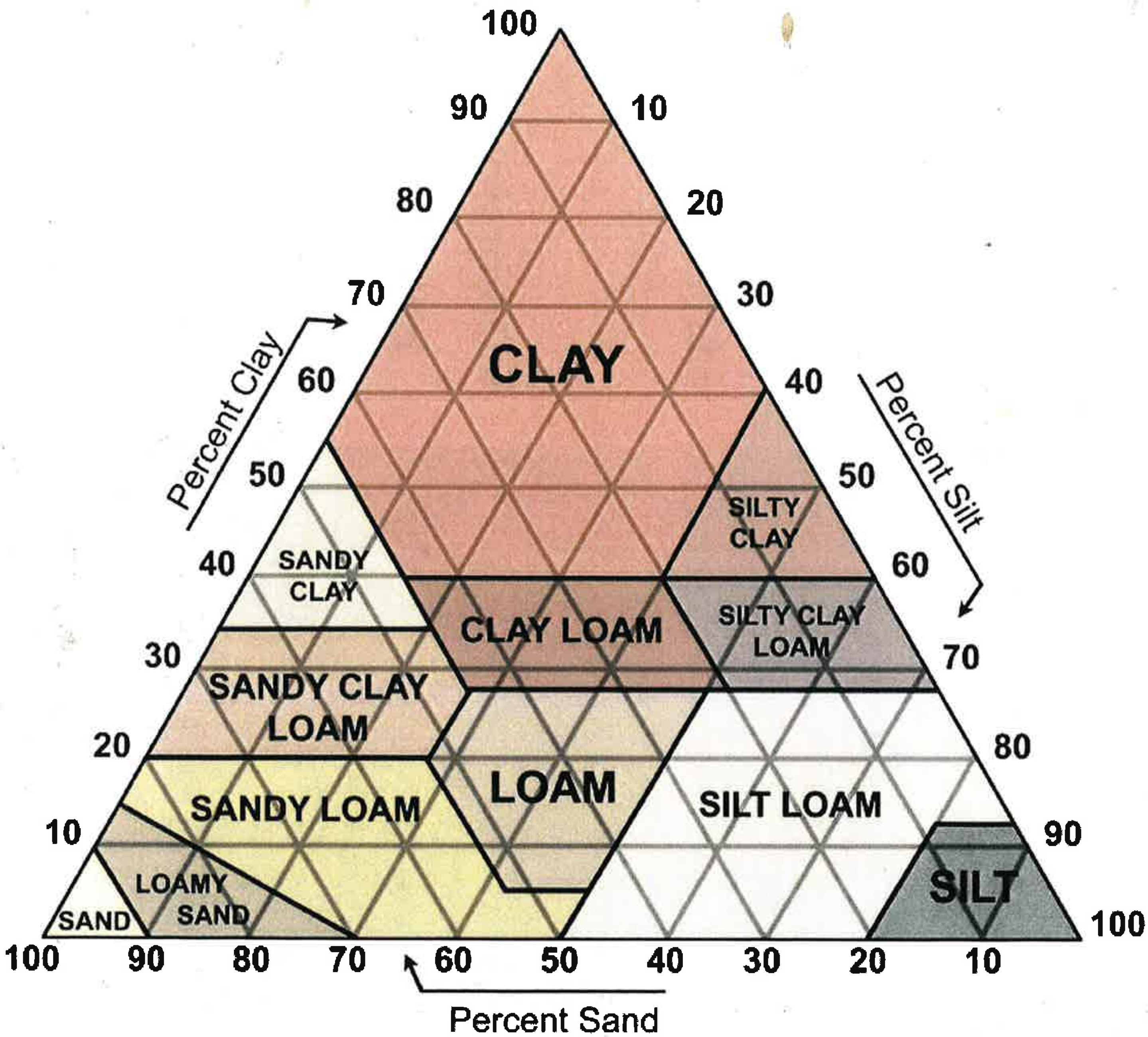
How to use the Soil Textural Triangle

- Locate the percent sand value at the bottom of the triangle.
- Locate the percent clay value on the left of the triangle.
- Follow the % value lines that run in the direction of the arrow near the component name.
- The section label where the percent sand and clay lines cross describes your soil texture.



