

Managing Risk Through Soil Health Practices

Research-based Practical Guidance for Organic and Transitioning Farmers

Presented by OFRF

Michael A. Stein

*This presentation was made possible by a grant from the
USDA Risk Management Agency*

National Organic Standards Require Investment in Soil Health

Section 205.203(a) Select and implement tillage and cultivation practices that maintain or improve the physical, chemical, and biological condition of soil and minimize soil erosion.

Section 205.203(b) Manage crop nutrients and soil fertility through rotations, cover crops, and the application of plant and animal materials.

Section 205.203(c) and (d) Manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances.

Section 205.205: The producer must implement a crop rotation including but not limited to sod, cover crops, green manure crops, and catch crops that provide the following functions that are applicable to the operations

- (a) Maintain or improve soil organic matter content;
- (b) Provide for pest management in annual and perennial crops;
- (c) Manage deficient or excess plant nutrients; and
- (d) Provide erosion control.

2016

National Organic Research Agenda

Outcomes and Recommendations from the
2015 National Organic Farmer Survey and Listening Sessions



By Diana Jerkins, Ph.D
and Joanna Ory, Ph.D



In a survey of more than 2,000 organic farmers conducted by OFRF:

- 74% cited soil health and quality as a high research priority.
- 66% cited fertility and nutrient management.

Download full report at <http://ofrf.org/>.



Research Issues:

- Best rotations, cover crops, and organic amendments for building soil organic matter (SOM) and soil health.
- Best practices for different regions, soils, climates, and farming systems.
- Practical field measurement methods for SOM and soil health.
- Restoring depleted soils, rebuilding soil health during organic transition.
- Minimizing negative impacts of tillage.
- Enhancing resilience to weather extremes and climate change.



