

USDA

United States  
Department of  
Agriculture



unlock the  
**SECRETS**  
IN THE **SOIL**

# 5 QUESTIONS

landowners should ask their farmers  
about soil health



unlock the  
**SECRETS**  
IN THE  
**SOIL**

**More farmers, ranchers and others who rely on the land are taking action to improve the health of their soil. Many farmers are actually building the soil.** How? By using soil health management systems that include cover crops, diverse rotations and no-till.

When they're building the soil they're doing something else – they're also building the land's production potential over the long-term.

But how do landowners know if their tenants are doing everything they need to do to make and keep their soil healthy? Barry Fisher, an Indiana farmer and nationally recognized soil health specialist with the USDA's Natural Resources Conservation Service, recommends that they ask their farming partner these five questions.

# #1



## DO YOU BUILD ORGANIC MATTER IN THE SOIL?

Organic matter (carbon) may be the most important indicator of a farm's productivity. The amount of soil organic matter often determines the price farmers will pay to rent or buy land. Finding a farmer who is interested in building organic matter by using practices like no-till and cover crops is like finding a bank with a better rate on a Certificate of Deposit, Fisher says.

# #2



## DO YOU TEST THE SOIL AT LEAST ONCE EVERY 4 YEARS?

Fisher says maintaining fertility and pH levels are important to your farm's productivity. Regular soil testing can give an indication of trends in soil fertility, pH and organic matter levels in each field. These tests will determine the amount of fertilizer each field needs. If a field has a history of manure application and very high fertility, a farmer could save money by planting cover crops to keep those nutrients in place rather than applying more nutrients that may not be needed.

## #3



### DO YOU USE NO-TILL PRACTICES?

Some landowners like the look of a clean-tilled field in the springtime. That “nice look” is short lived, though. “The reality is a field that has bare soil is subject to erosion and loss of organic matter, since it no longer has the protective cover from the crop residue on the surface,” Fisher says. “No-till farming utilizes the crop residue to blanket the soil surface to protect it from the forces of intense rainfall and summer heat. This protective blanket will conserve moisture for the crop and prevent loss of soil from wind erosion, water erosion and carbon that could be burned off by summer heat.”

## #4



### DO YOU USE COVER CROPS?

“Like no-till, cover crops provide a green, protective blanket through the winter months or fallow times. The green-growing cover is collecting solar energy, putting down roots and providing habitat when the soil would otherwise be lifeless and barren,” says Fisher. This habitat provides food and shelter for a broad population of wildlife above ground and beneficial organisms below ground. As the new life emerges, cover crops hold onto the nutrients left from the previous crop and in turn releases them to the next crop. The solar rays these plants collect are powering photosynthesis, taking in carbon dioxide from the atmosphere to produce food for the plant and the organisms living in the root zone. This same process also releases clean oxygen to the air and builds nutrient rich organic matter in the soil.

## #5



### WHAT CAN WE DO TOGETHER TO IMPROVE SOIL HEALTH ON MY LAND?

To improve soil health, landowners and tenants need to think long-term. According to Fisher, the duration of the lease agreement is perhaps the most critical matter in encouraging the adoption of these soil health management systems. “Farmers can actually build the production capacity and resiliency of their landowner’s soil, but it may take several years to realize the full benefits of doing so,” Fisher says. He suggests that landowners consider multiple-year leases that provide tenure security for the tenant. Longer tenures give both landowners and tenants more opportunities to improve soil health and realize the resulting longer-term production and profitability gains through sustainable conservation practices.

### LEARN MORE

“Improving soil health can provide long-term, stable dividends for you, your family and your farming partner,” Fisher says. “Improving soil health also can decrease the effects of flooding, make food production more resilient to weather extremes, and improve the health of water and wildlife, as well,” he adds.

Fisher encourages landowners to learn more about the basics and benefits of soil health management systems and to begin the soil health discussion with their farming partner right away. “Even if you’re not a farmer or landowner, everyone has a great stake in improving the health of our soil,” he says.

Landowners can also learn more about the benefits of soil health by visiting the **“Unlock the Secrets in the Soil”** section of the NRCS web site at [www.nrcs.usda.gov](http://www.nrcs.usda.gov).