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USDA

UNDERSTANDING TURF MANAGEMENT

The second in a series by
R.W. Sheard, PhD., P.Ag.

SAND, SILT and CLAY

Any sample of soil is made up of a continuous array of particles which may range from the very smallest clay particles to large gravel. In order to describe soils scientist have established a classification system for ranges of particle sizes; size ranges which reflect their role in many of the soil properties we are familiar with. This classification system divides the particles into four classes - gravel and stone, sand, silt, and clay. Table 1 lists the Canadian classification system for the size range of particles which may be found in a soil sample.

CLAY

The scientists have assigned the name *clay* to the finest particles and not without reason. Clay size particles are the source of most of the chemical properties of soil. They are responsible for the retention of many of the plant nutrients in the soil, such as calcium, magnesium , potassium, trace elements and some of the phosphorus. Clays react with the breakdown products of organic matter to stabilize the humus in the soil. A soil without clay particles can be a very infertile soil.

Clays, because of their very small size and very large surface area, are able to retain greater amounts of water than sandy soils. On the other hand, as will be discussed in a latter article, clays hold the water more closely and do not release the water as readily to grass roots as sands. Clay particles have a vastly greater tendency to stick together than sand, thus it is common farmer knowledge that soils high in clay are difficult to till. When a small sample of a clay soil is wetted and rubbed between the fingers it will feel very sticky and is easily formed into a string.

SILT

The particles classified as *silt* are intermediate in size and chemical and physical properties between clay and sand. The silt particles have limited ability to retain plant nutrients, or to release them to the soil solution for plant uptake. Silt tends to have a spherical shape, giving a high silt soil a soapy or slippery feeling when rubbed between the fingers when wet and is more difficult to form into a string than clays.

Because of the spherical shape, silt also retains a large amount of water, but it releases the water readily to plants. While silt soils are generally considered very fertile for the growth of plants, largely due to their water characteristics and ease of cultivation, engineers dread working with them due to their relatively easy release of water and lack of ability for the particles to stick together.

SAND

Sand particles are essentially small rock fragments, and as such, have little or no ability to supply grass with nutrients or to retain them against leaching. As rock fragments, sandy soils feel gritty between the fingers. The sand grains have little ability to stick together; thus sandy soils can not be rolled into a string when wetted.

It is well known that sandy soils are droughty soils because they retain little water when wetted. Nevertheless what water is retained is

Table 1: The classification system for soil particles; their sizes, surface area and visibility.

Soil Separate	Size Range (mm)	Surface area (cm^3/gm)	Visibility
Clay	less than .002	23,000	electron microscope
Silt	.002 to .05	2,100	light microscope
Very fine sand	.05 to .10	—	light microscope
Fine sand	.10 to .25	210	human eye
Medium sand	.25 to .50	—	human eye
Course sand	.50 to 1.0	21	human eye
Very coarse sand	1.0 to 2.0	—	human eye
Gravel	2.0 to 100	—	human eye
Boulders	larger than 100	—	human eye

Fig. 1: The textural triangle used for assigning textural class names. (A straight line drawn along the grid for the percentage clay and for the percentage silt will intersect within a class name area. Try it using the numbers in Table 2.)

