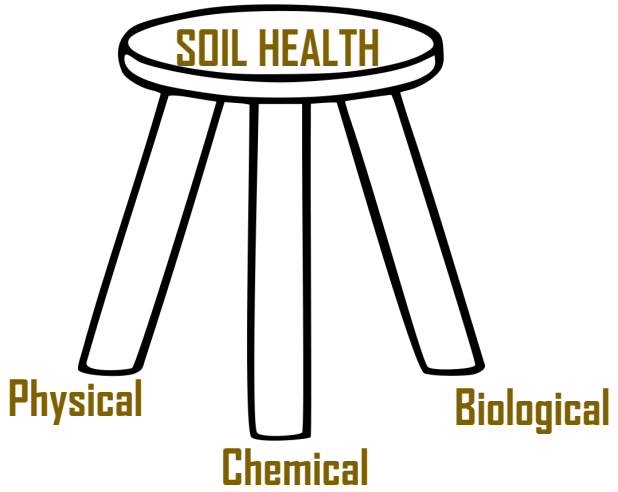
What is soil health? And why is it so important?

Soil is a complex living system consisting of plant roots, bacteria, fungi, micro- and macroscopic animals, and the mineral and organic material that gives them a home. Healthy soil provides the fundamental foundation for vibrant, productive plant communities, including crops, livestock forage, as well as habitat and food for wildlife. Soil health encompasses not just nutrient availability and other chemical parameters of the soil but also its physical properties, such as texture and, most important, the biological components. Only recently have bacteria, fungi and other soil microbiota been recognized for their multiple essential roles in: (1) forming aggregates, which reduce vulnerability to erosion by wind and water and increase soil porosity, (2) expediting transfer of water and nutrients to plants, (3) controlling harmful plant pests, and (4) sequestering carbon. Healthy soil, like that found in well-managed grasslands, is stable and self-repairing and is capable of taking in, storing, and transforming large amounts of water, carbon, and nutrients with maximum efficiency. Damaged, degraded soil on the other is vulnerable to further damage, holds and cycles fewer beneficial materials, and often needs large continuous inputs of nutrients and water to produce what humans need for their livelihoods. Healthy soil, in short, is soil that does its work steadily and efficiently. Unhealthy soil cannot.



Where to go for more information:

USDA's Natural Resource Conservation Service takes a lead role in soil health management for the nation. There are a host of resources on their website, including an interactive map of soil types, and descriptions, for the nation.
https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soils/soil-health

What does healthy soil look like?

Healthy soil starts with healthy grass cover. A vigorous community of plants protects the soil from erosion and converts carbon dioxide, water and nutrients into foliage and deeply penetrating roots. Through decomposition of roots and decaying surface leaf litter, these important ingredients are slowly recycled into the upper parts of the soil, especially with help from soil microbes. This process results in unique soils, known as Mollisols, that are characterized by surface layers rich in soil organic matter (SOM) to depths of one meter or more. The soil appears as a deep dark grey, brown, or black layer of crumbly topsoil. The SOM is very effective at capturing scarce rainfall and storing it for plant use between infrequent rains. This process is reinforced by a layered canopy of foliage of grass and forbs and a layer of decaying mulch which together minimize evaporative loss.

Healthy soil profile from Prairie Preserve, Nebraska
Photo credit; Schneider

Where to go for more information:

The Soil Health Institute is a global non-profit whose mission is to improve soil health. They have created a library of videos, reports and other documents on best management practices for soil health.
https://soilhealthinstitute.org/resources/

The Soil and Water Conservation Society is a non-profit, international organization of professionals who promote the science and conservation of natural resources. It publishes the Journal of Soil and Water Conservation. https://www.swcs.org/about-us/our-work/

How healthy is my soil? How can I find out?

The first and easiest way to tell if your soil is healthy is to look at it from the top: Does it have a healthy, diverse and native plant cover, with limited exposed soil, year-round? If so, it's a good indication that the soil beneath is in good enough shape to support perennial plants, and may also be maintaining or possibly rebuilding its reserves of organic matter and nutrients.

Dig deeper: Take a shovel out and dig a hold deep and wide enough to see the top 6-12" of soil. Is there a clear darker layer at the top? Do plant roots penetrate below the top few inches? Can you see insects, earthworms, or other small animals? Pick up a handful of soil: Can you detect larger crumbly aggregates? If the answer is yes, then you are seeing evidence of a healthy soil.

