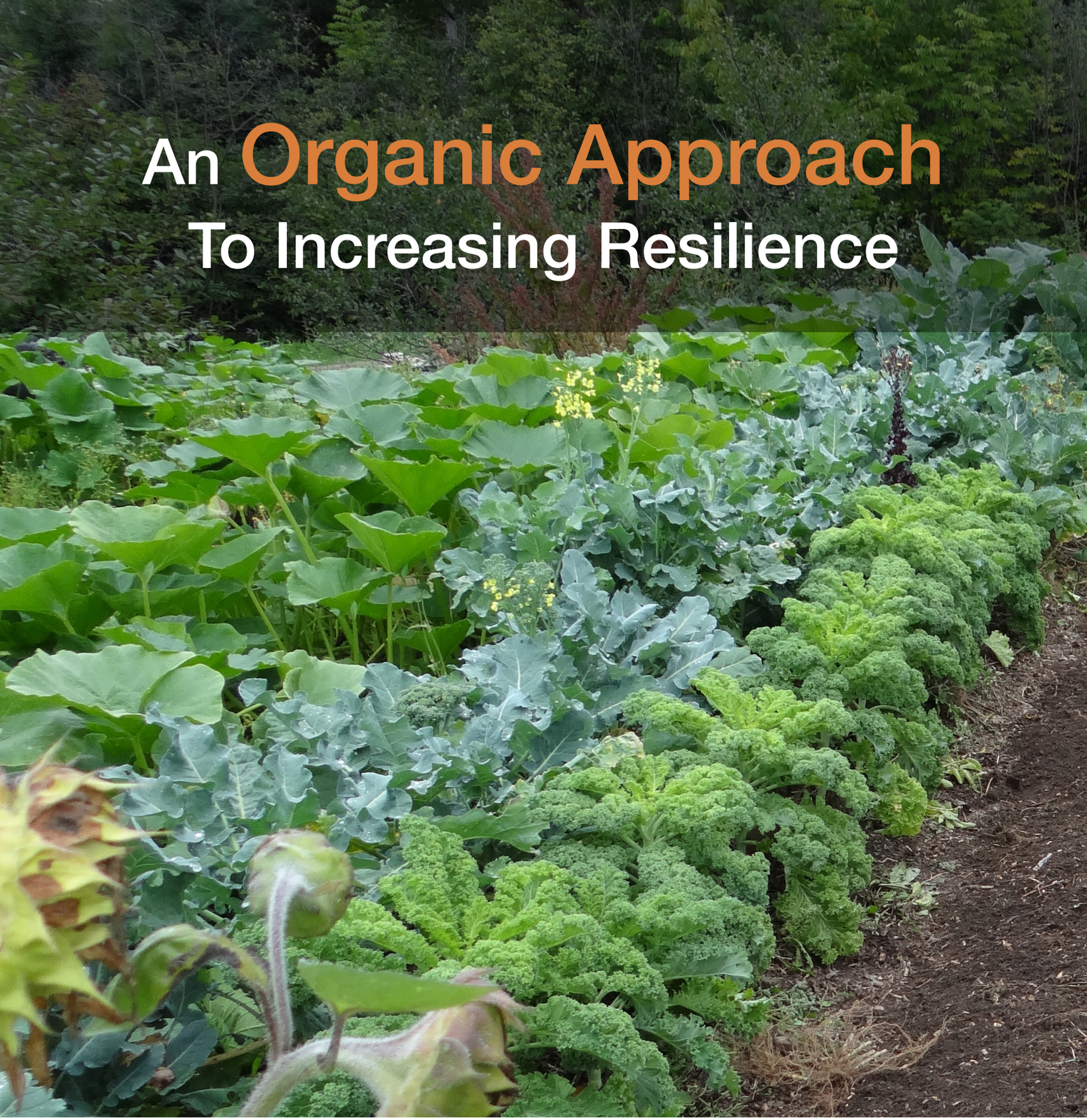
An Organic Approach To Increasing Resilience



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ORGANIC FARMING RESEARCH FOUNDATION

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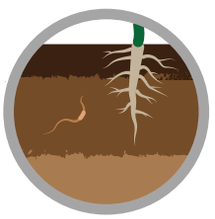
Few farmers need official reports to tell them that "increasing weather volatility" and climate change threaten their livelihoods and the resilience of their farming and ranching operations. With historic droughts, wildfires, flooding, and hurricanes in recent years, more farms are facing variable yields, crop losses, increased weed, pest, and disease pressures, and intensifying soil degradation, erosion, and compaction.