Soil Health and Organic Farming

Weed Management:
An Ecological Approach

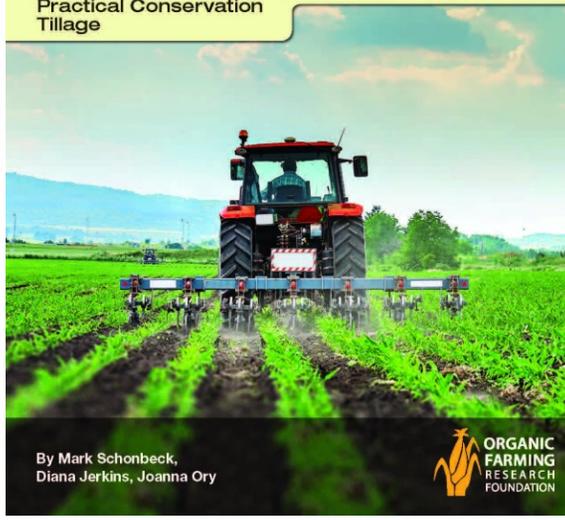


By Mark Schonbeck,
Diana Jerkins, Joanna Ory



Soil Health and Organic Farming

Practical Conservation
Tillage

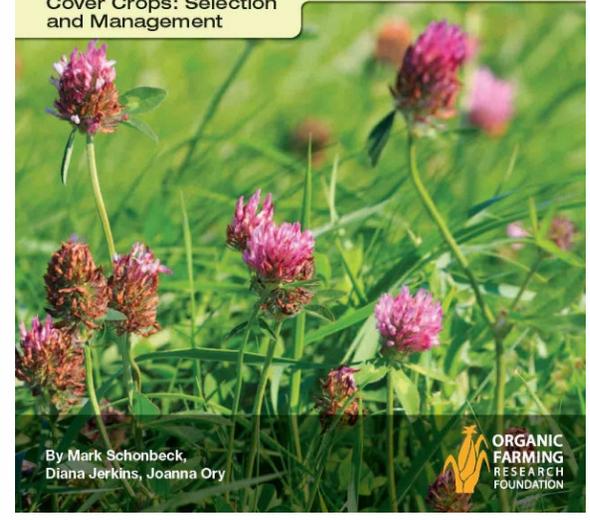


By Mark Schonbeck,
Diana Jerkins, Joanna Ory



Soil Health and Organic Farming

Cover Crops: Selection
and Management

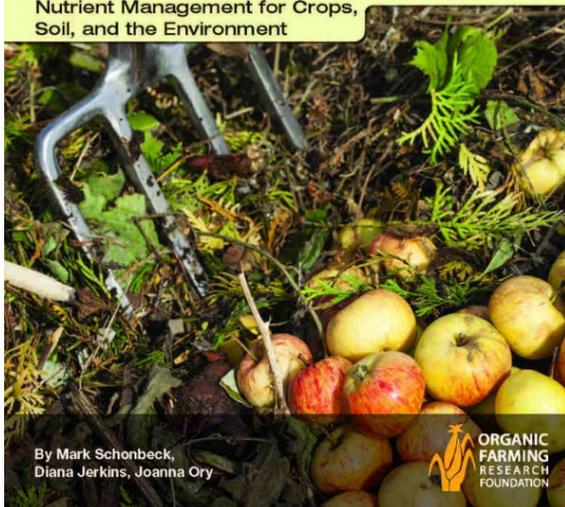


By Mark Schonbeck,
Diana Jerkins, Joanna Ory



Soil Health and Organic Farming

Nutrient Management for Crops,
Soil, and the Environment

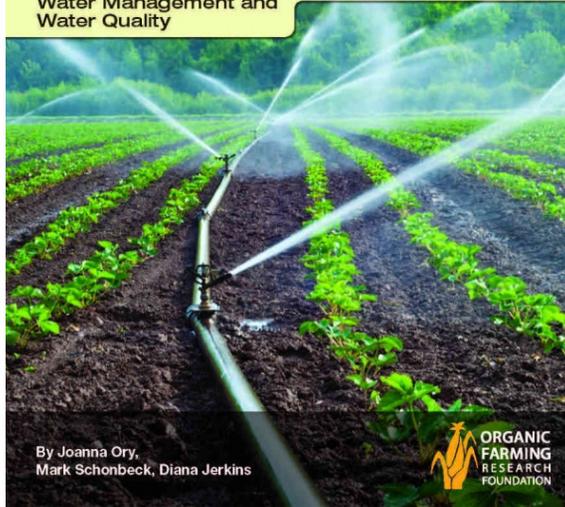


By Mark Schonbeck,
Diana Jerkins, Joanna Ory



Soil Health and Organic Farming

Water Management and
Water Quality

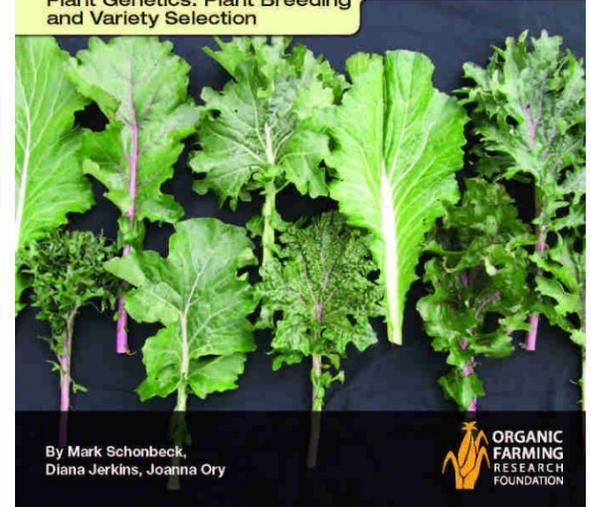


By Joanna Ory,
Mark Schonbeck, Diana Jerkins



Soil Health and Organic Farming

Plant Genetics: Plant Breeding
and Variety Selection



By Mark Schonbeck,
Diana Jerkins, Joanna Ory



All guidebooks available for free download at
www.ofrf.org

Farming is risky!

- Poor crop stands
- Drought
- Excessive rain, flooding
- Excessive heat
- Untimely frosts & freezes
- Hail, tornado, extreme weather
- Pests, weeds, diseases
- Crop nutrient deficiencies
- Soil degradation and loss
- Fickle markets, low prices



Stop, thief! Erosion steals the farm's natural capital.

Changing Weather will increase risks

- Poor crop stands
- Drought
- Excessive rain, flood
- Excessive heat
- Untimely frosts & freezes
- Hail, tornado, etc.
- Pests, diseases, weeds
- Crop nutrient deficiencies
- Soil degradation and loss
- Fickle markets, low prices



Meilssa Maynard



Rodale Institute

Risk management in organic farming

- Nitrogen (N) limitation
- Phosphorus (P) excesses
- Weeds
- Cultivation & soil
- Pests & diseases
- Costs of organic inputs
- Lower yields
- Knowledge-intensive system



Organic farmers rely on healthy soil to enhance crop resilience and reduce risk, but cultivation needed for weed control can compromise soil health.



What is soil health?
and
How can it help manage risk?

Healthy soil

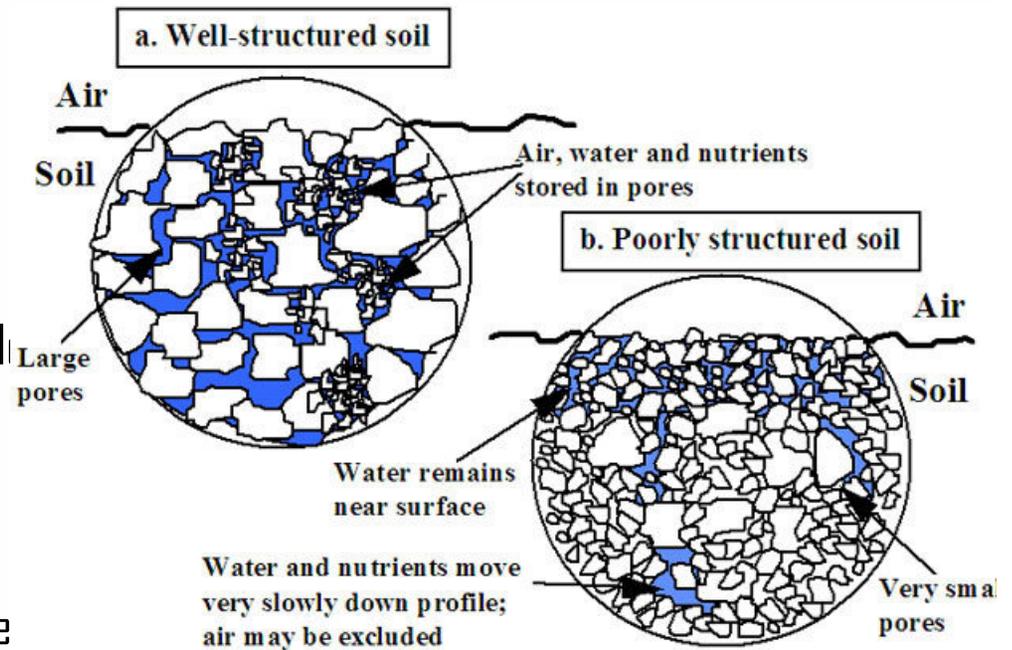
- Provides sufficient but not excessive plant nutrients.
- Retains and cycles nutrients, protects water quality.
- Hosts abundant, diverse beneficial soil organisms, few pests and pathogens.
- Enhances crop resistance and resilience to pests, diseases, and weather extremes.
- Requires less inputs to sustain yields.



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Healthy Soil Characteristics

- Has good tilth (crumb structure or aggregation).
- Has network of large and small pores that promote drainage and aeration.
- Absorbs, retains and provides plant available moisture.
- Fosters deep, extensive root system development.
- Resists compaction and erosion, and recovers from effects of disturbance.



How healthy soil reduces risk: physical properties

Soil life and soil organic matter (SOM)
maintain structure (tilth)

- Timely planting
- Better crop emergence
- Easy to work, saves fuel
- Easy cultivation for weed control

Resists compaction and erosion

- Reduced soil losses
- Sustained fertility



*The “crumb structure”
of healthy topsoil makes
it less likely to erode or
become compacted.*

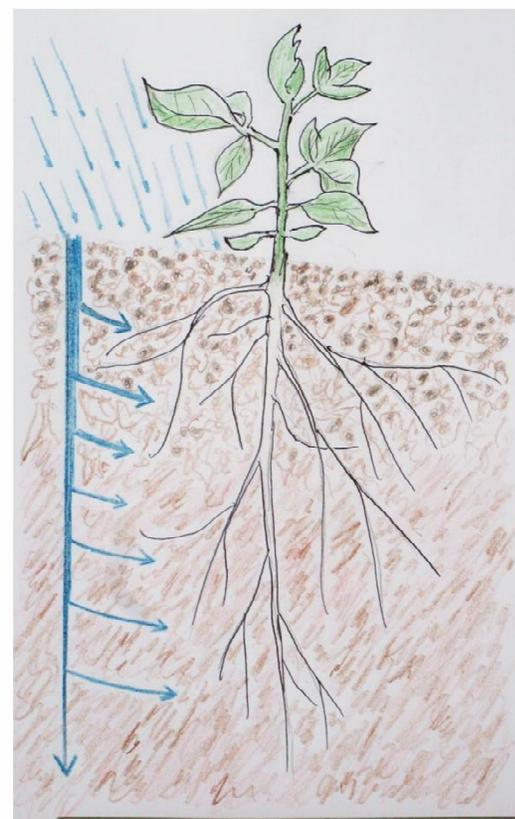
How healthy soil reduces risk: plant-available water

