat
- Sensors to monitor water needs and applications



Rolling Thunder greenhouse,
Four Season Farm, Harborside ME




Flooded field
Split production
High tunnel
Irrigation
Field
Permanent beds
Less risky crops
Short DTM
Trial new varieties
Successions
Infiltration/ Drainage
Soil health
Reduce compaction
Reduce tillage
Increase SOM
Tile drainage
Permanent wetland
Plantings

Prioritization and Triage



Flexible and Adaptive Mgt



“No Regrets” Decisions



Precautionary Actions



Support Mitigation



Fill Your Toolbox



Climate Adaptation Planning for Farms

American Farmland Trust
SAVING THE LAND THAT SUSTAINS US

This worksheet was developed for farmers to develop their own plan for climate adaptation and farm resilience, knowing the unique variables of their land and operation.

Five steps for farmland climate adaptation planning:

1. Define your farm goals and priorities
2. Identify specific, observed climate impacts
3. Conduct a risk & vulnerabilities assessment based on your climate impacts and farm goals
4. Develop a set of adaptation practices
5. Evaluate the effectiveness of those adaptations practices and update your plan accordingly



This approach is adapted from Adaptation Resources for Agriculture: Responding to Climate Variability and Change in the Midwest and Northeast. USDA Midwest, Northeast, and Northern Forests Climate Hubs. 2016.

1. Goals *What are the overall or immediate goals of your farm operation?*

These goals will inform your choices and priorities. Include considerations of resources, timeframe for goals, foundational values, financial requirements, etc.

2. Climate Impacts

What impacts of climate change have you observed and experienced on your farm?

*Refer to pages 6 and 7 for a summary of regional observations and projections.

Changing precipitation patterns

- ☐ Wetter springs or falls
- ☐ More frequent extreme precipitation
- ☐ Saturated soils affecting planting & harvest
- ☐ Seasonal drought
- ☐ Increased need for irrigation

Increased temperatures

- ☐ Increased seasonal temperatures
- ☐ Warmer average yearly temperature
- ☐ Changing pest or disease patterns
- ☐ Increased cooling needs
- ☐ Increased weed vigor
- ☐ Animal health declines

Extreme weather

- ☐ Flooding
- ☐ Increased erosion
- ☐ Nutrient leaching
- ☐ Infrastructure damage due to wind/ snow/rain/temperatures
- ☐ Wildfire frequency or size increases


TABLE 1. Observed and Expected Changes in Weather by U.S. Region

SUMMARY OF OBSERVED AND EXPECTED CHANGES

ANNUAL TEMP. | ANNUAL PRECIPITATION | GROWING SEASON

NORTHWEST: Higher temps, warmer winters, more frequent and intense heatwaves, more drought and more frequent wildfires are key climate change effects. Precipitation is more variable, especially in winter. Warming winters have increased rainfall, reduced snowpack, increased risk of flooding and soil saturation, advanced the timing of spring melt and reduced summer flow in river basins fed by snowmelt. The growing season is 11 days longer. These changes are expected to continue. Summer drought and winter flooding will become more frequent.

- Greatest increase in the SE
- Greatest summer increase in the interior
- Greatest winter increase in SE Idaho
- Greatest increase in eastern Wash.
- Decrease in central Idaho and SW Ore.
- Increase in most seasons; decrease in summer
- +25–35 DAYS
- Greatest increase west of the Cascades

SOUTHWEST: Average temps have increased in each season, most rapidly in winter. Heat waves have increased in frequency. Variability in precipitation has increased, with major droughts in the first two decades of the 21st century. The growing season is 14 days longer. Rising temperatures and shifting precipitation patterns, especially in the southern part of the region, are expected to alter crop productivity, crop-water requirements, crop-water availability, and costs of water access.