# unlock the secrets in the soil basics & benefits



**Healthy, fully  
functioning soil is  
balanced to provide  
an environment  
that sustains and  
nourishes plants,  
soil microbes and  
beneficial insects.**

Managing for soil health is one of the most effective ways for farmers to increase crop productivity and profitability while improving the environment. Positive results are often realized within the first year, and last well into the future.

## **Soil Health**

Soil is made up of air, water, decayed plant residue, organic matter from living and dead organisms, and minerals, such as sand, silt and clay. Increasing soil organic matter typically improves soil health since organic matter affects several critical soil functions. Healthy soils are also porous, which allows air and water to move freely through them. This balance ensures a suitable habitat for the myriad of soil organisms that support growing plants.

It's not difficult to improve soil health. Here's how: till the soil as little as possible; grow as many different species of plants as possible through rotations and a diverse mixture of cover crops; keep living plants in the soil as long as possible with crops and cover crops; and keep the soil surface covered with residue year round.

## Soil Health Benefits

Farmers who manage their land in ways that improve and sustain soil health benefit from optimized inputs, sustainable outputs and increased resiliency. Healthy soils benefit all producers – managers of large, row crop operations to people with small, organic vegetable gardens. Healthy soils provide financial benefits for farmers, ranchers and gardeners, and environmental benefits that affect everyone.

Healthy soils lead to:



**Increased Production** – Healthy soils typically have more organic matter and soil organisms which improve soil structure, aeration, water retention, drainage and nutrient availability. Organic matter holds more nutrients in the soil until the plants need them.



**Increased Profits** – Healthy soils may require fewer passes over fields because they are only minimally tilled and they aren't over-reliant upon excessive nutrient inputs to grow crops. Healthy soils can increase farmers' profit margins by reducing labor and expenses for fuel, and optimizing inputs.



**Natural Resource Protection** – Healthy soils hold more available water. The soil's water-holding capacity reduces runoff that can cause flooding, and increases the availability of water to plants during droughts. Good infiltration and less need for fertilizers and pesticides keep nutrients and sediment from loading into lakes, rivers, and streams. Groundwater is also protected because there is less leaching from healthy soils. Additionally, fewer trips across fields with farm machinery mean fewer emissions and better air quality.

## Soil Health Management Systems

Implementing Soil Health Management Systems can lead to increased organic matter, more soil organisms, reduced soil compaction and improved nutrient storage and cycling. As an added bonus, fully functioning, healthy soils absorb and retain more water, making them less susceptible to runoff and erosion. This means more water will be available for crops when they need it. Soil Health Management Systems allow farmers to improve profitability because they spend less on fuel and energy while benefiting from the higher crop yields resulting from improved soil conditions.

Contact your local NRCS office to learn more about Soil Health Management Systems and the technical and financial assistance available to help "Unlock the Secrets in the Soil."





**unlock** your farm's potential  
**dig a little**  
**learn a lot**



**A healthy, fully functioning soil is balanced to provide an environment that sustains and nourishes plants, soil microbes and beneficial insects.**

Soil is a living system, and healthy soil should look, smell, and feel alive.

Healthy soil can increase production, increase profits, and protect natural resources, such as air and water. Dig in to your soil to discover what your soil can tell you about its health and production potential.

### **Dig in and see**

Healthy soil is darker in color, crumbly, and porous. It is home to worms and other organisms that squirm, creep, hop, or crawl. Healthy soil provides the right amount of air, water, and organic matter for microorganisms to thrive and for plants to grow. Soil that is functioning at its full potential is full of the roots of the healthy and strong plants it supports.

An unhealthy, poorly functioning soil appears lighter in color, is compacted or has poor structure, and contains limited roots and living things.

## **Dig in and smell**

Healthy soil has a sweet and earthy aroma. This is the scent of geosmin, a byproduct of soil microbes called actinomycetes. These microbes decompose the tough plant and animal residues in and on the soil and bring nitrogen from the air into the soil to feed plants.

An unhealthy, out-of-balance soil smells sour or metallic, or like kitchen cleanser.

