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The Basics of Addressing Resource Concerns with Conservation Practices within Integrated Soil Health Management Systems on Cropland

Natural Resources Conservation Service

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Cover Photos

Top left: No-till soybean planted into rolled cereal rye. Adam Daugherty, USDA-NRCS TN
Top right: Silage corn planted with a one pass roller/crimper/planter into standing cereal rye. Chad Cochrane, USDA-NRCS NH
Bottom left: Cattle grazing cover crops on cropland. Jeff Moore, Windswept Maples, Loudon NH
Bottom right: Healthy cover crop roots providing food and shelter for soil organisms. Edwin Remsberg for USDA-SARE

Other Photo Credits

Figure 1: Dave Brandt, OH.
Figure 2: Barry Fisher, USDA NRCS Soil Health Division
Figure 3: Chad Cochrane, USDA-NRCS NH
Figure 4: David Lamm, USDA NRCS Soil Health Division (retired)

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Introduction

Conservation planning based in current soil health science is critical for achieving healthy soils. Agriculture fields (and farms) are systems, and so a conservation system that properly incorporates more than one soil health-targeted conservation practice is usually needed to fully address resource concerns related to improving organic matter quantity or quality, reversing soil organism habitat degradation, alleviating compaction, or improving soil aggregate stability.

The NRCS Conservation Practices of Cover Crop (340), Conservation Crop Rotation (328), and Residue and Tillage Management, Reduced Till (345) and No-till (329) are used to address various resource concerns, and these practices can be important contributors to sustainable cropping systems.

However, if these practices are used independently it is unlikely that any of them will provide full, long-term benefits to soil health. For example, adding a cereal rye cover crop to a system with a two-crop rotation and frequent tillage may provide some weed suppression benefit or help reduce erosion during otherwise non-cropped times of the year, but soil aggregate stability will likely still be impaired by regular tillage.

> ***Soil Health*** *is the continued capacity of soil to function as a vital living ecosystem to support plants, animals and humans.*
>
> *A* ***Soil Health Management System*** *(SHMS) is a collection of NRCS conservation practices that focuses on maintaining or enhancing soil health by addressing four soil health management principles: minimize disturbance, maximize soil cover, maximize biodiversity and maximize the presence of living roots.*

To improve soil function to fully meet the stated purposes and address the soil health resource concerns through management in annual cropping systems, changes will typically need to include the strategic, combined use of multiple practices with the same purposes, including CPS 340, 328, and 345 or 329 and other appropriate practices.

Because of this, it can be helpful to think in terms of choosing practices that can help implement a soil health management system that includes all four NRCS soil health principles (Table 1). Depending on the production system, each of the principles can be achieved through the appropriate, system-adapted use of conservation practices. Achieving all four principles by thoughtfully implementing and adaptively integrating multiple, complementary conservation practices together is the best way to ensure that practice purposes and their associated soil health resource concerns are adequately addressed.

The Four Soil Health Management Principles

Fig. 1. No-till planters minimize disturbance

Minimize soil disturbance. In some cropping systems, physical, chemical or biological soil disturbance is an inevitable consequence of crop production. However, advances in agronomic research and farm equipment and technology have created the potential for most annual cropland acres to be managed with reduced or often no tillage. Disturbance to the soil ecosystem can also result from the inappropriate use of nutrients and pesticides, over irrigation, or over grazing. Reducing disturbance helps to slow carbon losses from the soil, protects soil aggregates from physical destruction and maintains habitat for soil organisms.

Fig. 2. Crop residues maximize soil cover

<u>Maximize soil cover.</u> Crop residue and other organic materials such as mulch and compost, when left on the soil surface, provide a protective barrier between the soil and the destructive force of raindrops and wind. In addition, they moderate extremes in soil temperature and reduce evaporative losses from the soil. Soil cover can also be provided by leaves of growing plants. Keeping the soil covered throughout the year helps maintain soil aggregate integrity, protects habitat and provides food for soil organisms.

<u>Maximize biodiversity.</u> Diverse crop rotations, as well as integrated crop-livestock systems where feasible, can be important components of an integrated pest management (IPM) plan, and contribute to overall system resilience. Primarily through their roots, plants affect the kinds and abundance of soil organisms, thus directly influencing soil biology and biological processes such as nutrient cycling. Different plant species, and even cultivars, are typically associated with distinct soil microbial communities. In addition, plant root architecture often differs between species with resulting different effects on function. Above ground diversity encourages diversity in soil biology, and can help improve soil organic matter, provide food and habitat for a diverse soil community, promote greater aggregate stability, and help alleviate compaction.

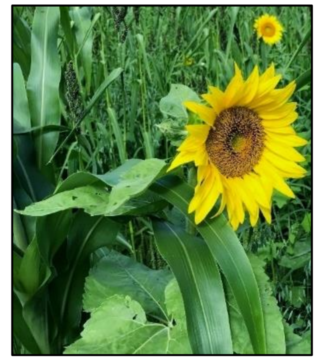

Fig. 3. Maximizing biodiversity with cover crop mixtures

Fig. 4. Living roots provide food and shelter for soil organisms

<u>Maximize the presence of living roots.</u> The area immediately around plant roots is typically where the highest number and greatest diversity of soil microorganisms are found. Living plant roots exude numerous carbon compounds, and slough cells from root surfaces. These organic carbon additions to the ecosystem feed soil organisms and contribute to habitat development. Plant roots are also involved in complex biochemical communication with soil microbes whereby beneficial organisms are recruited and pathogenic organisms deterred. In addition, roots can enmesh soil particles thereby creating and preserving soil aggregates. Also, living plant roots can help alleviate or prevent soil compaction.

Conservation Practice

Soil Health Principle	Conservation Cover (327)	Conservation Crop Rotation (328)	Cover Crop (340)	Forage & Biomass Planting (512)	Pest Mgmt. Conservation System (595)	Mulching (484)	Nutrient Mgmt. (590)	Prescribed Grazing (528)	Residue & Tillage Mgmt. (329/345)
Minimize Soil Disturbance	✓			✓	✓		✓	✓	✓
Maximize Soil Cover	✓		✓	✓		✓		✓	✓
Maximize Biodiversity	✓	✓	✓	✓				✓	
Maximize Living Roots	✓	✓	✓	✓				✓	

Table 1. Conservation practices that can be used in a soil health management system to help achieve the soil health principles.