- Less warming in coastal areas
- Warming likely in all seasons, with greatest increase in summer
- Largest decrease in the Sierra Nevadas and southern Ariz. and N.M.
- Largest decrease in summer in parts of Calif., Ariz. and N.M.
- +10–38 DAYS
- Least change in Calif. and greatest change in the interior for west

SOUTHERN GREAT PLAINS: Average annual temp has increased. Hot periods are hotter and cold periods are warmer. The growing season is six days longer. Winters and springs are wetter; summers are drier, and snowfall amounts have decreased, particularly in the eastern part of the region. Drought and extreme precipitation events are more frequent. These trends are expected to continue. The number of days over 100 degrees and nights over 80 degrees will quadruple. Heavy rains, flooding, drought and severe storms will become more frequent and intense.

- Greatest increase in the summer and fall, and least in spring
- Increase in the north and decrease in the south
- Little change in spring except for a decrease in Texas
- +15–30 DAYS
- Greatest increase in SE. Texas

NORTHERN GREAT PLAINS: Temps have risen annually and in all seasons. Northern areas warmed at the fastest rate in the nation over the 20th century. The growing season is six days longer. Winters and springs are wetter and summers drier. Snowfall has decreased, particularly in the east. Drought and extreme precipitation events are more frequent. Warming is expected to continue on average and in each season. Changes in precipitation vary by location and season, but include earlier snowmelt and stream flow runoff, a shift to more rain than snow, and snowpack declines.

- Greatest increase in winter and summer
- Greatest summer increase in southeast Wyo.
- Greatest winter increase in Neb. and N.D.
- Decrease in the south and increasing northward to a maximum in the NE.
- Greatest increase in winter and fall; greatest decrease in summer
- +20–30 DAYS

MIDWEST: Higher annual temps, warmer winters and springs, and more extreme precipitation events during the growing season are key climate change effects. Annual temps have increased, with warmer winters and springs, and cooler summers. The growing season is nine days longer. Precipitation has increased, especially in spring, summer and fall. Snowfall has decreased in the south and west but has increased in the north, in Indiana and along the Great Lakes shorelines. These temperature and precipitation trends are expected to continue annually and in most seasons.

- Greatest winter increase in NW Minn.
- Greatest summer increase in the south
- Greatest increase in the far north; little or no change in the south
- Increase in winter, spring and fall; no change to a decrease in summer
- +22–30 DAYS
- Greatest increase in northern Mich.

NORTHEAST: Temps have increased annually and in each season, and total precipitation has increased, especially in fall. Rainfall intensity has increased notably, particularly in the north. More intense heavy rainfalls, milder winters, earlier spring melt and sea-level rise have increased the risk of flooding. There are more hot days, fewer cold days and more intense rain. The growing season is nine days longer. These changes are expected to continue and will vary by location and season. The frequency and intensity of flooding will increase, especially in winter and spring.

- Both annual and seasonal temps increase with latitude
- Seasonal increase greatest in winter and summer; least in spring
- Greatest increase in NJ. and Del.
- Seasonal increase greatest in winter
- Summer precipitation expected to decline
- +19–27 DAYS

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3. Risks & Vulnerabilities

Based on the observed and projected climate impacts, what are the major vulnerabilities of your farm operation? What areas of land, important crops, animals, or essential infrastructure are a priority to protect? What is at most risk? Do the identified climate impacts directly impact your top farm goals?

4. Adaptation Practices & Strategies

Review the risks and vulnerabilities section, and choose which should be addressed first. These would be immediate vulnerabilities and/or precautionary actions to prevent risk.
Once you've chosen your priorities, consider practices that could address them. Refer to the ideas on p 4. Adaptive practices should involve:

- *A reasonable timeline*
- *Flexible management that can adapt with new information*
- *"No regrets" decisions that will create broad benefits with little risk*
- *Considerations of feasibility and potential effectiveness*
- *Resources that are available and supported in your network*

3

Adaptation Strategies

Use these lists of strategies and practices to brainstorm, develop and complete step 4.