By utilizing organic and sustainable practices to build soil health, farmers and ranchers can improve their resilience and reduce risk as our climate changes. While practices can vary depending on your operation, establishing optimum soil organic matter (SOM) and biological activity will help your operation through the difficult times to come. Following the USDA Natural Resources Conservation Service (NRCS) principles of soil health can greatly increase your operation's ability to stay resilient through these trying times. These include:



Minimize Disturbance

Maximize Soil Cover

Maximize Biodiversity

Maximize Presence of Living Roots

This brief provides science-based information, tools, and guidance to optimize soil health and ensure on-farm climate resiliency. You will learn the latest science on soil health building practices, the importance of choosing climate resilient seed varieties, and the state and federal resources available to help support you in making these beneficial production changes.

For additional resources, don't forget to check out: ofrf.org/programs/managing-on-farm-risk.

Soil Health as a Mitigation Strategy: What the Research Says

Farmers adapt to shifting climates by modifying their crop mix and crop rotations, and sometimes by increasing the use of irrigation or fertilizer to compensate for increased weather stresses *(Chen and Dall'erba, 2017; Crane-Droesch et al., 2019)*. The latter responses can deplete water resources and increase GHG emissions, and thus become maladaptive if widely implemented *(Crane-Droesch et al., 2019; IPCC, 2019)*. In contrast, organic and sustainable systems address climate risks while *reducing* the need for fertilizer and water inputs. *(Lengnick, 2018)*. Key practices for resilience include the following.

- Building soil health with cover crops, reduced tillage, compost, etc.
- Diversifying crop rotations and farm enterprises
- Implementing crop-livestock integration and management-intensive rotational grazing
- Conducting whole farm planning

Research and farmer experience continues to demonstrate how these practices can sustain yields through drought years and enhance the soil's capacity and ability to absorb excess rainfall and retain nutrients *(Brennan, 2018; Brown, 2018; Rodale, 2015; Figure 1)*.

A

Z. Kabir, NRCS, Davis CA

B

Rodale Institute

Figure 1. A. Adjacent fields (same soil type) in winter cover crops vs fallow in Woodland, CA the day after a two-inch rainfall in February, 2017. The cover cropped soil easily absorbed the water (left) while the fallow field was inundated (right). B. In the Rodale Farming Systems Trials in Kutztown, PA, corn grown in the organic system (left) withstood droughts in 1995 and 2012, and yielded 31% more than conventional corn (right).

Invest in Cover Crops

Cover crops may require a lot of upfront time and investment, but research suggests it can pay off, particularly in organic production. Organic production systems that exclude synthetic herbicides have unlimited flexibility for integrating diverse cover crops into crop rotations. In conventional systems, herbicide carryover limits cover crop choices, which can increase costs.

In 2019, the USDA Sustainable Agriculture Research and Education (SARE) program published its report *Cover Crop Economics*, based on five years of farmer surveys. The report showed that cover cropping pays over the long run. After several years of planting cover crops, farmers observed greater drought resilience in cash crops, fewer planting delays in wet years, and improved yield stability, providing in effect "a form of crop insurance" *(SARE, 2019)*.

Cover Crop Payoffs

Cover crop payoffs accrue most quickly when:

- They are one of a suite of integrated soil health practices.
- They are selected and used to address specific issues such as compaction, weeds, nutrient cycling, and soil moisture holding capacity.
- They are rotationally grazed in a crop-livestock integrated system.
- EQIP or other cost-share programs are used to offset the initial investment.