## **Dig in and feel**

Healthy soil is easy to dig into. It is soft, moist, and crumbly, and allows plants to grow their roots more freely and unimpeded. This crumbly or granular structure is ideal because porous, healthy soil holds water for plants to use when they need it. Its increased water-holding capacity reduces runoff that can cause flooding, and increases the availability of water to plants during droughts.

An unhealthy, poorly functioning soil feels dry, crusty, and cloddy and does not crumble readily when pulled apart.

## **Dig a Little. Learn a Lot.**

Understanding how healthy soils look, smell, and feel are the first steps towards achieving soil health. Dig a little! If you find soil that is out of balance, NRCS can offer management tips to improve soil health.

## **Soil Health Management Systems**

Implementing Soil Health Management Systems can lead to increased organic matter, more soil organisms, reduced soil compaction and improved nutrient storage and cycling. As an added bonus, fully functioning, healthy soils absorb and retain more water, making them less susceptible to runoff and erosion. This means more water will be available for crops when they need it. Soil Health Management Systems allow farmers to enjoy profits because they spend less on fuel and energy while benefiting from the higher crop yields resulting from improved soil conditions.

Contact your local NRCS office to learn more about Soil Health Management Systems and the technical and financial assistance available to help “Unlock the Secrets in the Soil.”





# unlock your farm's potential do not disturb



## If soil health is your goal, till as little as possible.

Tillage can destroy soil organic matter and structure along with the habitat that soil organisms need. Tillage, especially during warmer months, reduces water infiltration, increases runoff and can make the soil less productive. Tillage disrupts the soil's natural biological cycles, damages the structure of the soil, and makes soil more susceptible to erosion.

### Benefits of Reduced-Till/No-Till



**Aiding in Plant Growth** – Soils managed with reduced/no-till for several years contain more organic matter and moisture for plant use. Healthy soils cycle crop nutrients, support root growth, absorb water and sequester carbon more efficiently.



**Reducing Soil Erosion** – Soil that is covered year-round with crops, crop residue, grass or cover crops is much less susceptible to erosion from wind and water. For cropping systems, practices like no-till keep soil undisturbed from harvest to planting.



**Saving Money** – Farmers can save money on fuel and labor by decreasing tillage. Improving nutrient cycling allows farmers to potentially reduce the amount of supplemental nutrients required to maintain yields, further reducing input costs.

A simple green leaf icon with a brown stem and a few smaller leaves.

**Providing Wildlife Habitat** – Crop residue, grass and cover crops provide food and escape for wildlife.

## Production Inputs

Soils can be disturbed if inputs are not applied properly, potentially disrupting the delicate relationship between plants and soil organisms. Soil Health Management Systems help minimize that potential disturbance, while maximizing nutrient cycling, which can lead to greater profitability for producers.

## Livestock Grazing

Improperly managed grazing can disturb the soil. There are several ways to graze livestock to reduce environmental impacts. For example, implementing a rotational grazing system instead of allowing livestock to continuously graze pasture allows pasture plants to rest and regrow.

## Soil Health Management Systems

Implementing Soil Health Management Systems can lead to increased organic matter, more soil organisms, reduced soil compaction and improved nutrient storage and cycling. As an added bonus, fully functioning, healthy soils absorb and retain more water, making them less susceptible to runoff and erosion. This means more water will be available for crops when they need it.

Soil Health Management Systems allow farmers to enjoy profits over time because they spend less on fuel and energy while benefiting from the higher crop yields resulting from improved soil conditions. Healthy soils also provide a buffer for precipitation extremes (too wet or too dry).

Contact your local NRCS office to learn more about Soil Health Management Systems and the technical and financial assistance available to help “Unlock the Secrets in the Soil.”





# unlock your farm's potential discover the cover



## **Biodiversity increases the success of most agricul- tural systems.**

Biodiversity helps to prevent disease and pest problems associated with monocultures. Using cover crops and increasing diversity within crop rotations improves soil health and soil function, reduces costs, and increases profitability. Diversity above ground improves diversity below ground, which helps create healthy productive soils.

