Soil Health and Sustainability

SGN Workshop February 2025

What is soil?

Soil is unconsolidated mineral and organic material that has been influenced by the following factors:

-parent material: the original rock or mineral from which the soil developed

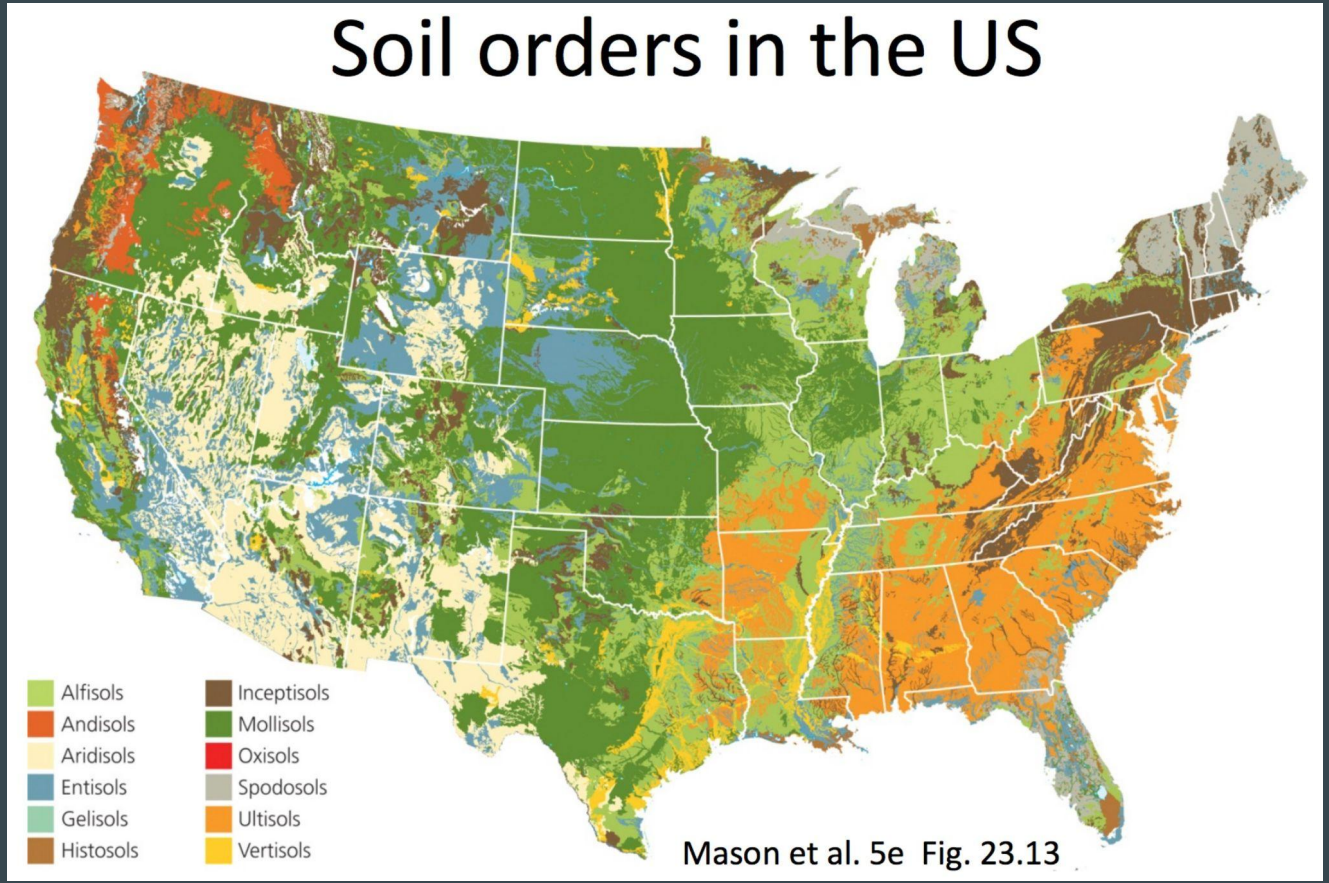
-climate: greatly affects the rate of soil development

-biota: living organisms, including microbes, in the surrounding environment

-topography

-time: minerals “weather” over long periods of time to create soil

These are the 5 “soil forming factors” which combine to create many different types of soil throughout the world.



Soil orders of the U.S.