(SARE, 2019)

Cover Crop Benefits

- **Improves soil moisture**
  Studies show that cover crops can reduce irrigation needs anywhere from 33%-50%, particularly when using integrated strategies such as diversified rotation, reduced tillage, and compost *(Gaudin et al., 2018; Renwick et al, 2017; DeVincentis 2019)*.

- **Reduces weed pressure and improves fertility**
  In an organic vegetable rotation in Montana, grazing winter cover crops with poultry doubled cover crop biomass, prevented weeds from setting seed, improved soil fertility, and improved yields of winter squash and sweet corn *(Menalled, 2018)*.

- **Reduces erosion and prevents nutrient runoff**
  In certain circumstances, cover crops can dramatically reduce risk by preventing erosion during an extreme weather event (Figure 2), or by retrieving nutrients that would otherwise leach. In an organic vegetable double-cropping rotation in the Salinas

Melissa Maynard

Figure 2. In Floyd, VA, timely planting of a late summer cover crop of sorghum-sudangrass (top left) after a July potato harvest prevented catastrophic soil loss when a freak rainstorm on September 29, 2015 sent three feet of flood waters into the field (top right). The raging river toppled the fence (bottom left) and flattened the cover crop but took no soil at all (bottom right).

> Valley of California, spring lettuce consistently yielded ~30,000 lb per acre after winter cover crops, but yielded much less or failed completely after winter fallow allowed nutrients to leach away *(Brennan, 2018)*.

Build Your Biota

The community of life in the soil plays a central role in building and maintaining healthy soil, retaining and delivering crop nutrients, and reducing risks of crop losses to drought, plant pathogens, and other stresses. Organic farming systems reduce risk by protecting, building, and maintaining a healthy, diverse, well-fed soil biota.

Do Inoculants Work? The Science Says...

One risk management challenge that organic producers encounter is whether to use a purchased microbial inoculant. Will the product enhance soil function and crop production, or is it just a waste of money? Recent research suggests:

- No yield benefits on already-fertile, organically managed soils *(Kleinhenz, 2018)*.
- Yields may be improved in soils of moderately-low fertility *(Wang et al., 2016)*, such as:
  - Highly weathered Ultisols and Oxisols of tropical and warm-temperate regions
  - Fields transitioning from conventional to organic production
- Mycorrhizal inoculants often improve crop vigor and yield on soils low in phosphorus and soluble nitrogen *(Hoeksema et al., 2010)*.

Benefits of Building Biota

- **Promotes stable soil organic matter content (SOM)**
  Most stable SOM results from microbial processing of plant-derived organic carbon by soil microbes *(Kallaenback et al., 2016)*.
- **Reduces need for fertilizer inputs**
  Effective plant root – soil microbe associations, promoted by best organic practices, can greatly reduce the need for fertilizer inputs *(Berthong et al., 2013; Kloot, 2018)*.
- **Enhances nutrient uptake**
  Beneficial root-zone microbes that enhance nutrient uptake and disease resistance in carrot are more abundant in organic than conventional fields *(Abdelrazek, 2018)*.
- **Increases disease resistance for higher yield**
  Organic disease control methods like mustard seed meal and anaerobic soil disinfestation promote disease-suppressive microbes and thereby provide longer-lasting protection than conventional fumigants *(Shennan et al., 2014; Mazzola, 2017)*. Similarly, mustard seed meal or seed treatment with microbial disease antagonists reduced seedling disease and improved stands in organic rice *(Zhou, 2018)*.
- **Reduces risk of foodborne pathogens**
  Increased microbial and dung beetle diversity in organic systems can reduce foodborne pathogen risks in produce from crop-livestock integrated operations *(Jones et al., 2019)*.

Use Integrated Organic Practices for Best Results

New research continues to clarify the importance of organic nutrient sources, diversified crop rotations and integrated complementary practices in building soil health, sequestering carbon, and reducing risk. A few recent findings include the following.