## **Cover Crops**

Cover crops can be an integral part of a cropping system. Cover crops can be managed to improve soil health, as they help to develop an environment that sustains and nourishes plants, soil microbes and beneficial insects.

Cover crops are typically planted in late summer or fall around harvest and before spring planting of the following year's crops. Examples of cover crops include rye, wheat, oats, clovers and other legumes, turnips, radishes, and triticale. Planting several cover crop species together in a mixture can increase their impact on soil health. Each cover crop provides its own set of benefits, so it's important to choose the right cover crop mixture to meet management goals.

## Cover Crop Benefits



**Restoring Soil Health** – Cover crops help increase organic matter in the soil and improve overall soil health by adding living roots to the soil during more months of the year. Cover crops can improve water infiltration into the soil. Deep-rooted crops like forage radishes create natural water passages. Legume cover crops serve as natural fertilizers while grasses scavenge nutrients that are often lost after harvest or during winter.



**Natural Resource Protection** – Along with crop residue above ground, cover crops protect the soil against erosive heavy rains and strong winds. Cover crops trap excess nitrogen, keeping it from leaching into groundwater or running off into surface water – releasing it later to feed growing crops.



**Livestock Feed** – Cover crops can provide livestock producers with additional grazing or haying opportunities.



**Wildlife Habitat** – Cover crops provide winter food and cover for birds and other wildlife. During the growing season, they can provide food for pollinators.

## Soil Health Management Systems

Implementing Soil Health Management Systems can lead to increased organic matter, more soil organisms, reduced soil compaction and improved nutrient storage and cycling. As an added bonus, fully functioning, healthy soils absorb and retain more water, making them less susceptible to runoff and erosion. This means more water will be available for crops when they need it. Soil Health Management Systems allow farmers to enjoy profits because they spend less on fuel and energy while benefiting from the higher crop yields resulting from improved soil conditions.

Contact your local NRCS office to learn more about Soil Health Management Systems and the technical and financial assistance available to help “Unlock the Secrets in the Soil.”





# healthy, productive soils checklist for growers



**Managing for soil health is one of the best ways farmers can increase crop productivity while improving the environment.**

Results are often realized immediately and last well into the future. Following are four basic principles to improving the health of your soil.

1. Keep the soil covered as much as possible
2. Disturb the soil as little as possible
3. Keep plants growing throughout the year to feed the soil
4. Diversify as much as possible using crop rotation and cover crops

Use the checklist on the back of this page to determine if you're using core Soil Health Management System farming practices. It is important to note that not all practices are applicable to all crops. Some operations will benefit from just one soil health practice while others may require additional practices for maximum benefit. These core practices form the basis of a Soil Health Management System that can help you optimize your inputs, protect against drought, and increase production.



**United States  
Department of  
Agriculture**

**[www.nrcs.usda.gov](http://www.nrcs.usda.gov)**

USDA is an equal opportunity provider and employer.  
June 2013

# Soil Health Management Systems Include:

## What is it?

## What does it do?

## How does it help?

### Conservation Crop Rotation

Growing a diverse number of crops in a planned sequence to increase soil organic matter and biodiversity in the soil.



- Increases nutrient cycling
- Manages plant pests (weeds, insects, and diseases)
- Reduces sheet, rill and wind erosion
- Holds soil moisture
- Adds diversity so soil microbes can thrive

- Improves nutrient use efficiency
- Decreases use of pesticides
- Improves water quality
- Conserves water
- Improves plant production

### Cover Crop

An un-harvested crop grown as part of planned rotation to provide conservation benefits to the soil.



- Increases soil organic matter
- Prevents soil erosion
- Conserves soil moisture
- Increases nutrient cycling
- Provides nitrogen for plant use
- Suppresses weeds
- Reduces compaction

- Improves crop production
- Improves water quality
- Conserves water
- Improves nutrient use efficiency
- Decreases use of pesticides
- Improves water efficiency to crops

### No Till

A way of growing crops without disturbing the soil through tillage.



- Improves water holding capacity of soil
- Increases organic matter
- Reduces soil erosion
- Reduces energy use
- Decreases compaction

- Improves water efficiency
- Conserves water
- Improves crop production
- Improves water quality
- Saves renewable resources
- Improves air quality
- Increases productivity

### Mulch Tillage

Using tillage methods where the soil surface is disturbed but maintains a high level of crop residue on the surface.