Sustain fundamental functions of soil and water	Reduce existing stressors of crops and livestock	Reduce risks from warmer and drier conditions	Reduce the risk and long-term impacts of extreme weather	Manage farms and fields as part of a larger landscape	Alter management to accommodate expected future conditions	Alter agricultural systems or lands to new climate conditions	Alter infrastructure to match new and expected conditions
Maintain and improve soil health	Reduce the impacts of pests and pathogens on crops	Adjust the timing or location of on-farm activities	Reduce peak flow, runoff velocity, and soil erosion	Maintain or restore natural ecosystems	Diversify products, crops, livestock, varieties, or breeds	Minimize potential impacts following disturbance	Improve or install water systems to match demand and supply
Protect water quality	Reduce competition from weedy and invasive species	Manage crops to cope with warmer and drier conditions	Reduce severity saturated soil and flood damage	Promote biological diversity across the landscape	Diversify using new varieties, breeds, or combinations	Realign systems toward future conditions	Use structures to improve environmental control for crops
Match management practices to water supply and demand	Maintain livestock health and performance	Manage livestock to cope with warmer and drier conditions	Reduce extent of wind damage to soils and crops	Enhance landscape connectivity	Switch to commodities better suited to future conditions	Alter lands in agricultural production	Develop infrastructure to reduce animal heat stress

Content from Adaptation Resources for Agriculture: Responding to Climate Variability and Change in the Midwest and Northeast. USDA Midwest, Northeast, and Northern Forests Climate Hubs. 2016.

Adaptation Practices

- Cover crops to protect bare soil, cycle nutrients, fix nitrogen, etc
- Adjust nutrient application timing due to excessive rainfall
- Manage water to prevent ponding, run off, erosion
- Increase irrigation capacity
- Sensors to measure water needs and applications
- Create shade for animals, crops
- Diversify crops and livestock
- Transition to perennial crops
- Improve or expand pasture
- Build soil health
- Conservation buffer strips
- Reduced tillage
- Greenhouses/ high tunnels
- Trial new varieties
- Irrigation expansion
- Water-bank by using less irrigation non-drought years
- Install tile drainage
- Water storage
- Optimize post-harvest cooling
- Climate controlled storage
- Shade/cooling for employees
- Convert wet cropland to riparian buffer
- Create pollinator habitat

4

5. Evaluate

Choose one or two criteria to measure the effectiveness of your climate adaptation practices. What will indicate success? How often will you take that measurement?

Use tools like the NRCS In-Fiel sessment, soil health tests, fo er data to measure success.

☐

☐



In Summary:

This climate adaptation planning cycle sho peated over time as new practices yield re mation is gathered, and new challenges er

Please see below for references and regio

Primary References

Adaptation Resources for Agriculture
"Cultivating Climate Resilience on Farms and Ranches"
Adaptation Resources for Agriculture: Case Studies
Building Soils for Better Crops
Managing Cover Crops Profitably

Websites and Organizations

The Adaptation Workbook

Regional Resources

The Farming and Climate Change P
Extension Center for Sustainal
Cornell Climate Smart Farming Pro
Quick Guide to "Climate Change ar
Vermont"
UVM Farming & Climate Change: N
ers Adapt video series

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GROWER EXPERIENCES

NORTHWEST

SpringRain Farm and Orchards

SOUTHEAST

Colusa Farms

NORTHEAST

Simple Gifts Farm



Organic No-Till Farming: A Response to Climate Disruption

The first two years of no-till transition at Simple Gifts Farm

Jeremy Barker Plotkin (Simple Gifts Farm) & Caro Roszell (American Farmland Trust)