If you want to dig deeper into measuring soil health, there are batteries of tests that can be performed. A comprehensive diagnostic assessment must include all three legs of the soil health stool and a suite of protocols have been identified for the physical, chemical and biological components. Some properties can be measured in the field – for instance, whether rainwater is infiltrating readily into the soil or if it is tending to pool up or run off. Other tests need to be conducted in a lab setting that will give precise figures on metrics like nutrient and organic matter content as well as indicators of the health of the microbial community. Comparing these metrics to some basic benchmarks, as well the state of the soil in any local grassland remnants, can put a much finer point on the health of soil near to you.

Cornell University's Soil Health Laboratory in New York has developed a comprehensive testing system, with clear, transparent protocols and reporting that is easy to interpret. Other Labs are available regionally.

Examples of key soil properties	
Chemical:	pH, availability of Nitrogen, Phosphorus and Potassium,
Physical:	texture, organic matter content, aggregate stability, available water holding capacity
Biological:	organic matter, microbial biomass, active carbon content

Where to go for more information:

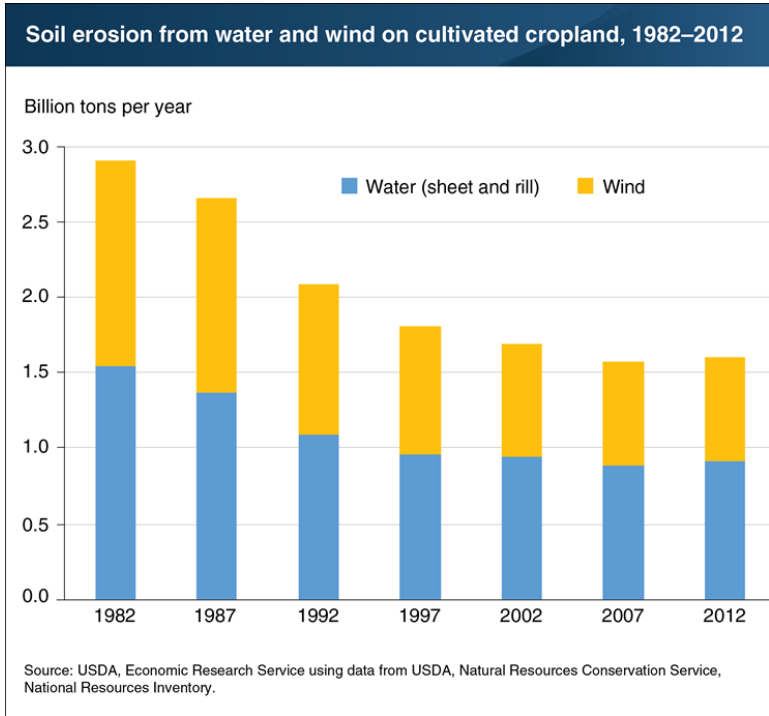
Cornell University Soil Health Lab: https://soilhealth.cals.cornell.edu/

Ontario, Canada's Ministry of Agriculture, Food and Rural Affairs has an excellent website on simple tests you can do yourself:
http://omafra.gov.on.ca/english/crops/field/news/croptalk/2017/ct-0917a6.htm#:~:text=Soil%20fertility%20tests%20can%20indicate,a%20reasonable%20soil%20biological%20indicator.

What is the current status of North American grassland soils?

Soil can degrade when the plant cover is reduced or removed and the soil profile itself is disturbed. In many areas of North America and globally, a long history of clearing the native grass communities, plus excessive, long-term tillage or overgrazing by livestock have degraded the surface soils. Chronic cultivation tears apart the soil microbial network and exposes the microbes to deadly conditions of UV light and freezing temperatures. Once the upper layers have dried out and died, the former topsoil material can become powdery and loose, making it no match for rain and wind erosion. Intensive erosion was documented across the Great Plains in historic photographs of the 1930's Dust Bowl, but continues even today at lower rates. Hundreds of millions of hectares have been impacted by erosion across the Great Plains. Soil disturbance can also encourage very rapid losses of carbon and nutrients by allowing the deeper soil to dry out and warm up. Healthy soil can be seen as a "non-renewable" resource over shorter time horizons because once it is used up, it can take decades to centuries to restore.