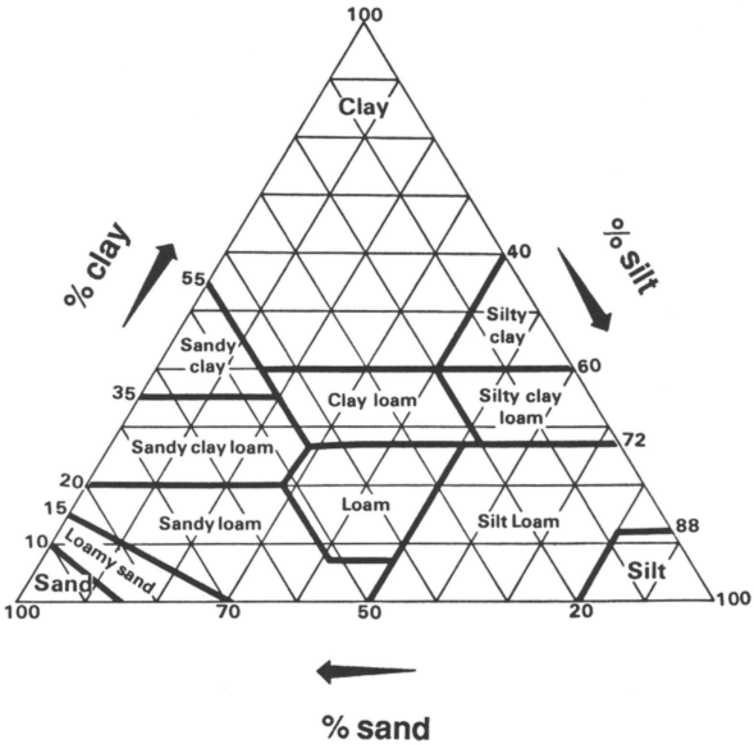

Table 2: Some typical particle size analysis and the corresponding class name.

Particle size analysis			
Sand	**Silt**	**Clay**	**Textural class name**
	- % by weight -		
92.5	5.5	2.0	Sand
61.0	28.0	11.0	Sandy loam
40.0	41.0	19.0	Loam
20.0	61.0	19.0	Silt loam
3.5	89.0	7.5	Silt
28.5	42.0	31.0	Clay Loam
10.0	31.0	59.0	Clay

released to plants easily. When rain or irrigation occurs the water readily penetrates the soil surface, the excess moves through rapidly and the soil remains well aerated. These properties make sands a desirable medium for growing sports turf where there is no limitation in appling water and nutrition, as needed, throughout the season.

The analysis for the distribution of the various particles in a soil sample (particle size analysis) for the sand portion is done using a set of screens which have mesh sizes that retain the various ranges of sand particles. Estimating the silt and clay is more complicated as it requires measuring the rate of settling of the particles in water. The analysis is based on a law of physics which says that small diameter particles settle more slowly in water than larger diameter particles. By dispersing a sample of soil in a column of water so that all particles will settle independently of each other and taking samples at a set depth and time interval, the technician can calculate how much silt and clay is in the sample.

Because there can be an infinite array of percentages of sand, silt and clay in soils, scientist have devised a procedure for classifying the potential combinations into 12 groups which reflect broad soil properties. These groups are called textural class names and are obtained by applying the particle size analysis to a textural triangle (Figure 1). Thus a soil which contains 40% sand, 40% silt and 20% sand would be called a loam soil. Table 2 lists several textural class names and a typical particle size distribution for each.

Some confusion occurs between the use of these terms by many turf managers and the soil scientist. The soil scientist considers the name loam or clay to refer to a range of particle sizes in a soil. The turf manager often refers to a loam as a soil which is easy to till or is not compacted whereas a clay is dif-

Sand, Silt and Clay

continued from page 5

ficult to work, is compacted or may be a subsoil.

In summary many chemical and physical properties of a soil can be assessed in rough terms from a knowledge of a particle size analysis or the textural class name. For example in comparing a clay to a sandy loam it can be expected that

1) the clay will be relatively more fertile,
2) the clay will have greater nutrient holding capacity for potassium, calcium and magnesium,
3) the clay will have more organic matter,
4) the clay will hold more plant available water and be less droughty,
5) the clay will have smaller pores resulting in slower air and water movement within the soil, and
6) the clay will have greater stickiness, ability to be retain a shape when moulded and be harder when dry.