Absorbs, retains, and delivers
plant-available moisture

- Drought resilient crops
- Less irrigation needed
- Reduced runoff and erosion

Drains well

- Healthier roots, less disease
- Fewer planting delays



*Healthy soil holds
more plant-available
water.*

How healthy soil reduces risk: drought resilience and yield stability



In Rodale trials, organically managed soil held sufficient moisture to sustain corn through drought (left), while conventional corn showed severe water stress (right) and 31% lower yields.

How healthy soil reduces risk: soil life

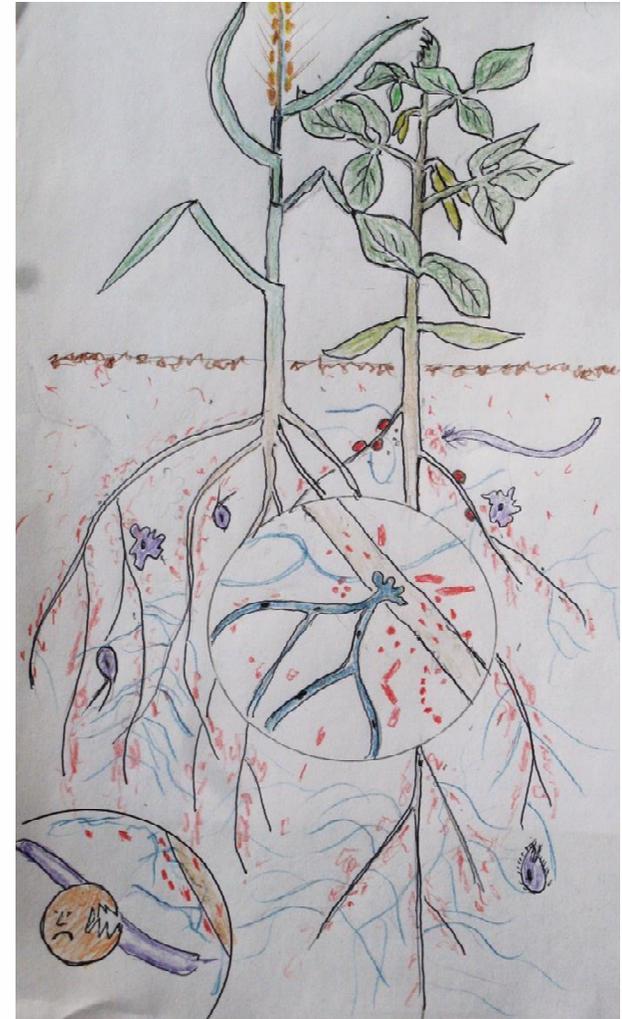
Hosts many beneficial organisms, few
pests and pathogens

- Reduced plant disease
- Resilient crops
- Enhanced nutrient and water use efficiency



Plant-soil-microbe partnerships

- Mycorrhizal fungi
 - Water and nutrient uptake
- N fixing bacteria
 - Legume nodules
 - Root zone other crops
- Disease suppression
 - Competition
 - Predation, antibiosis
 - Induced systemic resistance (ISR)



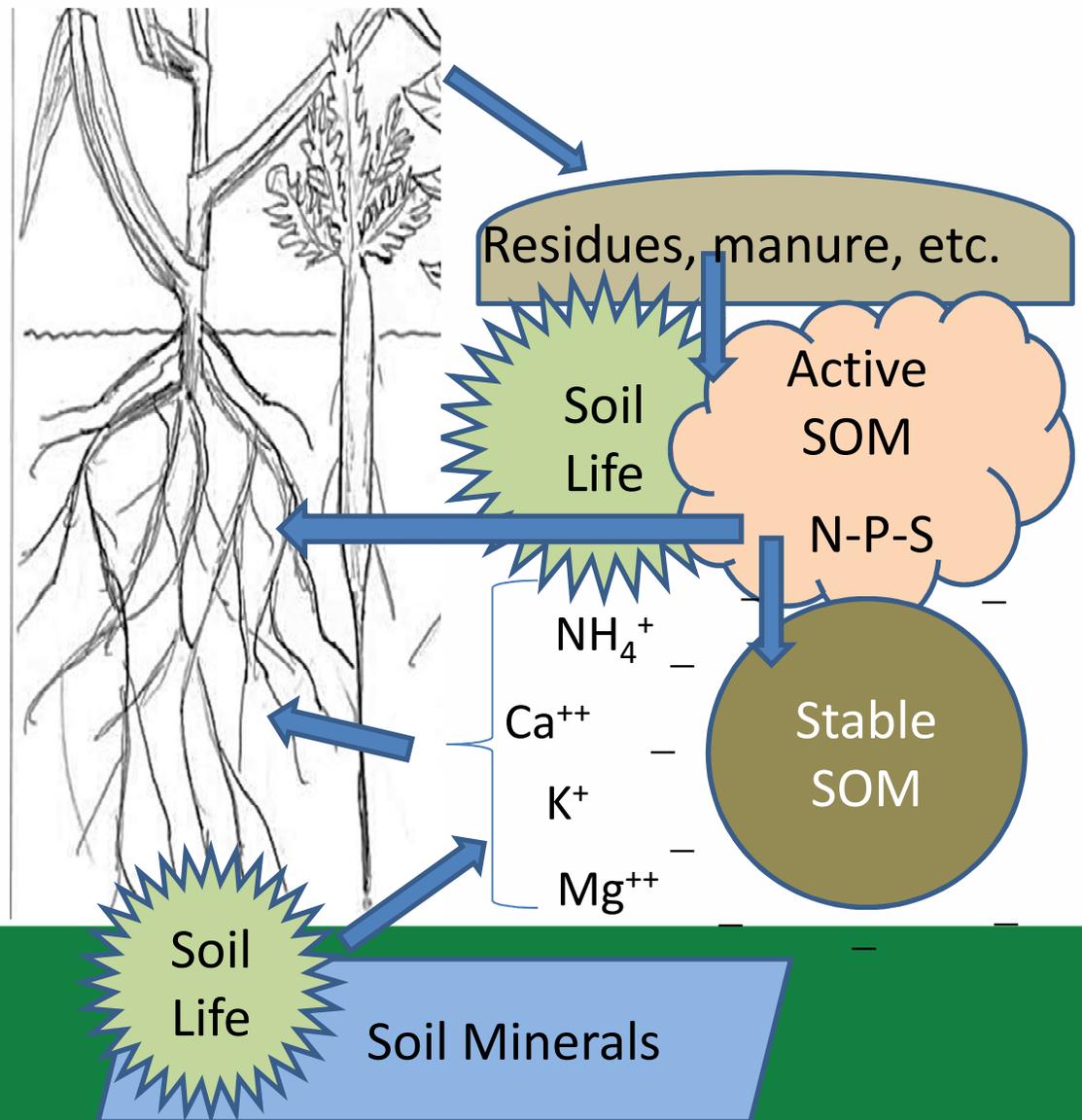
How healthy soil reduces risk: crop nutrients