Important Soil Functions

- Substrate for plant (root) growth
- Reservoir of nutrients and water for plants
- Home to soil organisms having many critical ecological roles (a handful of soil may contain as many microorganisms as there are people on the planet)
- Recycling of organic materials
- Regulation of the hydrologic cycle (soils absorb water and reduce runoff)

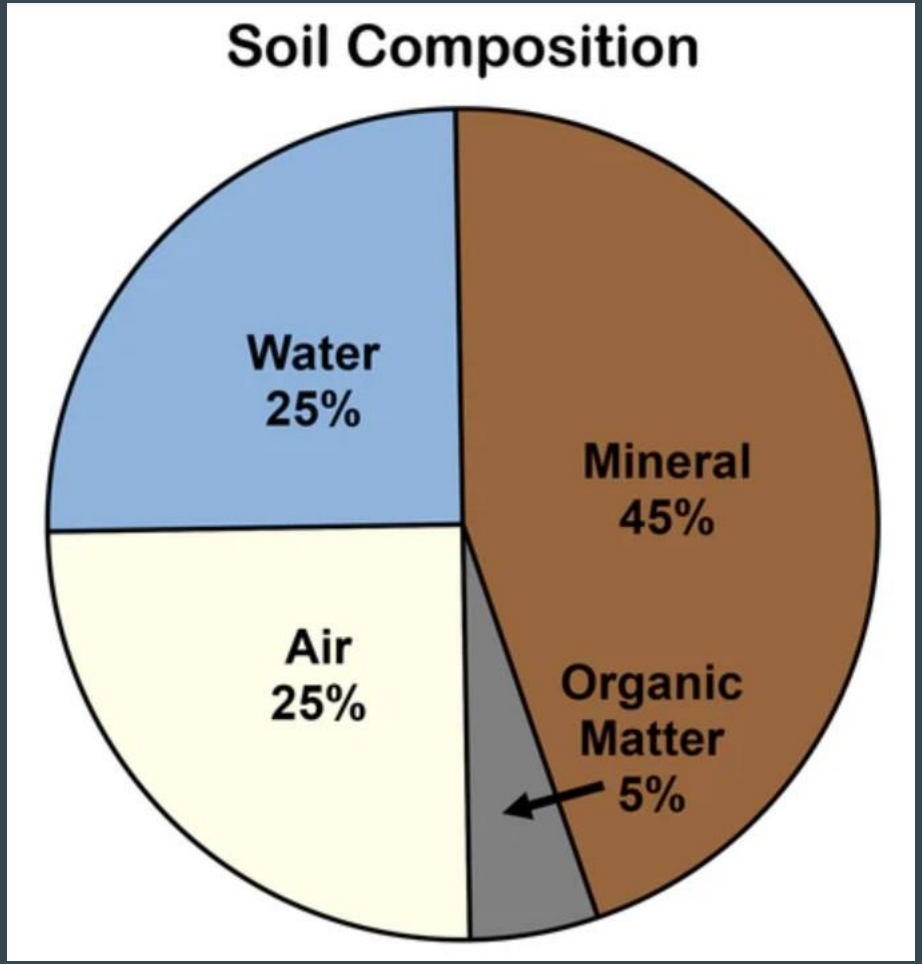
Soils are “Holey”

Only about half of a soil’s volume is made up of solids. Most of the solids in a soil are mineral particles, but organic matter makes up a very important 1 to 5% of the soil.

The rest of the volume of soil is ‘holes’ or pores, collectively called the “pore space”

Pore space is very important. Soil water and air fill the pores and move through them. Plant roots and soil organisms are found in the pore space.

Maintaining good soil porosity is an important goal in soil management.