The Sports Turf Association extends a warm welcome to New Members ...

...who have joined since August of 1990.

Dennis Arnott	Hamilton Parks and Recreation
Peter Booker	Hamilton Parks and Recreation
Tom Coffey	Hamilton Parks and Recreation
Dave Cowan	Hamilton Parks and Recreation
Joe Holmes	Hamilton Parks and Recreation
Darrell Pomfret	Hamilton Parks and Recreation
Gerry Companion	York Region Board of Education
Dan Ellis	York Region Board of Education
Grant McKeich	York Region Board of Education
Ron Scheepers	York Region Board of Education
Jane Rivers	Oakville Parks and Recreation
Mike Gorman	Town of Vaughan Parks Department
Herman Krecher	Town of Vaughan Parks Department
Rick Reeves	Town of Vaughan Parks Department
Jeff Maslanka	Kitchener Parks Department
Fred Williams	City of Kingston Parks
Ian Blundy	Seneca College
John Hopkins	Lawrence Park Bowling Green
Steve Pollard	Green Thumb Horticultural Services
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Karen Nesbitt	Nesbitt Aggregates
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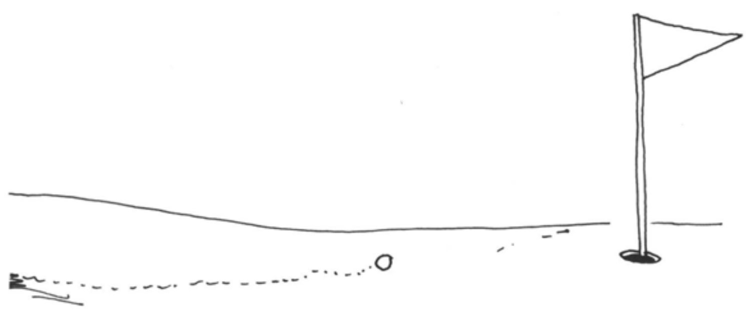
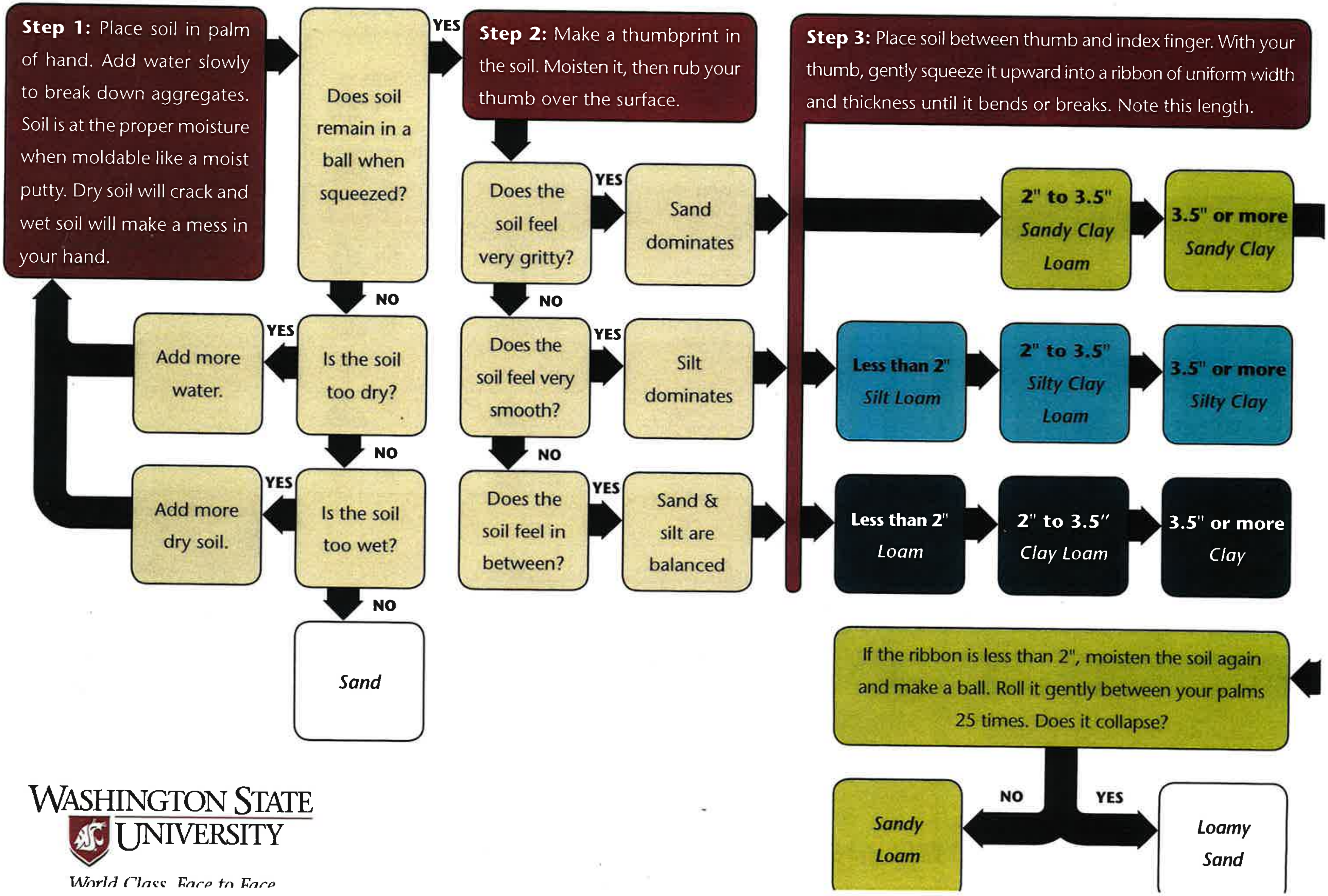