SIMPLE GIFTS FARM

American Farmland Trust®

SAVING THE LAND THAT SUSTAINS US

CLIMATE ADAPTATION FELLOWSHIP






FARMSTAND
CARROTS
YOGURT
GRASSFED BEEF
APPLES
SALAD GREENS
ONIONS
STRAWBERRIES
POTATOES





No-Till
& Climate Adaptation

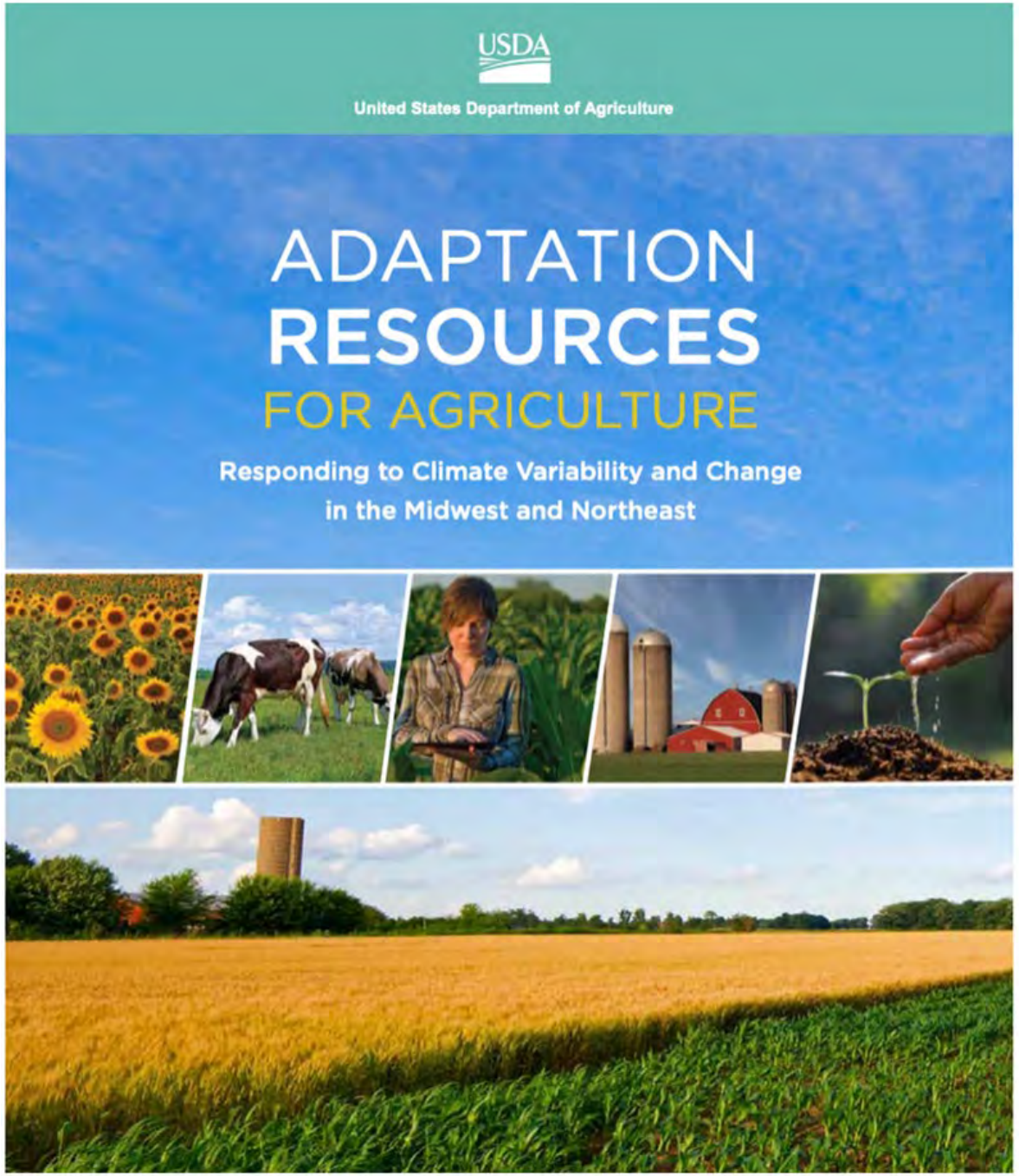
Regional climate change projections for the Northeast include:

An overall **gradual increase** in:

- Frost-free days
- Days > 90 °F
- Total precipitation volume
- Humidity

Precipitation, however, is expected to be **concentrated in more extreme precipitation events** with **higher frequency in the winter and early spring** months, while summers are expected to include **longer periods without precipitation**.

Janowiak Maria K. et al. 2016. Adaptation Resources for Agriculture: Responding to Climate Variability and Change in the Midwest and Northeast. Technical Bulletin 1944. Washington, DC: U.S. Department of Agriculture. https://www.climatehubs.usda.gov/sites/default/files/AdaptationResourcesForAgriculture.pdf Accessed January 17, 2021.





