USDA United States Department of Agriculture

NATURAL RESOURCES CONSERVATION SERVICE

UNLOCK THE SECRETS IN THE SOIL
Principles for High Functioning Soils

Soil Health Defined

Soil health is the continued capacity of a soil to function as a vital, living ecosystem that sustains plants, animals, and humans. Only living things can have "health," so viewing soil as a living, breathing ecosystem reflects a shift in the way we view and manage our nation's soils. Soil isn't an inert growing medium, but rather is the home of billions of bacteria, fungi, and other organisms that together create an intricate symbiotic ecosystem. This ecosystem can be managed to support the plants and animals, by providing nutrients, absorbing and retaining rainwater and snowmelt for use during dry periods, filtering and buffering water to remove potential pollutants, and providing habitat for the soil biological population to flourish and diversify to keep the ecosystem functioning well.

Key soil health management principles

These principles are represented in the circular diagram (Fig. 1) to emphasize their relationship as a continuum where each complements the others and also depends on the others.

- Minimize disturbance
- Maximize soil cover
- Maximize biodiversity
- Maximize presence of living roots

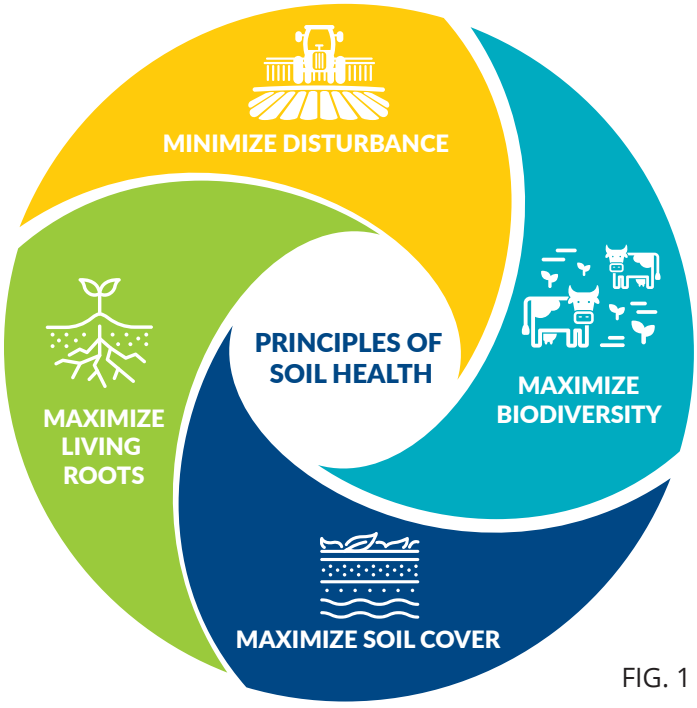

FIG. 1

Protecting the Soil Habitat

The first two principles of soil health, minimizing disturbance and maximizing soil cover, focus on protection of the soil habitat. They maintain or increase stable soil aggregates and soil organic matter (SOM) and protect the fragile surface of the soil that is most susceptible to the degrading forces of wind and water.

SOM is highest at the soil surface and is critical for stabilizing soil aggregates. Maintaining SOM helps support additional soil functions including water infiltration and storage, nutrient-holding capacity and release, and habitat for soil life.

Feeding the Soil Organisms Inhabiting Soil

The second two principles, maximize presence of living roots and maximize biodiversity, focus on feeding the organisms inhabiting the soil. Maximizing the diversity of food (energy and carbon inputs) and aboveground biodiversity through increased plant, animal, or soil amendments to increase the diversity of soil animals and microorganisms. Diversity not only refers to food sources, but also aboveground diversification of plants and animals, as well as microbial diversification underground. Diversification stimulates a host of additional benefits including breaking disease cycles, providing habitat for pollinators, wildlife, and beneficial predators, and stimulating plant growth.

Increasing the time that there are living roots in the soil achieves the first three principles, and can be accomplished through crop rotations, inclusion of cover crops, and/or through dedicated grasslands (native or pasture). Mixing up which plants are grown during the year or over the course of multiple years may help to break disease/pest cycles. Maximizing biodiversity and living roots helps to stimulate belowground biological activity and increase biodiversity belowground as well as increase predator and pollinator populations aboveground. When these two principles are properly applied, soils not only maintain SOM but can build SOM and enhance nutrient cycling and overall plant growth (crop or forage).

Worm emerging from egg within the pore space of a well-aggregated soil.

Healthy, Functioning Soils Are Able to:

- Improve nutrient cycling
- Provide good aeration to promote plant root growth
- Improve farm and ranch profitability and resiliency
- Produce food, feed, fiber, fuel, and medicinal products at sustainable levels
- Reduce sedimentation and runoff
- Improve water storage and plant available water while protecting water quality
- Be resilient to drought, temperature extremes, fire, and flood
- Reduce disease and pest problems
- Store carbon in the form of soil organic matter

More Information

To learn more about Soil Health Management Systems and the technical and financial assistance available visit **farmers.gov/conserve/soil-health** or contact your local NRCS office. To find your local NRCS office, visit **farmers.gov/service-center-locator**.

SOIL DISTURBANCES

can occur in several different forms. Physical disturbances are those that occur by tillage or compaction from heavy machinery. Chemical disturbances are inputs such as fertilizer and pesticide applications particularly when they are over applied or misused. Lastly there are biological disturbances, such as over-grazing animals which can lead to compaction and reduction in perennial root systems as well as introduction of invasive species. Some other types of disturbance include the use of monocultures which can cause biological imbalances. All disturbance can affect soil functions.

SOIL COVER

consists of two main forms: 1) living plant material such as a growing crop, cover crop, or grassland; and 2) mulch, either as plant residues (e.g. crop redidues, bark chips, prunnings from trees and shrubs, thatch in grasslands, compost) or other suitable materials.

BIODIVERSITY

is the variety of life forms within a given ecosystem or farm field. The different life forms include all the plants, animals and microorganisms that are present. Each life form includes their own unique set of exudates, secretions or waste products that further contribute to increased diversity. Healthy management systems are full of biodiversity. Increases in diversity can be achieved through a variety of approaches, including plant diversity, (through the use of diversified crop rotations and cover crop mixes), integration of grazing animals (e.g. livestock) into the system. It includes animals living within the soils or microbial diversity, as well as direct additions with biological amendments. All four soil health management principles contribute to biodiversity.

LIVING ROOTS

in the soil provide secretions that help feed soil biology throughout the year. They provide carbohydrates and organic acids which are part of the diet of many life forms in the soil. The exudates help solubilize mineral nutrients for plants. Root hairs also assist with formation of aggregates by entangling and enmeshing soil.

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