Estimating Soil Texture



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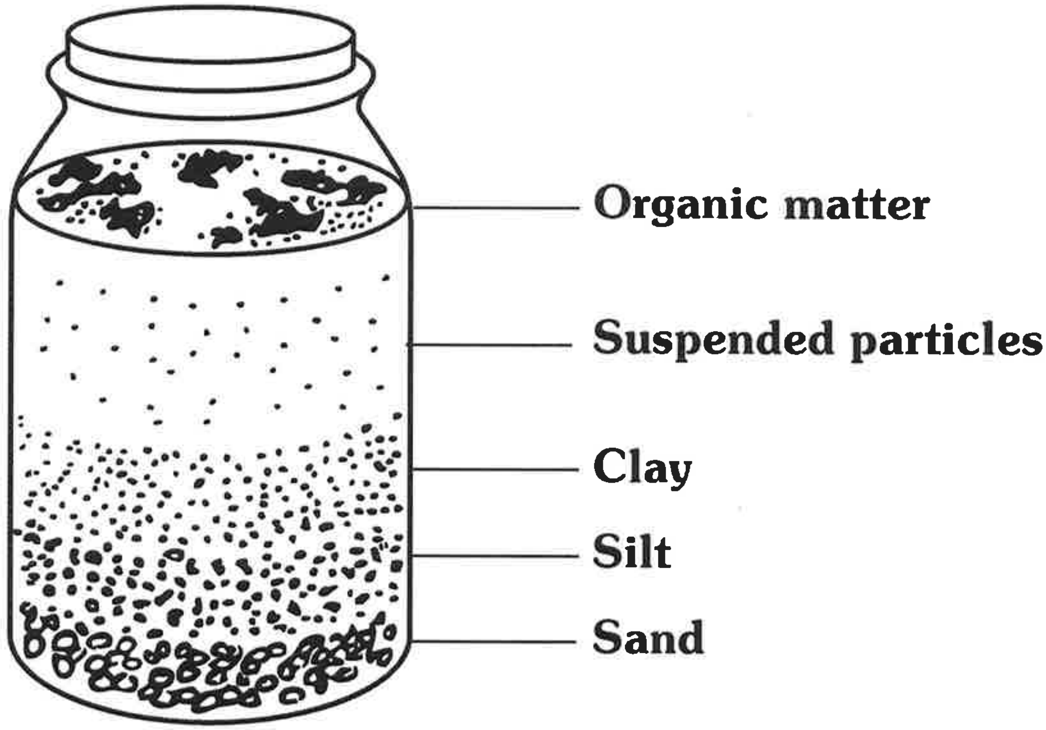
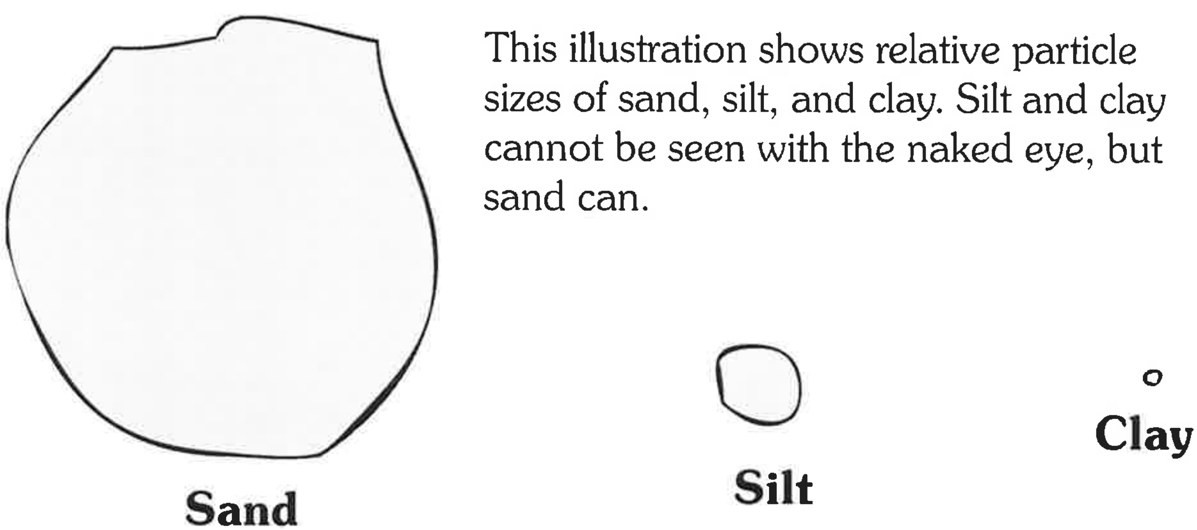


Particle Size