Cropping system diversity plays a key role in soil carbon sequestration by enhancing habitat for soil microbes that build stable SOM *(Kravchenko et al., 2019)*.

Compost applications and crop rotation diversity each enhanced SOM and soil aggregation (tilth) in Michigan *(Mpeketula and Snapp, 2019)*.

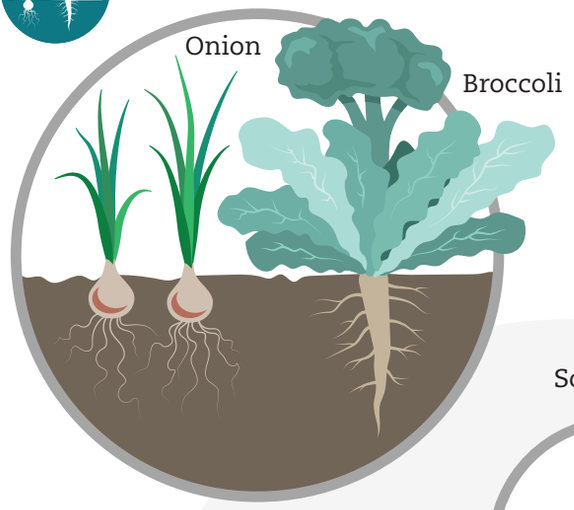
In an organic farming system trial in Salinas, CA, winter cover crops enhanced microbial biomass, while finished compost increased SOM *(Brennan and Acosta-Martinez, 2017)*.

In long term farming trials in Davis, CA, cover crop + compost enhanced SOM from surface to 2 meters (6.6 ft), while cover crop + conventional soluble fertilizer depleted SOM below 30 cm (1 ft) with a net loss throughout the profile *(Tautges et al., 2019)*.

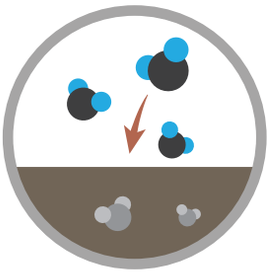
Organic farms show less risk of "deep losses" than conventional farms, likely related to healthier soils and more diverse rotations *(Morris and Schahczenski, 2019)*.

Integrated organic systems with minimal inputs maintained blueberry yield and reduced production costs by 33% compared to "organic by input substitution" *(Montalba et al., 2019)*.

Intercropping



Soil Carbon Sequestration



Cropping system diversity increases carbon sequestration by enhancing soil microbe habitats.

Planting winter cover crops can enhance microbial biomass while finished compost increases SOM.

Soil Microbes

Cover Cropping

Combining organic practices helps build soil health and reduce risk.

Soil Aggregation

Long term trials have shown that cover crops + compost can enhance SOM up to two meters below the surface.

Applying compost and rotating crops can enhance SOM and soil aggregation.

Composting

Choose Climate Resilient Cultivars

Improved crop genetics for organic systems, including traits like disease-resistance, nutrient efficiency, seedling vigor, and competitiveness toward weeds, can reduce risk and improve climate resilience. Several OREI-funded farmer-breeder research teams are evaluating existing germplasm and developing new public crop cultivars. Some recent outcomes include the following.

- Rice cultivars have been identified that combine good yield, competitiveness toward weeds, and resistance to rice water weevil and narrow brown leaf spot *(Zhou, 2018)*.
- Carrot cultivars for organic producers are being developed for disease and nematode resistance, drought tolerance, competitiveness against weeds, enhanced mycorrhizal associations, flavor, nutritional value, and other desired market traits *(Simon, 2018)*.
- Quinoa lines with enhanced heat and drought resilience and improved protein quality were identified in an organic quinoa breeding program *(Murphy, 2018)*.
- Regionally adapted cultivars of hairy vetch, crimson clover, and winter pea cover crops selected for winter hardiness, biomass, nitrogen fixation, weed suppression, disease resistance, and desired life cycle traits are in development for organic producers in California, the Pacific Northwest and Great Plains, and the North Central, Northeast, and Southeast regions *(Mirsky et al., 2018)*.