Retains and recycles nutrients:

- Lower fertilizer costs
- Water quality

Delivers sufficient but not surplus nutrients to crops:

- Yield and quality
- Soil life



“Living soil changes everything”

Robin Kloot, 2017 Organic Agriculture Research Symposium, Lexington, KY

5-year trial:

- Corn-soy-wheat with cover crops.
- Sandy soil.
- Organic practices.
- No P or K vs recommended rate.
- N at half of recommended rate.

Results:

- SOM 1.2 → 1.7%
- Full yield without P and K.
- Soil pH, P, and K stable.



Southeast coastal plain soil in good health, with plant roots accessing subsurface nutrients and moisture.

Soil Health and Risk Reduction

Management challenges and
opportunities

The Journey to Soil Health: Four Main Principles



Keep soil covered



Diversify the cropping system

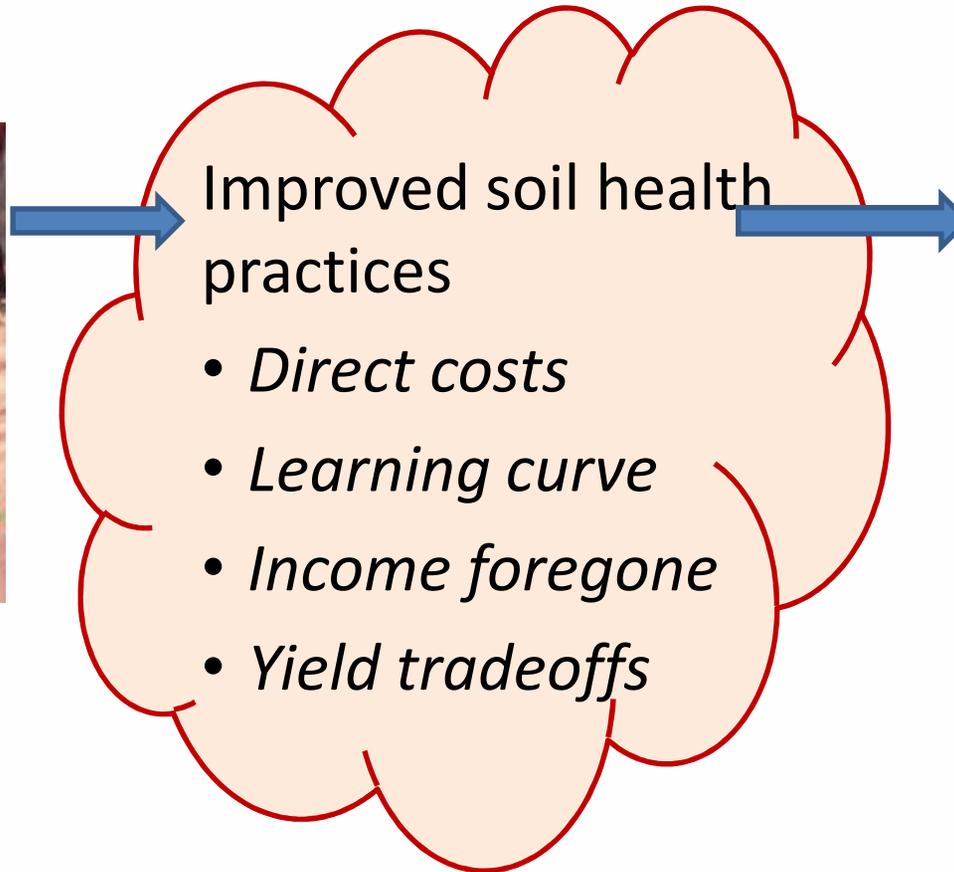


*Maintain
living
roots*

*Minimize
disturbance*



The Journey to Soil Health: Investments and Risks



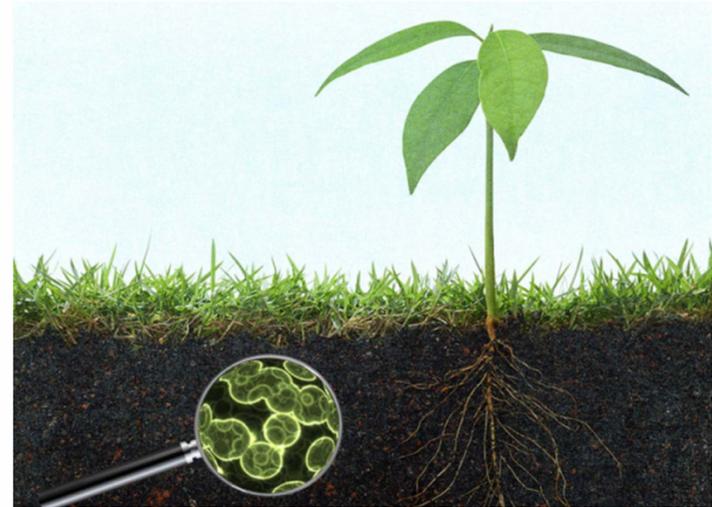
*Photos by
Rodale Institute*

Reducing risk through soil health management

Practical steps and resources

Step 1: Assess the farm's soil resources

- Soil survey
 - Texture, drainage, etc.
- Assessments
 - Standard soil test
 - Crop foliar analysis
 - Soil health indicators
- Field observations
 - Soil physical condition
 - Soil life
 - Crop condition



Read soil tests through the “lens” of living soil. In healthy soil, crops can find more nutrients than the lab sees.