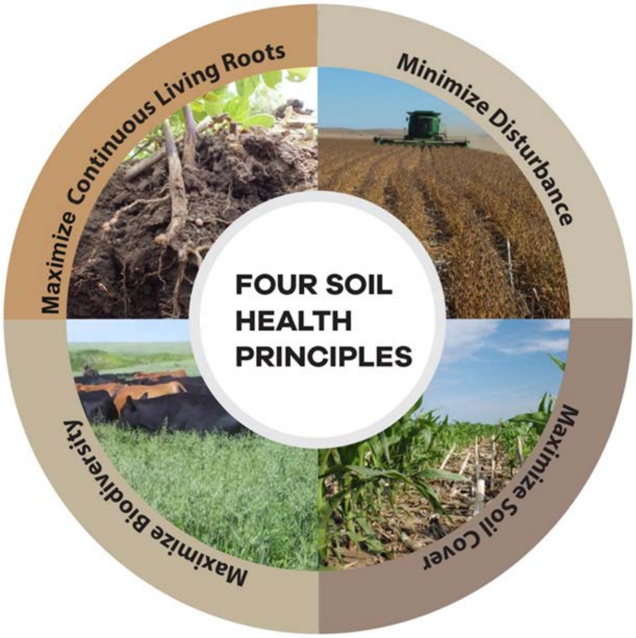
This illustration shows relative particle sizes of sand, silt, and clay. Silt and clay cannot be seen with the naked eye, but sand can.