Soil Composition
Water
25%
Mineral
45%
Air
25%
Organic
Matter
5%

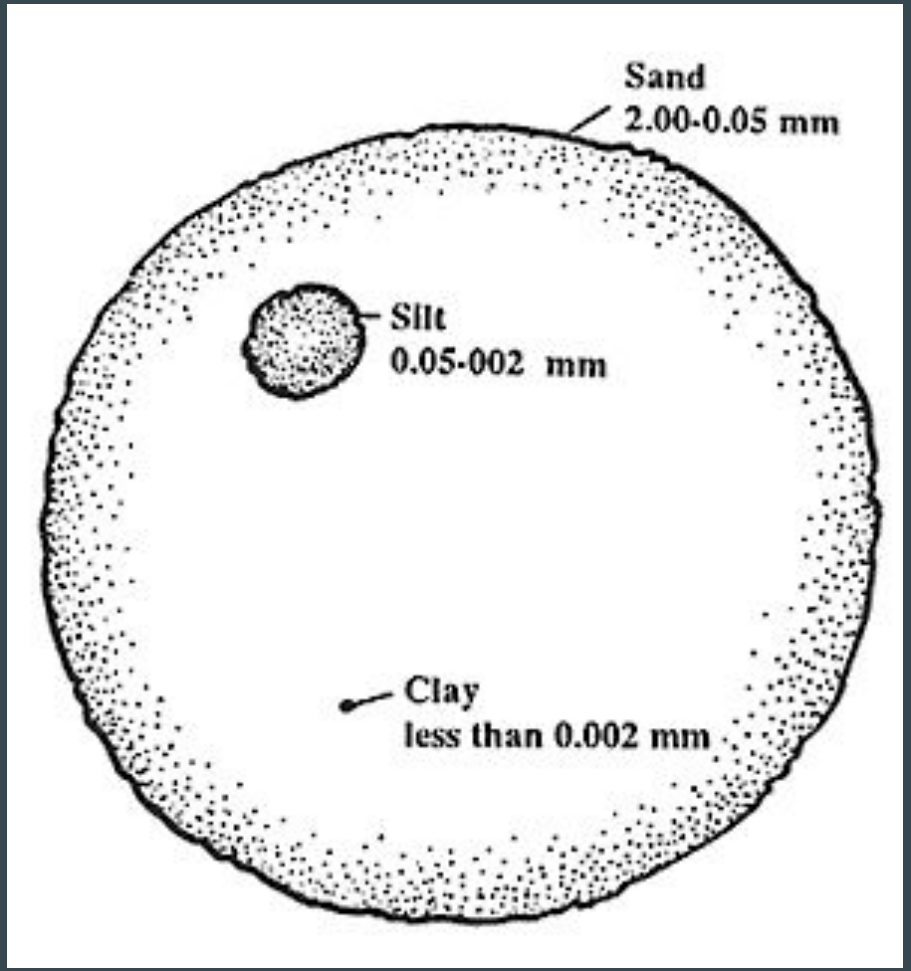
Soil Texture

A soil's texture is defined by how it 'feels' and is determined by the amount of sand, silt and clay present in the soil.

Clay particles are the smallest mineral particles in the soil, sand particles are the largest, silt is intermediate.