Get to know your soil

Use the NRCS Web Soil Survey



USDA United States Department of Agriculture
Natural Resources Conservation Service

Web Soil Survey

Home About Soils Help Contact Us

You are here: Web Soil Survey Home

Search
Enter Keywords
All NRCS Sites

Browse by Subject

- Soils Home
- National Cooperative Soil Survey (NCSS)
- Archived Soil Surveys
- Status Maps
- Official Soil Series Descriptions (OSD)
- Soil Series Extent Mapping Tool
- Soil Data Mart

The simple yet powerful way to access and use soil data.

START WSS

Welcome to Web Soil Survey (WSS)

Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

Four Basic Steps

I Want To...

- Start Web Soil Survey (WSS)
- Know the requirements for running Web Soil Survey — will Web Soil Survey work in my web browser?
- Know the Web Soil Survey hours of operation
- Find what areas of the U.S. have soil data

Announcements/Events

- Web Soil Survey 2.3 has been released! View description of new features.
- Web Soil Survey Release

A simple and direct approach to assessing soil health trends in your fields

- Get to know your soil, its inherent properties, strengths, and weaknesses, as well as past management history.
- Make your own field observations each year to track changes in soil tilth, soil color, earthworm abundance, crop vigor, and other indicators of soil health.
- Conduct soil health assessments tests periodically to evaluate several physical, chemical, and biological soil properties.
- Conduct quantitative in-field measurements if you have the time and find that they help fine tune your management system.

Tips for field observation

- Is the topsoil soft and crumbly, with visible aggregates, or is it hard, cloddy, or crusted?
- Is the topsoil a dark, rich brown (high SOM), or a lighter tan or reddish (lower SOM)?
- Dig a few holes with shovel or soil probe. Is there a subsurface hardpan that could restrict root penetration?
- Does rainfall or irrigation water soak in quickly, or tend to pond or run off?
- Do you see an abundance of:
 - Earthworms?
 - Other macroscopic organisms?



Tips for field observation

- Are crops thriving and resilient, or prone to drought, pests, diseases, and other stresses?
- Dig up some plants – are the roots deep, abundantly branched, and a healthy white color, or is root growth restricted or affected by disease (dark, discolored)?



Step 2 – Review your practices

- Crop rotation
 - Fallow periods
 - Cover cropping
 - Tillage practices
 - Cultivation / weed control
 - Fertilizers and amendments
- Soil health impacts
 - Benefits, costs, and risks
 - Low-cost solutions



Seeding clover with cereal grain replenishes soil N at a fraction of the cost of organic fertilizers.

Step 3: Build a resilient production system for your site

- Add crops



- Reduce tillage



- Adjust inputs

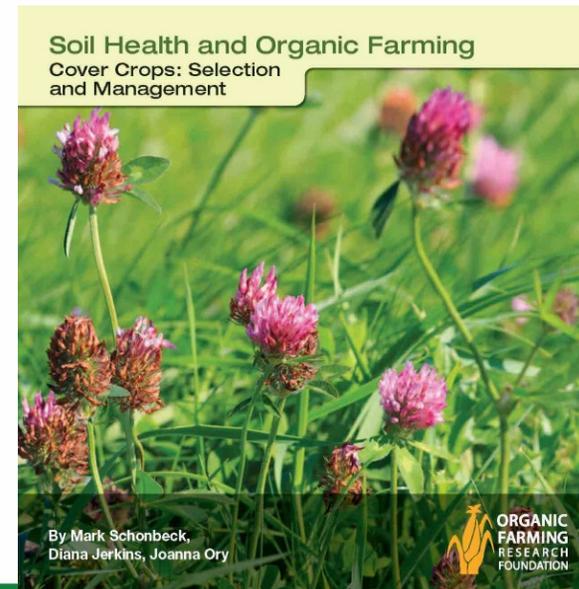


- Add one new crop, practice, or enterprise at a time:
 - Small scale trial
 - Comparison trial
 - Enterprise budget
 - Partial budget for new practice or cover crop
- Scale up promising crops or practices.

Step 3: Build a resilient production system for your site

Adding Crops

Cover crops
Cash crops
Forage crops



A diverse plant community builds soil diversity



Each species offers a different root architecture and "recipe" of root exudates, and thereby supports a particular suite of soil microbes.



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Process for adding new crops

- Map out your current crop rotation.
- Identify risks or concerns (e.g. fallow / erosion.)
- Identify new crop(s) to add or substitute.
- Keep record of implementation and outcomes.
- Create balance sheet of costs, benefits, and net financial impacts of the added crops.
- Plan next steps.

Example: assess current rotation



Current rotation		Concerns
May-Sept	Corn	N-limited yield
Oct-May	Fallow	N leaching
June-Oct	Soybean	Weeds
Nov-Apr	Fallow	Erosion

Example: adding cover crops



Current rotation		Concerns	New crops
May-Sept	Corn	N limited	
Oct-May	Fallow	N leaching	Rye
June-Oct	Soybean	Weeds	
Nov-Apr	Fallow	Erosion	Vetch



Example: assessing outcome



New rotation		Outcomes	Next steps
May-Sept	Corn	Yields up 25%	Assess net return
Oct-May	Rye	Good biomass	
June-Oct	Soybean	Gaps in stand, fewer weeds	Adjust planter for residue
Nov-Apr	Vetch	A bit less erosion	Try oats + vetch

Example: Assessing risk reduction

Direct financial benefits	Costs	Long-term benefits
Crop yield and yield stability	Cover crop seed and inoculant	Avoided erosion
Reduced need for cultivation (fuel, labor savings)	Cover crop planting & mgmt (fuel, labor)	Improved SOM, soil health, and fertility
Reduced fertilizer bills	New coulters for soybean planter	Better water quality

Net benefit = \$ (income + savings – costs) + long term

SARE Cover Crop Surveys: 2012 – 2016

- Benefits cited by farmers:
 - Healthier soil (85%)
 - Weed management (69%).
 - Yield stability (66%).
 - Increased net return (33%)
- Corn and soybean yield response to cover crops:
 - Up 1 – 5% most years
 - Up 9 – 11% in 2012 drought

<https://www.sare.org/Learning-Center/Topic-Rooms/Cover-Crops/Cover-Crop-Surveys>



Rye, crimson clover, and radish were most widely planted.

Cover Crops

Benefits:

- Prevent erosion
- Feed soil life, build SOM
- Increase soil water holding capacity
- Fix N (legumes)
- Retain nutrients
- Suppress weeds
- Reduce pests and diseases



Late-summer cover crop mix of pearl millet, sudangrass, and radish sends roots five feet deep, breaking hardpan and retrieving nutrients.