Seed-Saving

On-farm seed-saving with skilled selection can build resilience to climate and other risks by "fine-tuning" existing cultivars for a particular farm's microclimates, soils, pests, diseases, and production practices. Seed catalogues carry a growing number of farmer-developed cultivars.

Institutional Support for Soil-Based Risk Management

Soil-enhancing practices such as cover cropping, conservation tillage, and rotational grazing entail some up-front costs and may require learning new skills, while the financial payoffs from improved yield stability and climate resilience usually begin to accrue several years later. The initial cost of adding new practices or inputs can carry substantial risk for cash-strapped producers–often sufficient to deter adoption *(DeVincentis, 2019)*.

Federal Programs

Government programs such as the USDA Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP) can play a vital role in helping farmers clear these initial hurdles and reap the long-term benefits of improved practices. The 2018 Farm Bill includes several provisions that can help organic farmers meet the challenges of climate change and other risks. The following table outlines some of the most significant provisions.

Environmental Quality Incentives Program (EQIP)	Financial assistance to producers for adaptation and mitigation of increased weather volatility Higher (90%) cost share for priority EQIP practices selected by each state
Conservation Stewardship Program (CSP)	Financial assistance to producers for adaptation and mitigation of increased weather volatility Increased payments for cover crops, improved crop rotation, and rotational grazing Beginning in 2020, CSP payment for comprehensive conservation planning Funds allocated for organic and transitioning growers to each state
Organic Research and Extension Initiative (OREI)	Increased and permanent funding for organic research and education projects
Risk Management Agency- Crop Insurance Programs	Crop Insurance programs modified to better serve beginning, organic, diversified, and specialty-crop producers *(Stein, 2019)*

USDA agencies began implementing these provisions during the 2019 and 2020 fiscal years.

The Soil Health Institute (SHI) and National Sustainable Agriculture Coalition (NSAC) published an excellent report summarizing the soil health provisions that were included in the 2018 Farm Bill (https://sustainableagriculture.net/wp-content/uploads/2019/09/FINAL-DIGITAL-Impact-of-2018-Farm-Bill-Provisions-on-Soil-Health.pdf). NSAC also provides regular updates on USDA program implementation and signup periods.