No till farming systems go even further in increasing soil health

- **We became interested in pursuing organic no-till after extreme wet season of 2018**
- **Organic matter in the soil acts as a sponge to absorb more moisture when it's wet and release it when it's dry**
- **Surface residues also slow soil moisture loss and protect soil surface**
- ***In theory,* reduced tillage= fewer weeds over time**

Organic No-till Systems

Two Soil Health Management Systems:

Intensive system using compost as a mulch and tarps for weed control

- Mimics “postage stamp” sized farms
- Started in 2020

Extensive system with heavy transferred mulch

- Based on ideas of German agronomist Jan-Hendrik Cropp
- Started in 2021 with help from MDAR ACRE grant



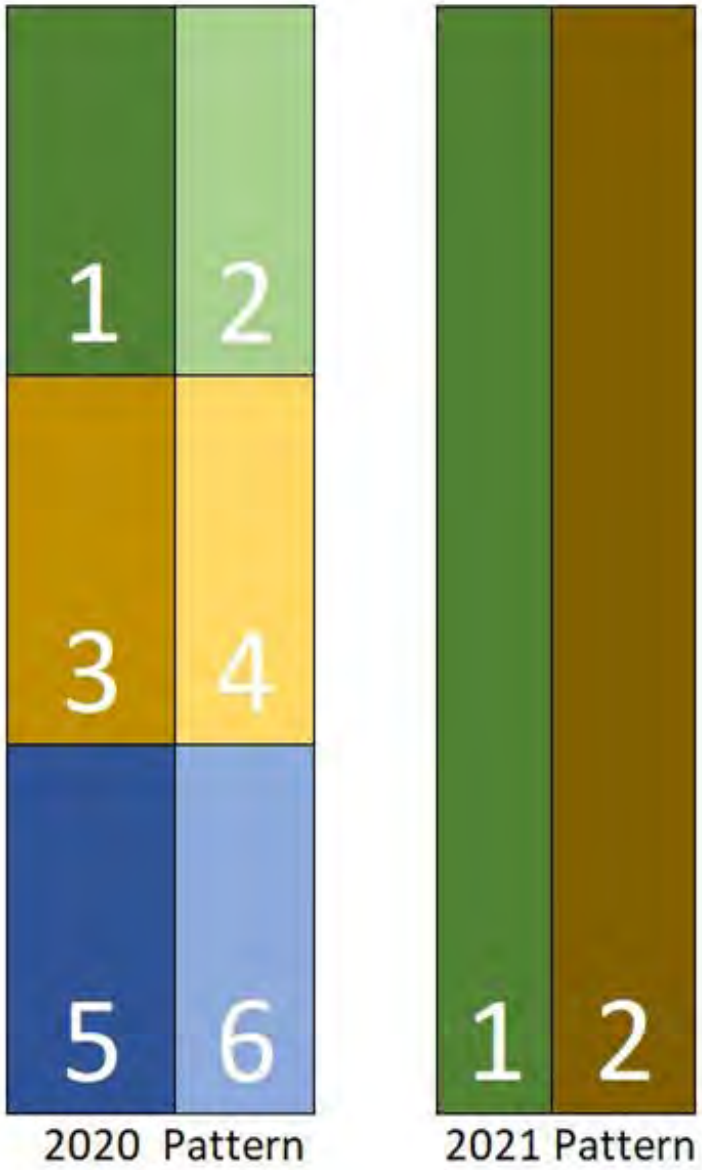






Intensive system

- Compost mulch applied
- Tarps laid to clear the beds
- Seed directly into compost
- Harvest
- Tarp after harvest to kill crop
- Seed salad again after 3 weeks of tarping
- 2020: rotated 3 cycles through field
- 2021: practiced on more blocks


1
2
3
4
5
6
2020 Pattern
1
2
2021 Pattern







Weed Control Largely Successful

BUT:

- **Seeding into compost and dead crop residue is sometimes problematic.**
- **Second year in this system, perennial grass weeds coming in**
- **Questions remain about fitting the system into rotation and size of tarp**

Extensive System
(transferred mulch)



- **Use the spiky transplanter to plant into heavy mulch**
- **Mulch can come from cutting cover crops elsewhere or leaves from the spring**
- **Need heavy enough mulch to keep weed control going all season**
- **Timing of mulch harvest critical**
- **Use weed mat as a backup**



2021: Significant Learning Curve for Transferred Mulch System

- **Transplanting into mulch a real challenge: lack of soil flow, mulch pushed into hole -> difficult root-to-soil contact**
- **Possible nitrogen tie-up issues**
- **Timing of cover crop mowing and quantity of mulch need a lot of work**

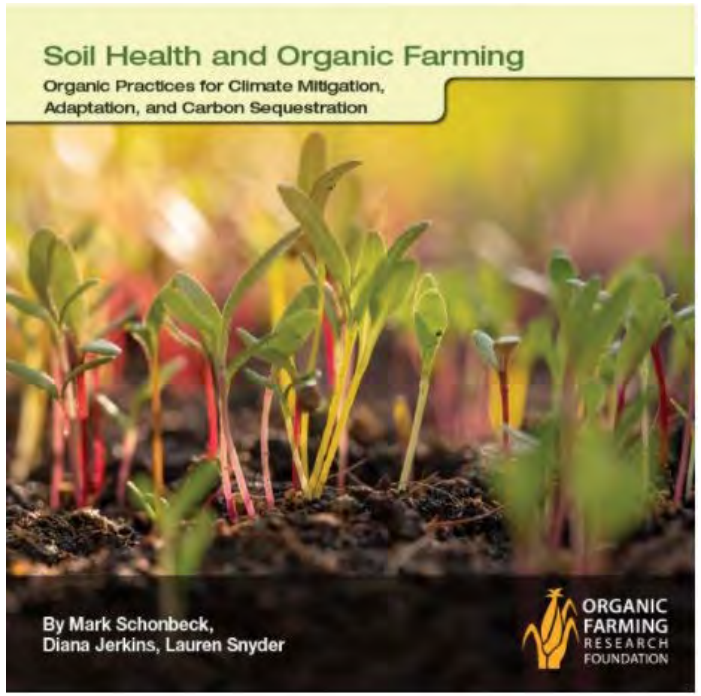








Jeremy's Recommended Resources



Organic Practices for Climate Mitigation, Adaptation and Carbon Sequestration. Organic Farming Research Foundation

https://ofrf.org/soil-health-and-organic-farming-reports/



Rotational No-till and Mulching Systems for Organic Vegetable Farms Webinar, Jan-Hendrik Cropp

https://eorganic.org/node/12857



Tools for Transitioning to No-Till Vegetable Production: Event Highlights Video from Soil Health Field Day at Simple Gifts Farm
(& lots of other organic no-till videos)

NOFA/Mass YouTube Channel

https://www.youtube.com/c/nofamass/videos

Resources

Adaptation Resources for Agriculture:
Responding to Climate Variability and Change in the Midwest and Northeast
https://www.climatehubs.usda.gov/sites/default/files/adaptation_resources_workbook_ne_mw.pdf

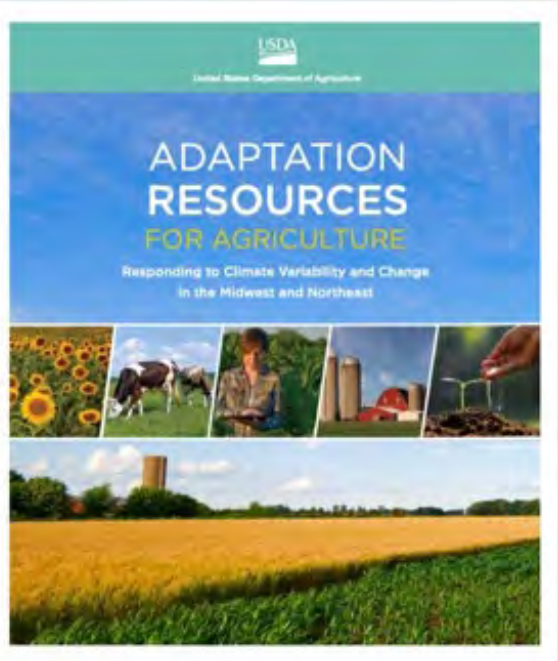
Cultivating Climate Resilience on Farms and Ranches
https://www.sare.org/wp-content/uploads/Cultivating-Climate-Resilience-on-Farms-and-Ranches.pdf?inlinedownload=1