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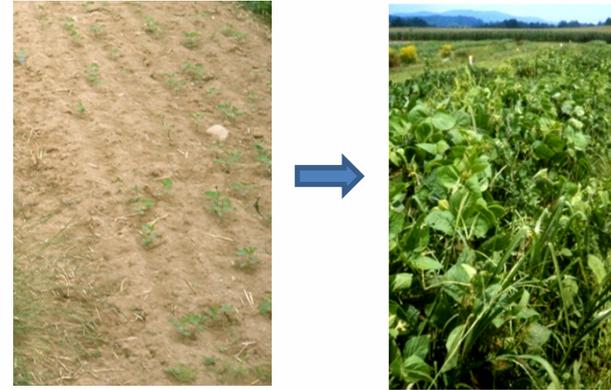
Cover Crops

Direct costs:

- Seed
- Planting, management

Risks:

- Cash crop planting delays
- N tie-up or N leaching
- Water use in dry years
- Cover crop failures
- Self seeding



Poor seed grows weedy cover crop (top); self-seeded cover becomes weed (bottom).

Diversify the cropping system

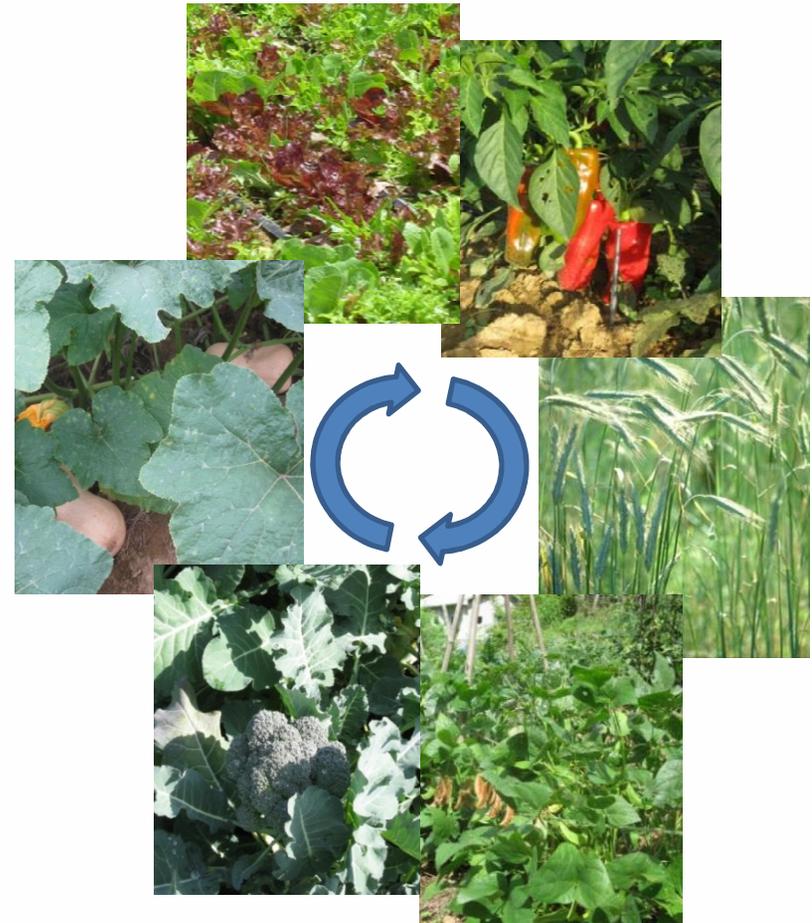
Crop rotation

Benefits:

- Soil organic matter
- Soil functional biodiversity
- Fewer weed, pest, and disease problems
- Market opportunities

Risks and costs:

- New skills and equipment
- More complex system
- Market challenges



Sod phase in crop rotation

Benefits:

- Organic matter, soil life
- Erosion control.
- Tilt & fertility
- Reduced weed seed bank
- Forage for grazing

Costs and risks:

- Income foregone
- Tillage to terminate sod
- Moisture consumed



Multispecies grazing



Sod regrowth through rolled cover crop

A few cover cropping tips

- Choose best cover crops for your needs.
- Use fresh, high-vigor seed.
- Optimize planting date, rate, and method.
- Plant grass + legume to balance carbon and nitrogen.
- For short growing season, interplant cover into cash crop.
- For dry regions, choose water-efficient cover crops.

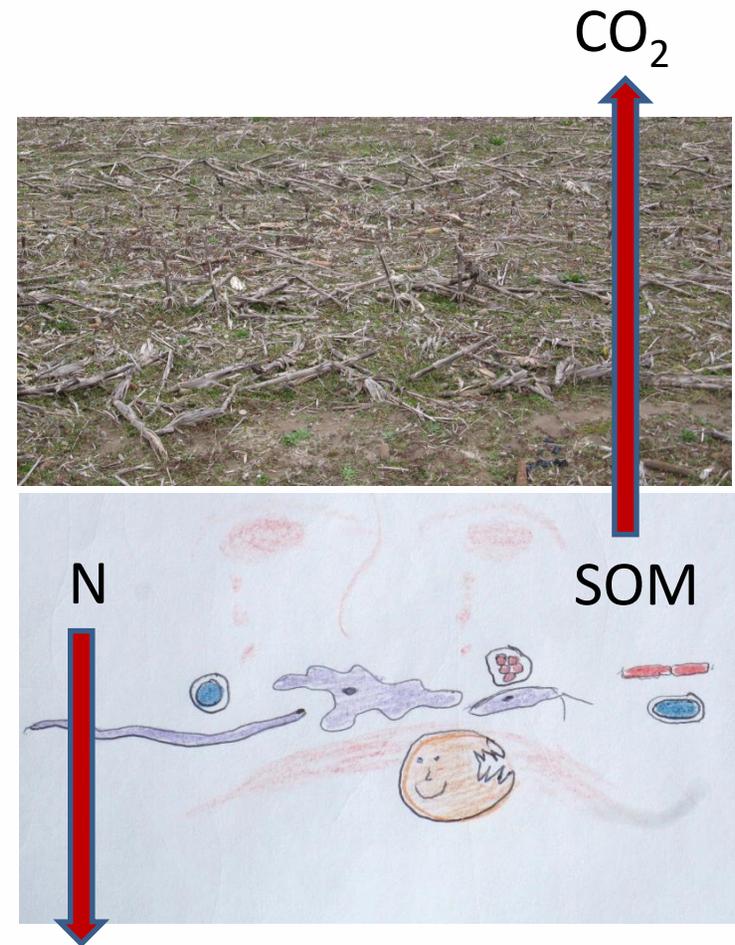


Mix of rye, pea, and vetch balances C : N

Bare soil is at risk!