State Initiatives

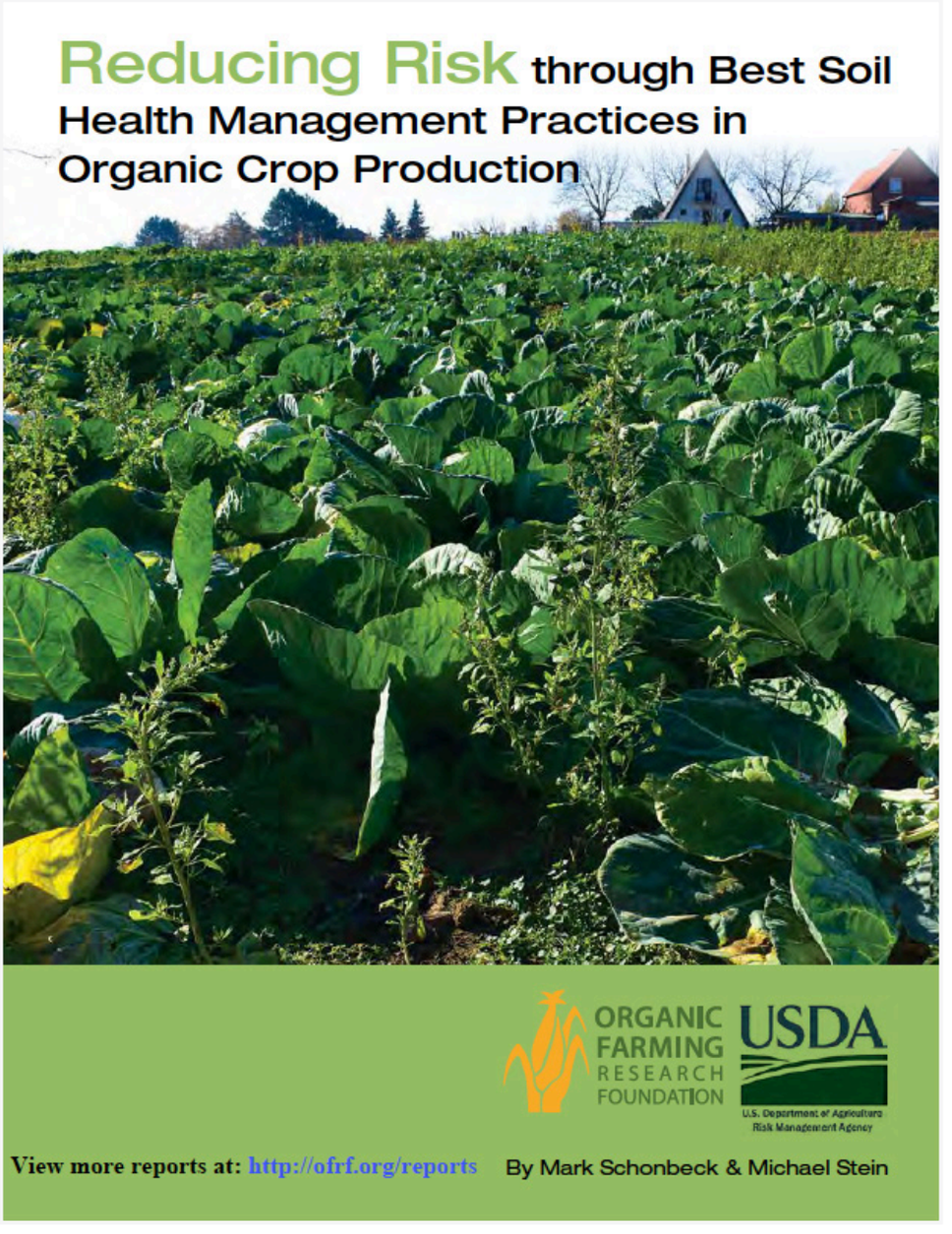
A growing number of state level soil health, carbon sequestration, and climate resiliency initiatives offer financial and technical assistance to farmers adopting practices toward these goals. For example, some states offer cost share for cover crops, composting, strip cropping, nutrient management, riparian buffers, and other soil and water stewardship practices, while others distribute grants to farms to build more climate resilient practices.

Below is more information on state cost share and technical support programs for soil health and climate resilience practices to reduce production risks.

State	Specific Practices Identified for Support	Designated Committees, Task Forces, or Agency Capacity	Research/ Education Provided	Technical Assistance Provided	Funding Assistance/ Funding Stream
CA	No-till, cover crops, compost, grazing	✓	✓	✓	$7.5M
HI	Compost, agroforestry	✓	✓	✓	$25,000 for study
MD		✓	✓	✓	
OK	Trees, conservation, re-vegetation	✓	✓		Creates fund
UT	Advance forestry, grazing	✓			
MA	No-till, cover crops, grazing, integrated	✓	✓	✓	Creates fund
NY	Carbon farming as defined by the NRCS COMET-Planner		✓	✓	Tax credit
VT	No synthetic chemicals	✓		✓	Marketing program

NOFA-NY & Earthjustice 2019

Find more resources, including OFRF's comprehensive guidebook, *Reducing Risk through Best Soil Health Management Practices in Organic Crop Production*, at ofrf.org/programs/managing-on-farm-risk.



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* For project proposal summaries, progress and final reports for USDA funded Organic Research and Extension Initiative (OREI) and Organic Transitions (ORG) projects, enter proposal number under "Grant No" and click "Search" on the CRIS Assisted Search Page at: http://cris.nifa.usda.gov/cgi-bin/starfinder/0?path=crisassist.txt&id=anon&pass=&OK=OK.

Note that many of the final reports on the CRIS database include lists of publications in refereed journals that provide research findings in greater detail.

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