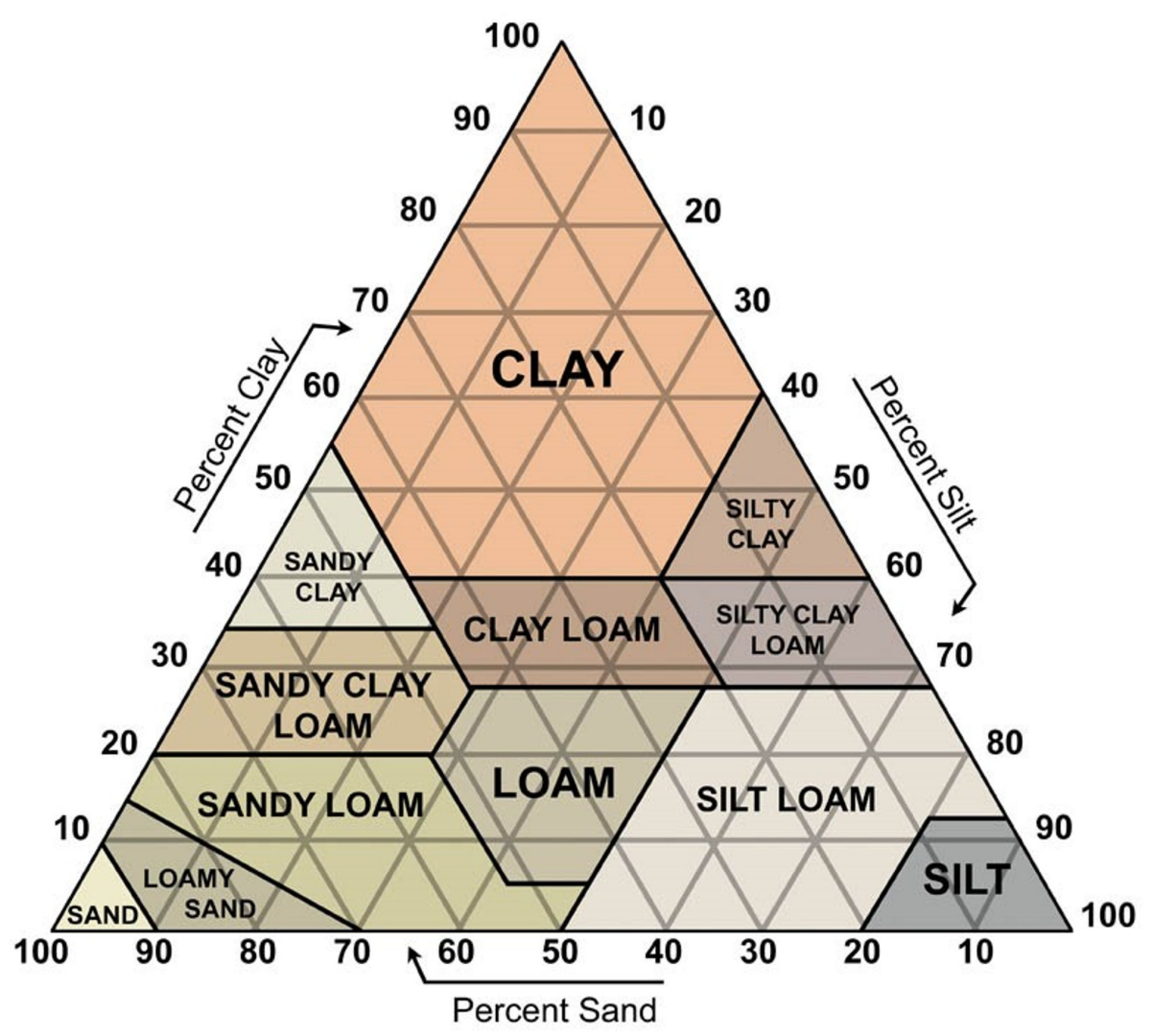
Soil texture affects the soil's ability to hold nutrients and water.

Increasing the organic matter in your soil will improve on its nutrient and water holding capacity.



Soil particle size comparison

Soil Textural Triangle



Soil Structure

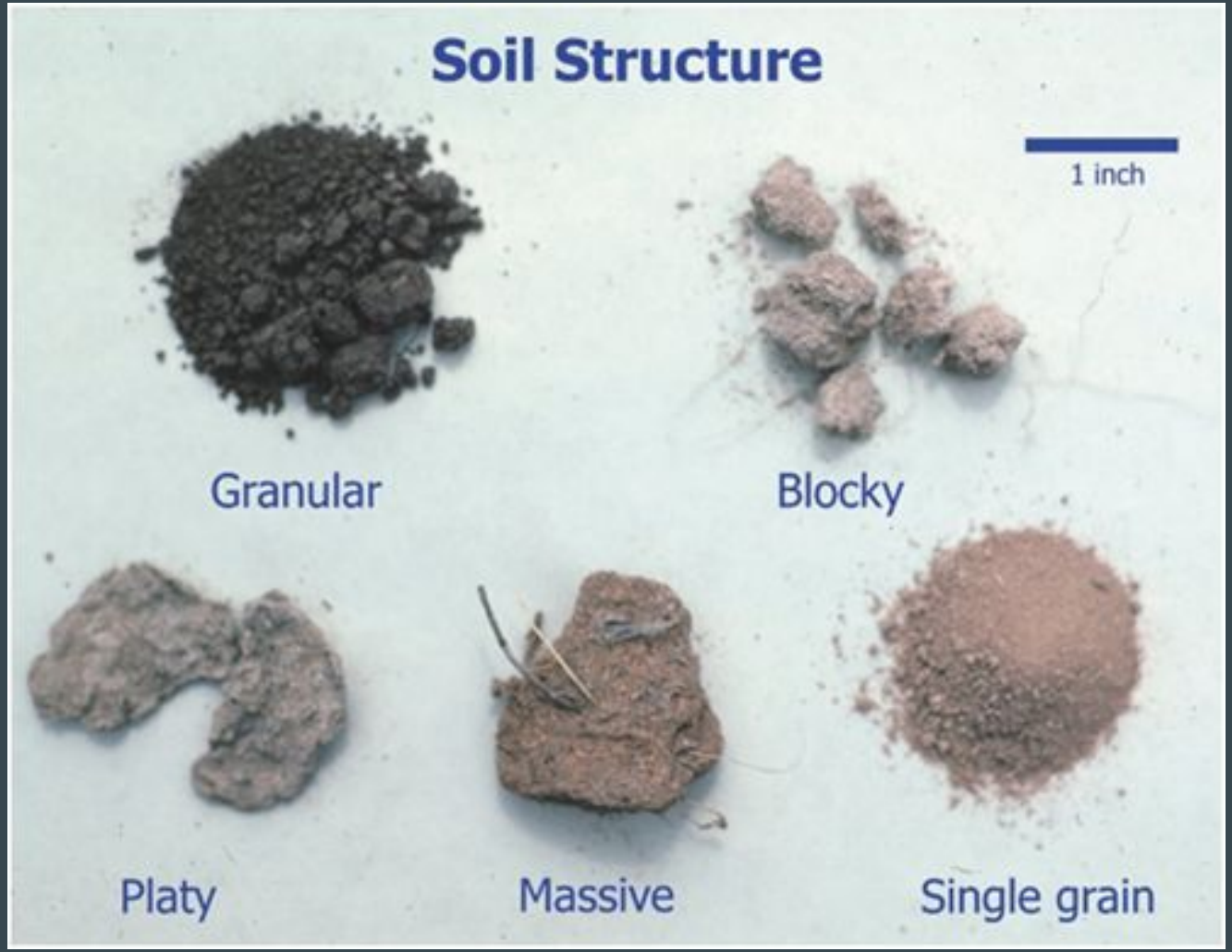
Soil structure refers to the way soil particles are held together to form aggregates.