During bare fallow:

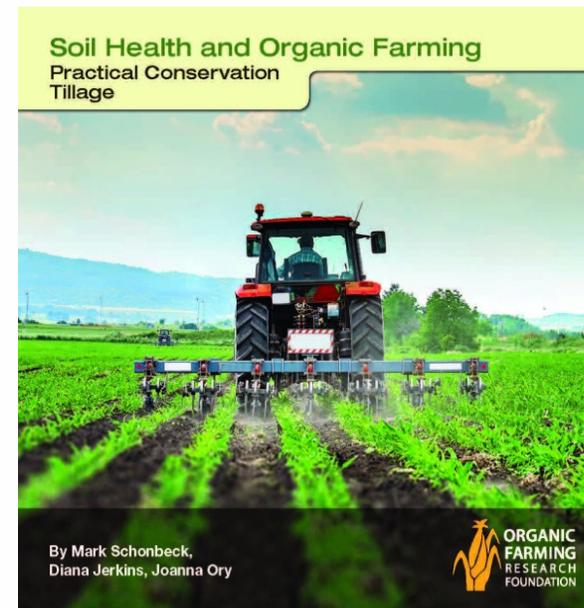
- Erosion is imminent.
- Soil life goes hungry.
- Mycorrhizal fungi and other crop symbionts lack “green bridge.”
- Nutrients leach.
- Fertilizer costs increase.
- Soil loses SOM and water holding capacity.



Step 3: Build a resilient production system for your site

Reducing tillage

You don't have to eliminate all tillage to build soil health during an annual crop rotation.





There is a fine balance between tillage and cultivation required for weed control and building healthy soils

Practical options for reducing tillage intensity in organic systems

- Strip or zone tillage
- Ridge tillage
- Rotary harrow
- Spading machine
- Sweep plow undercutter
- Rotary tiller geared down.

Resource: **Reduced Tillage in Organic Systems Field Day Program Handbook.**

https://rvpadmin.cce.cornell.edu/uploads/doc_699.pdf



Zone tillage tools (left) work; cabbage planted into zone-tilled field (right).

Photo by Cornell Small Farms Pgm.

No-till planting in rolled cover crop

Benefits:

- Enhanced SOM & soil health.
- Reduced erosion & compaction.

Costs and risks:

- Equipment (roll-crimper, no-till planter).
- Planting delays & challenges
- Cooler soil, slower N release
- Increased weed pressure
- Lower yields

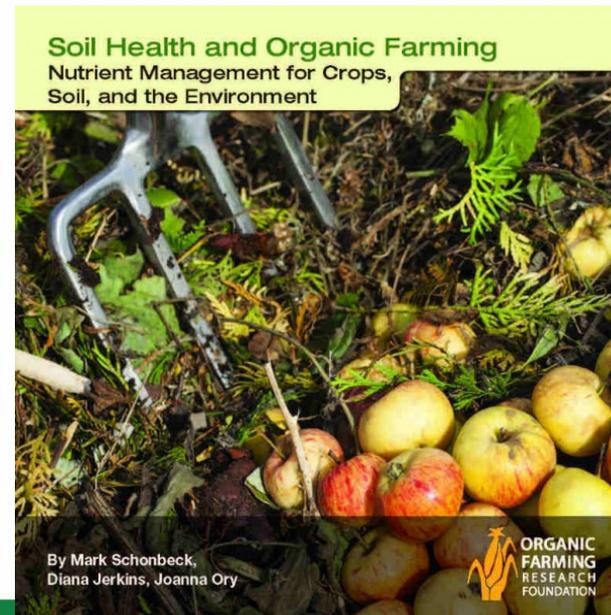


Organic no-till broccoli in rye residue suffers N deficiency and weed competition.

Step 3: Build a resilient production system for your site

Adjusting inputs

More is not always
better



Complementary soil building practices: organic and mineral amendments



Compost (top) and tree leaf mulch (bottom) can add organic residue and protect soil surface.

- Use finished compost to build stable soils.
- Return on-farm manure and other organic residues to the soil.
- Use organic mulches to protect soil surface (e.g., vegetable crops).
- Use off-farm organic or natural mineral inputs as needed to restore soil balance or replenish nutrients removed in harvest.
- Use commercial soil inoculants if needed to restore soil life.

A balanced approach to NPK

- Test soil, compost, crop foliage.
- Grow legumes to save \$ on N.
- Credit N from legumes, SOM, and organic amendments.
- Add N in band or by in-row drip.
- Avoid over-irrigation (N leaching).
- Adjust compost rates based on P.
- Apply K only when needed.



Pepper and other fruiting vegetables thrive on moderate soluble N levels.

Step 4: Defray Costs

Input frugality

- Reduce need to add nutrients:
 - Build healthy soil.
 - Grow deep-rooted crops.
 - Return on farm residues to soil.
 - Integrate crops and livestock.
- Conduct side-by side trials:
 - Did the crop respond?
 - Did soil health improve?
 - Did the yield increase pay for the input?