- Reduces soil erosion from wind and rain
- Increases soil moisture for plants
- Reduces energy use
- Increases soil organic matter

- Improves water quality
- Conserves water
- Saves renewable resources
- Improves air quality
- Improves crop production

### Mulching

Applying plant residues or other suitable materials to the soil surface to compensate for loss of residue due to excessive tillage.



- Reduces erosion from wind and rain
- Moderates soil temperatures
- Increases soil organic matter
- Controls weeds
- Conserves soil moisture
- Reduces dust

- Improves water quality
- Improves plant productivity
- Increases crop production
- Reduces pesticide usage
- Conserves water
- Improves air quality

### Nutrient Management

Managing soil nutrients to meet crop needs while minimizing the impact on the environment and the soil.



- Increases plant nutrient uptake
- Improves the physical, chemical and biological properties of the soil
- Budgets, supplies, and conserves nutrients for plant production
- Reduces odors and nitrogen emissions

- Improves water quality
- Improves plant production
- Improves air quality

### Pest Management

Managing pests by following an ecological approach that promotes the growth of healthy plants with strong defenses, while increasing stress on pests and enhancing the habitat for beneficial organisms.



- Reduces pesticide risks to water quality
- Reduces threat of chemicals entering the air
- Decreases pesticide risk to pollinators and other beneficial organisms
- Increases soil organic matter

- Improves water quality
- Improves air quality
- Increases plant pollination
- Increases plant productivity



United States Department of Agriculture

# Soil Health Key Points



## What's critical about soil health now?

1. World population is projected to increase from 7 billion in 2013 to more than 9 billion in 2050. To sustain this level of growth, food production will need to rise by 70 percent.
2. Between 1982–2007, 14 million acres of prime farmland in the U.S. were lost to development.
3. Improving soil health is key to long-term, sustainable agricultural production.

## Soil health matters because:

1. Healthy soils are high-performing, productive soils.
2. Healthy soils reduce production costs—and improve profits.
3. Healthy soils protect natural resources on **and** off the farm.
4. Franklin Roosevelt's statement, "The nation that destroys its soil destroys itself," is as true today as it was 75 years ago.
5. Healthy soils can reduce nutrient loading and sediment runoff, increase efficiencies, and sustain wildlife habitat.

## What are the benefits of healthy soil?

1. Healthy soil holds more water (by binding it to organic matter), and loses less water to runoff and evaporation.
2. Organic matter builds as tillage declines and plants and residue cover the soil. Organic matter holds 18-20 times its weight in water and recycles nutrients for plants to use.
3. One percent of organic matter in the top six inches of soil would hold approximately 27,000 gallons of water per acre!
4. Most farmers can increase their soil organic matter in **three to 10 years** if they are motivated about adopting conservation practices to achieve this goal.

## How to begin your path to Healthy Soils:

1. Keep it covered.
2. Do not disturb.
3. Use cover crops and rotation to feed your soil.
4. Develop a **soil health management plan** with the help of NRCS.

## Follow four basic soil health principles to improve soil health and sustainability:

1. Use plant diversity to increase diversity in the soil.
2. Manage soils more by disturbing them less.
3. Keep plants growing throughout the year to feed the soil.
4. Keep the soil covered as much as possible.

## What is a Soil Health Management Plan?

1. It's a roadmap to soil health.
2. It outlines a system of practices needed to enhance crop production and soil function, and improve or sustain water quality, air quality, energy efficiency and wildlife habitat.  
Some of the recommended conservation practices include: Conservation Crop Rotation, Cover Crops, No Till, Mulching, Nutrient Management, and Pest Management.
3. It provides environmental, economic, health, and societal benefits.
4. It **saves energy** by using less fuel for tillage, and maximizes nutrient cycling.
5. It **saves water** and increases drought tolerance by increasing infiltration and water holding capacity as soil organic matter increases.
6. It **reduces disease** and pest problems.
7. It **improves income sustainability** for farms and ranches.
8. It **improves plant health**.