This is done by cementing agents like clays, organic matter, and oxides.

Aggregates tend to increase water infiltration and drainage and enhance plant growth by making it easier for roots to penetrate the soil.

Soil structure is especially important in clay soils and can be improved or degraded by management practices. Degradation can occur because of improper tillage, compaction or loss of organic matter.

Good structure is promoted by organic matter and balanced soil chemistry.


Soil Structure
1 inch
Granular
Blocky
Platy
Massive
Single grain

Soil Chemistry

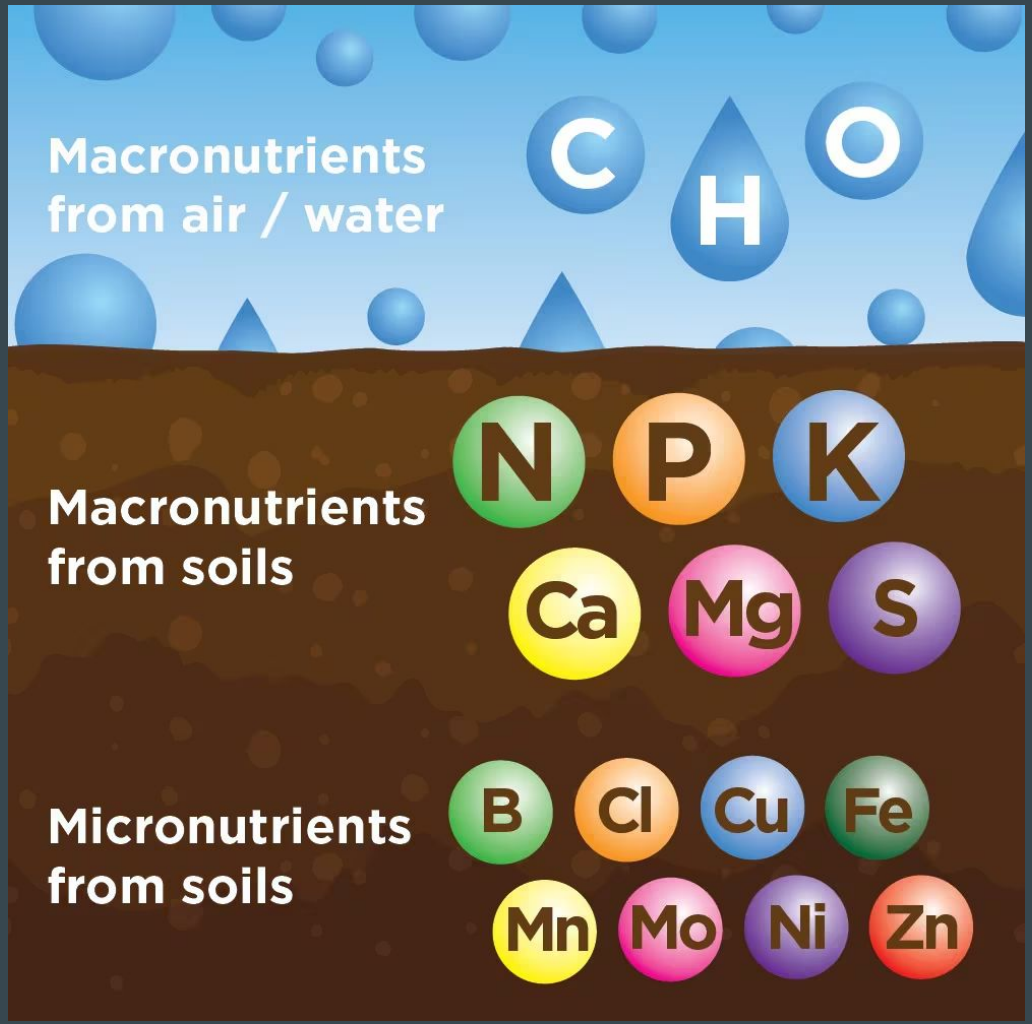
Healthy plants require a chemically balanced soil which supplies adequate amounts of the mineral nutrients necessary for growth and development.