Step 4: Defray Costs

Federal Programs that support soil health

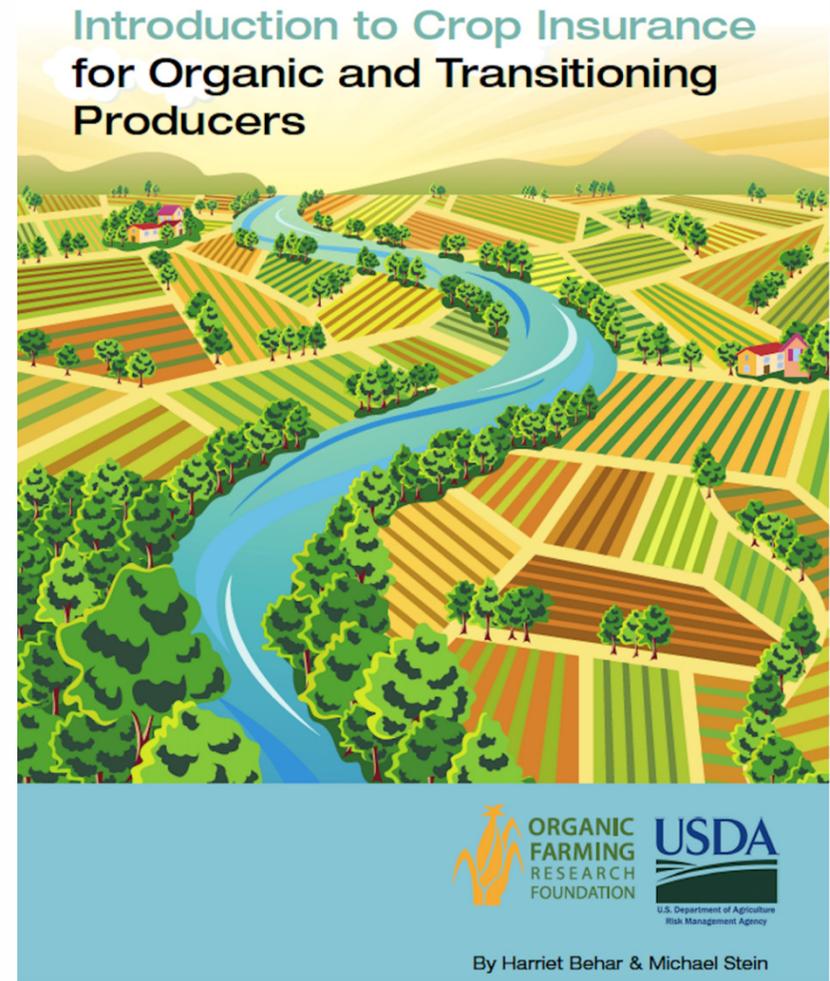
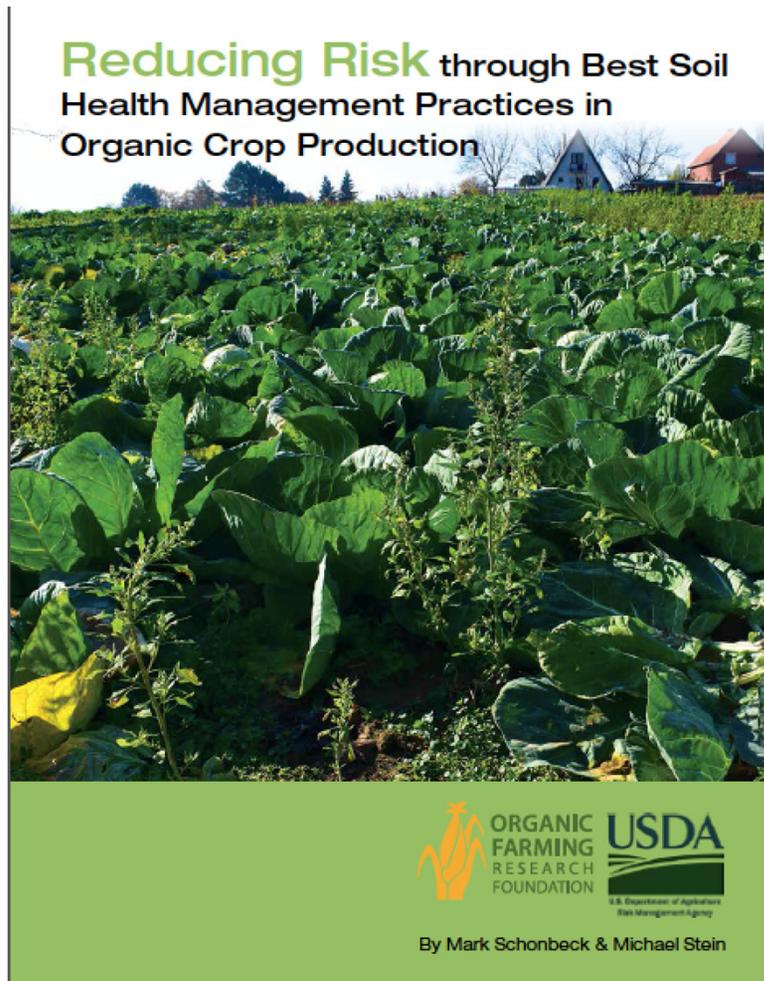
Natural Resources Conservation Service (NRCS)

<https://www.nrcs.usda.gov/>.

Working lands programs:

- Environmental Quality Incentives Program (EQIP)
 - EQIP offers cost-share for newly adopted basic soil health practices like cover cropping and conservation tillage
- Conservation Stewardship Program (CSP)
 - CSP provides financial and technical support for whole farm conservation, with additional payments for adopting high-level soil health and resource stewardship enhancement activities.

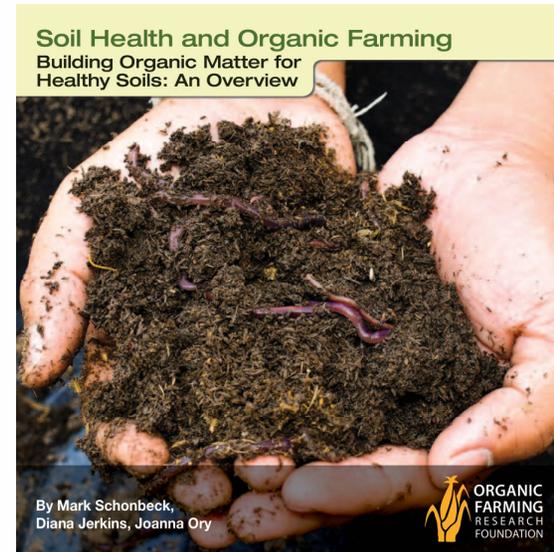
New Risk Management Guidebooks



FREE Downloads and upcoming webinars on these guidebooks available at www.ofrf.org

Information Resources

- OFRF Soil Health and Organic Farming Guides <http://ofrf.org/>.
- eOrganic articles and webinars. <https://articles.extension.org/>.
- **Building Soils for Better Crops** <http://www.sare.org/Learning-Center/Books/>.
- **National Sustainable Agriculture Information Service (aka ATTRA)** <https://attra.ncat.org/>
- **Explore the Science of Soil Health (NRCS)** <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/health/?cid=stelprdb1245890>.



What are your
biggest
challenges in
managing risk?



A close-up photograph of a person's hands holding a large amount of dark, rich soil. Several earthworms are visible, crawling through the soil. The person is wearing a white, textured wristband on their left wrist. The background is dark and out of focus.

Questions?

Download the Soil Health and Risk Management Guidbooks
at www.ofrf.org.

*Production of the Risk Management guides & webinars are made possible by a grant from the USDA-
Risk Management Agency.*