The Adaptation Workbook
https://adaptationworkbook.org/

Adaptation Resources for Agriculture: Case Studies
https://www.climatehubs.usda.gov/hubs/topic/adaptation-resources-agriculture-case-studies-using-adaptation-workbook

American Farmland Trust Climate Programs
https://farmland.org/project/climate/

Soil Health and Organic Farming:
Organic Practices for Climate Mitigation, Adaptation and Carbon Sequestration
https://ofrf.org/soil-health-and-organic-farming-reports/





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Resources Shared in the Webinar Chat Portal

Simple Gifts Farm Field Day Video: https://www.youtube.com/watch?v=V0-rXH8YkA4

Xerces Society Invertebrate Conservation: https://www.xerces.org/

SARE – Pollinator Habitat: https://www.sare.org/sare-category/crop-production/pollination/pollinator-habitat/

Savanna Institute – Agroforestry in the Midwest: https://www.savannainstitute.org/

USDA Climate Hubs: https://www.climatehubs.usda.gov/

The Fourth National Climate Assessment https://nca2018.globalchange.gov/

"Tarping in the Northeast: A Guide for Small Farms," https://extension.unh.edu/blog/2022/03/new-tarping-guide-available

Beat the Heat growing resource: hensleyseeds.com

Climatelinks – Global Knowledge Portal: https://www.climatelinks.org/sector/adaptation

USAID – Climate-Resilient Development: https://pdf.usaid.gov/pdf_docs/PBAAA245.pdf

Dry Farming Institute: https://dryfarming.org/

USDA – Dry Farming in the Pacific Northwest: https://www.climatehubs.usda.gov/hubs/northwest/topic/dry-farming-techniques-maritime-pacific-northwest

OSU Dry Farming Info: https://smallfarms.oregonstate.edu/smallfarms/dry-farming

https://smallfarms.oregonstate.edu/dry-farming-demonstration

WSDA – Dry Farming in the Pacific Northwest: https://wastatedeptag.blogspot.com/2017/10/beyond-wheat-dry-farming-in-pacific.html

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Resources from the AFT Worksheet

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Adaptation Resources for Agriculture: Case Studies
Building Soils for Better Crops
Managing Cover Crops Profitably

Websites and Organizations
The Adaptation Workbook
USDA Climate Hubs
U.S. Climate Resilience Toolkit
American Farmland Trust: Climate
Link to find local NRCS office
Climate Adaptation Knowledge Exchange
Fourth National Climate Assessment
Sustainable Agriculture Research and Education (SARE) Outreach Videos

Technical Resources
NRCS Climate Smart Conservation Practices
SARE Ensuring Sustainable Field Crop Agriculture in the Face of a Changing Climate
Tile Drainage Fact Sheet
SARE Outreach videos
Tarping in the Northeast

Regional Resources
The Farming and Climate Change Program at the UVM Extension Center for Sustainable Agriculture
Cornell Climate Smart Farming Program
Quick Guide to "Climate Change and Agriculture in Vermont"
UVM Farming & Climate Change: New England Farmers Adapt video series
New England Adaptation Survey
Northeast Cover Crops Decision Tool
Midwest Cover Crop Selection Tool (Row and Vegetable Crop Tools)
Colorado Small Acreage Irrigation Guide
Climate Adaptation Resources for Northern New England Farmers
California Climate and Agriculture Network (CalCAN)
Cal-Adapt (California Climate Tool)
Agriculture Climate Network: Climate and Agriculture Research for the Northwest

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