Depth of erosion from original surface, Roosevelt Co., New Mexico 1957

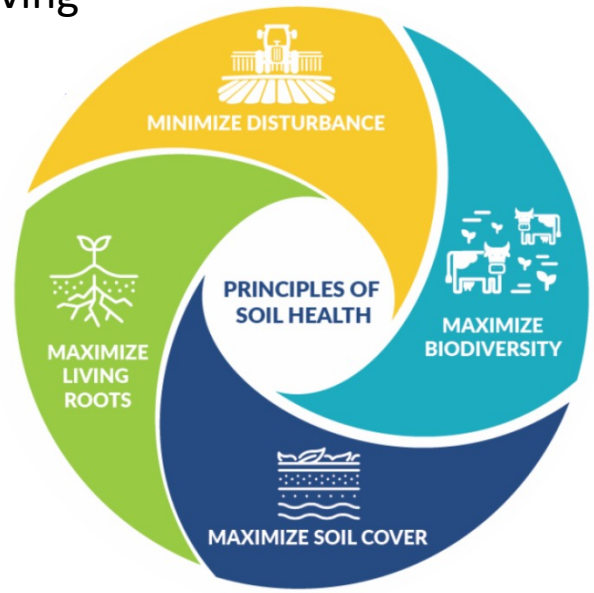


Improved agricultural practices have reduced the rates of soil erosion across the U.S., but erosion continues.

More information on soil erosion is available. The complete USDA report is at https://www.ers.usda.gov/publications/pub-details/?pubid=93025

What can I do to improve the health of my soil?

The U.S.D.A.'s Natural Resource Conservation Service identifies four key principles for improving soil health. These can be expanded into a set of guidelines:



1. Wherever possible, reduce or eliminate plowing or any deeper soil disturbances.
2. Avoid management choices that see the plant community completely removed or seriously disrupted, unless it is to plant a wider range of diverse native plants.
3. Increase soil organic matter content by adding organic amendments, or switching to deep rooted perennial grass crops, such as kernza or switchgrass.
4. Use cover crops to protect and stabilize the soil, reducing erosion potential.
5. Look into regenerative practices like rotational grazing, or the reintroduction of low-intensity fires. Tap your local extension office for advice.
6. Get your soil tested to inform what interventions could be helpful. Work with your local ag consultant, soil and water conservation district staff, or extension office for advice on specific correctives when soils need help getting "over the hump". These could include projects to aid vegetation restoration, reintroduction of organic matter, and other short-term corrections to get your soil back on a healthy path.

Where can I go for more information:

USDA – NRCS: https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soils/soil-health

The Soil Health Institute is a global non-profit whose mission is to improve soil health. They have created a library of videos, reports and other documents on best management practices for soil health. https://soilhealthinstitute.org/resources/

What are remnant soils and why are they useful as a soil health reference?

Much of the central grasslands of north America began to be degraded by western agriculture and animal husbandry in the mid-19th century. The fact is that very few people alive have even seen, let alone have deep familiarity with, un-damaged grassland landscapes or un-degraded healthy grassland soils. The bulk of the very best soils have been degraded under intensive management now for many decades. It is hard to understand what has been lost, or to estimate how much better our soil health could be, without understanding what it could be at its very best.

Remnants are areas of grassland that, either by accident or because of careful stewardship, have remained as intact, never cultivated and/or well-managed, lightly grazed native grasslands. Their intact soils and plant communities provide valuable insights into the natural processes which helped these systems to be self-sustaining. Remnants, although scarce, can still be found in preserves, cemeteries, along fence roads or railways, and in land under indigenous management. Soil samples from remnants can provide a valuable diagnostic baseline for comparison and powerful guidance for managing and restoring grasslands. When we examine these remnants today, we get a glimpse into what healthy soils in different regions look like and behave, and what modern soils could return toward if given a chance to recover.

Who can I talk to about my soil?

Soil Water and Conservation Districts, also known as Natural Resource Conservation Districts, are a subdivision of state governments authorized to provide assistance to the public in the protection of natural resources, including soil. There are ~3,000 district offices, with almost one in every county. They can provide assistance on determining the health of your soil, on what practices can help improve your soil and also help find funding. Technicians are available in your local office to assist you.

The *National Association of Conservation Districts* website provides more information, including an interactive map to help you find the District Office nearest to you.
https://www.nacdnet.org/about-nacd/about-districts/

U.S.D.A.'s National Institute of Food and Agriculture oversees the **Cooperative Extensive System** which links university-based research on agriculture and soils in almost every state with farmers and other landowners. Cooperative extension educators can work one-on-one with farmers, ranchers, gardeners, and other groups to help improve their land stewardship, get funding, in order to improve agricultural viability.
https://www.nifa.usda.gov/about-nifa/how-we-work/extension/cooperative-extension-system