Important factors include:

-A proper balance of the essential nutrients for plants. This includes the macro-nutrients and the micro-nutrients.

-Cation exchange capacity: a measure of the soils ability to store and release cations (Ca, Mg, K).

-pH: a measure of the acidity of the soil. Most plants do best when the pH is between 6 and 7.5. Outside of this range various mineral deficiencies and toxicities can occur.


Macronutrients
from air / water
C
H
O
Macronutrients
from soils
N
P
K
Ca
Mg
S
Micronutrients
from soils
B
Cl
Cu
Fe
Mn
Mo
Ni
Zn

Soil Organisms and Biology

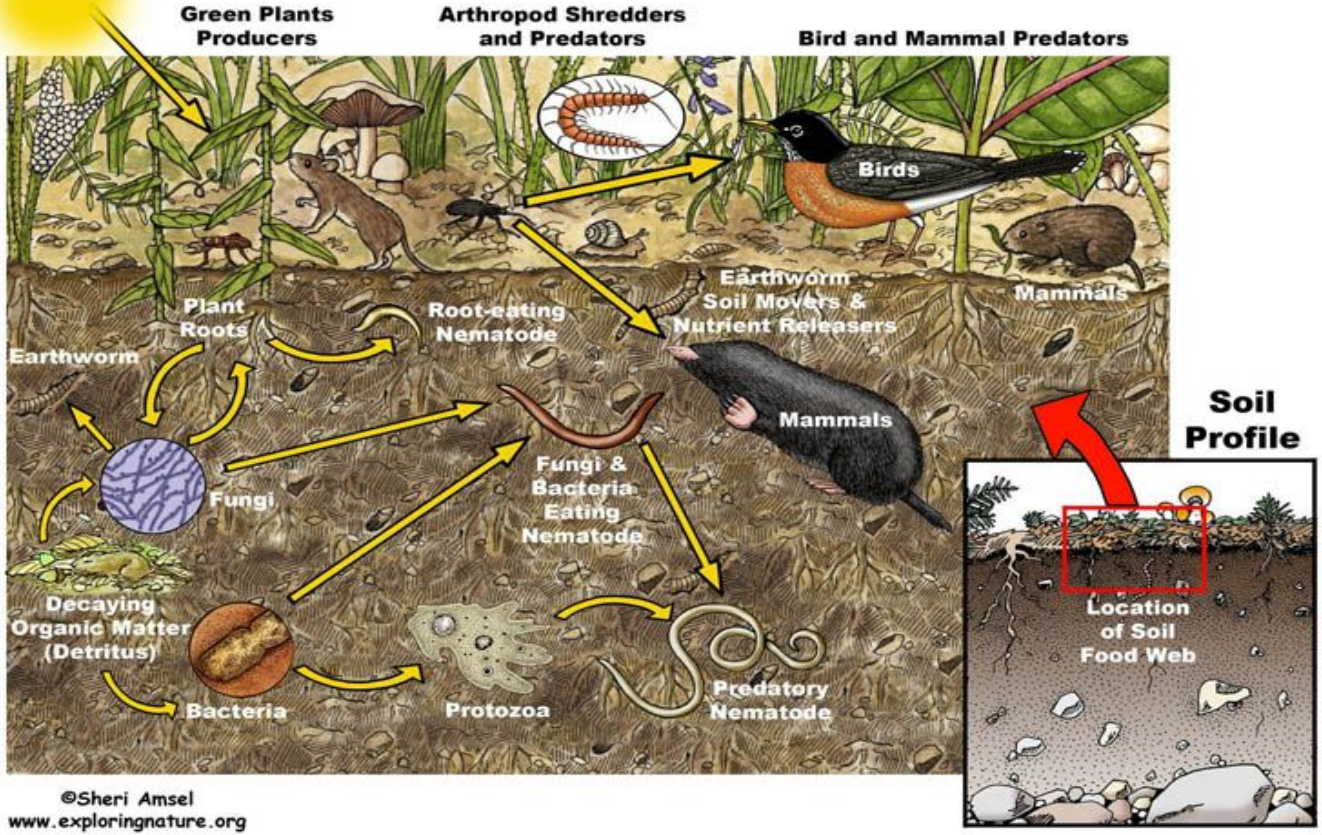
The diverse communities and activities of the micro and macro organisms living in the soil have many important impacts.