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 plants and animals, by cycling nutrients, absorbing, draining 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 to the right to emphasize their relationship as a continuum where each complements the others and also depends on the others.

1. Minimize disturbance
2. Maximize soil cover
3. Maximize biodiversity
4. Maximize presence of living roots

PROTECTING THE SOIL HABITAT

The first two principles, shown on the right side of the diagram above focus on protection of the soil habitat: minimize disturbance and maximize soil cover. Practices that use these principles maintain or increase stable soil aggregates and soil organic matter (SOM), and protect the surface of the soil that is most susceptible to the degrading forces of wind and water. Maximizing soil cover also buffers against temperature fluctuations that stress plants and soil organisms, reduces evaporation rates, and increases the amount of water entering the soil profile from precipitation and irrigation.

SOM is highest at the soil surface and is critical for stabilizing soil aggregates.

Maintaining SOM helps support additional soil functions including water infiltration, drainage and storage, nutrient-holding capacity and release, and habitat for soil biota.

FEEDING THE SOIL ORGANISMS INHABITING SOIL

The second two principles, shown on the left side of the circular diagram, focus on feeding soil organisms. Maximizing the diversity of food (energy and carbon inputs) and aboveground biodiversity increases the diversity of soil animals and microorganisms. Diversity not only refers to food sources, but also aboveground diversification of plants and animals, and microbial diversification underground. Diversification stimulates a host of additional benefits including breaking disease cycles, providing habitat for pollinators, and stimulating plant growth.

Maximizing the presence of living roots in the soil can be accomplished through eliminating fallow, diverse crop rotation, 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.

When these two principles are properly applied as part of a soil health management system, soils can maintain or even increase SOM content as well as enhance nutrient cycling.

Worm being born within the pore space of a well-aggregated soil.

HEALTHY, FUNCTIONING SOILS ARE ABLE TO:

- Cycle nutrients effectively
- Store carbon and nutrients in soil organic matter
- Provide good aeration to promote root growth
- Improve farm and ranch resiliency and profitability
- Improve yield stability
- Reduce runoff and erosion
- Improve water storage and plant available water while protecting water quality
- Be resilient to drought, heavy rainfall events, and temperature extremes
- Reduce disease and pest problems

Soil Health Management Systems Principles can be generally used in all production systems to achieve this. However, the specific practices chosen to implement the principles must be adapted to each production system, climate, ecosystem, and soil to effectively build and maintain healthy, functioning soil.

SOIL DISTURBANCES

Physical disturbances such as tillage or compaction from heavy machinery; Chemical disturbances such as fertilizer and pesticide applications, especially over application or misuse. Biological disturbances, such as over-grazing animals that can lead to compaction and reduction in perennial root systems, introduction of invasive species and/or use of monocultures can cause biological imbalances which all can affect soil functions.

SOIL COVER

consists of two main forms: 1) living plant canopy such as a growing crop, cover crop, or grassland; and 2) mulch, either as dead plant material (e.g. crop residues, prunings from trees and shrubs, thatch in grasslands) or as an amendment (e.g. compost, bark chips).

BIODIVERSITY

is the variation of life forms within a given ecosystem or field. The different life forms include all of the plants, animals and microorganisms, and their secretions. For soil health management systems, biodiversity can be increased through a variety of approaches including: plant diversity through the use of diversified crop rotations, cover crop mixes, diversity through the proper integration of grazing animals (e.g. livestock) into the system and 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.