The communities of soil organisms are very diverse and the vast majority of organisms serve beneficial functions.

In general, highly diverse and active soil ecosystems exhibit more efficient nutrient cycling and have fewer pest problems because no one species can dominate in a diverse system.

Additions of diverse types of organic matter help promote diversity by feeding a wide range of microorganisms.

Soil Food Web



Soil Organic Matter (SOM)

SOM is composed of living, dead, and ‘very dead’ organisms and their waste products. Although not a large percentage of most soils SOM performs important roles.

-provides food and habitat for soil organisms

-promotes good soil structure

-raises CEC; SOM itself has a high CEC and may be the major component of the total CEC in a sandy soil

-is a direct source of plant nutrients; as SOM decomposes it releases nutrients. It is the primary reservoir of nitrogen in most soils

Managing Soils Sustainably

- Feed soil microorganisms by recycling (adding) organic matter
- Avoid chemical imbalances; monitor soil and plant nutrient levels and use information in making management decisions
- Use tillage only when necessary and carefully
- Rotate crops/use cover crops to improve the soil and minimize pest problems
- Manage water to minimize erosion and nutrient losses and avoid accumulation of salts in the soil
- Minimize soil erosion through various biological, engineering and management methods

Cover Crops

Cover crops have many benefits for the soil and following crops.

They can add organic matter which feeds soil microbes and releases nutrients.

They add Nitrogen if legumes are planted.

Help minimize nutrient leaching.

Can help improve soil structure and soil-water relations; and can reduce runoff and erosion.

Cover crops require management, resources, and time to grow.

Crop Residues

Crop residues have similarities with cover crops, but also may have important differences.

-They may add significant OM or very little depending on the crop.

-They typically have lower nutrient concentrations than cover crops as much of the nutrient may be concentrated in the harvested portion of the crop.

-Sometimes the decomposition of residues may immobilize soil N for a while.

Animal Manures

Manures have been used to improve soils for millennia.

They can add fresh organic matter and significant amounts of plant nutrients to the soil.

Poultry manure is richer than cattle manure, which is richer than horse manure.

Fresh manure contains more Nitrogen because N can volatilize from manure fairly quickly.

Other disadvantages of manure: may contain weed seeds or pathogens. Hot composting can eliminate these issues.

Composts

Proper composting can convert a wide variety of organic materials into a valuable resource.

Potential benefits

- Add relatively stable OM; longer composting period results in more stable OM
- Add beneficial microorganisms to the soil and a food source for them
- Add plant nutrients, most in plant available form (N release may be relatively slow)

Composts are also quite variable. Knowing the starting materials and composting method can help users choose the right compost for a given situation.

Supplying Plant Nutrients

Chemically balanced soils that efficiently supply nutrients to crops without polluting the environment can be achieved by:

- Enhancing SOM and CEC to develop stable nutrient ‘reserves.’
- Using organic matter and other amendments to achieve neutral soil pH and balanced concentrations of cations.
- Recycling nutrients from rural and urban sources back into the soil; such sources include green wastes, gardening by-products, and manures.
- Utilizing concentrated forms of nutrients carefully.
- Using methods such as soil and plant analysis to make management decisions.

A & L Western Laboratories, Inc.

1311 Woodland Avenue, Modesto CA 95351 209-529-4080
10220 SW Nimbus Avenue Bldg. K-9, Portland OR 97223 503-968-9225

REPORT NUMBER: 110409 **CLIENT NO:** 14651 **SUBMITTED BY:** COURTNEY DELELLO

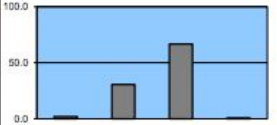
SEND TO: SCHOOL GARDEN NETWORK
PO BOX 1367
Sebastopol CA 95473

GROWER: UNIVERSITY ELEMENTARY
LOCATION: SCHOOL GARDEN

SUBMITTED DATE: 2/4/2025
P.O. No:
COC No:

Graphical Soil Analysis Report

DATE OF REPORT: 02/10/25 **LAB NO:** S110409-01 **SAMP NO:** FOOD **PAGE:** 1



Analyte	Loss On Ignition OM %	Nitrogen NO_3-N ppm	Phosphorus Weak Bray* ppm	Phosphorus $NaHCO_3$-P ppm	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Chloride Cl ppm
Results	13.9	11	110	75	340	1570	5720	64							

Potassium K %	Magnesium Mg %	Calcium Ca %	Sodium Na %
2.0	30.6	66.8	0.6

LOW AVERAGE HIGH

ACIDIC BASIC

ECe dS/m — INCREASING SALINITY →

CEC meq/100g: 42.8

Lime Presence

pH: 6.1

Buffer pH:

← INCREASING NEED FOR LIME

Soil Fertility Guidelines

CROP: VEGETABLES **RATE:**** lb/1000 sq ft **NOTES:**

Dolomite (70 score)	Lime (70 score)	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B	
	90			2.3										

COMMENTS

MAGNESIUM: If levels are very high (generally, they increase with depth), one may encounter drainage problems and potassium uptake may be hindered. Extra calcium may provide some benefit.
PLEASE NOTE, the above guidelines are in lb/1,000 sq ft. Reduce accordingly for smaller areas. An ounce volume measure (2 tablespoons) will generally hold about an ounce of most fertilizers.
PRIOR TO PLANTING: Spread the above requirements per 1,000 sq ft and mix into the top 6-8 inches of soil. Initially, limit nitrogen to 1.5 lb/1,000 sq ft or 25-30 ppm NO3-N to avoid salt damage.
SPLIT extra nitrogen as necessary over the active growing season. Adjust rate according to local conditions and requirements. Allow for adequate establishment first (up to 30 days).
HIGH levels of organic matter should have a beneficial effect on growth and "soil" pH may not be as critical. However, watch carefully as amendments and extra nitrogen may still be necessary.
LIME REQUIREMENT: Liming may be necessary if buffer index is less than 6.9. Guidelines are based upon common agricultural lime (70-score) per six-inch depth to raise SOIL pH to about 6.5.

Please call if you have any questions.

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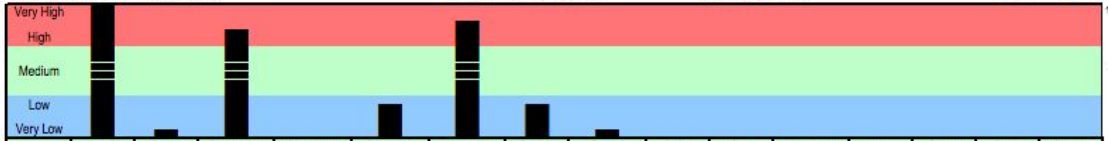
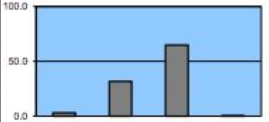
Graphical Soil Analysis Report

DATE OF REPORT: 02/10/25 **LAB NO:** S110409-02 **SAMP NO:** PER **PAGE:** 2





Analyte	Loss On Ignition OM %	Nitrogen NO_3-N ppm	Phosphorus Weak Bray* ppm	Phosphorus $NaHCO_3$-P ppm	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Chloride Cl ppm
Results	21.1	1	58	52	441	1390	4740	44							

Potassium K %	Magnesium Mg %	Calcium Ca %	Sodium Na %
3.1	31.7	64.8	0.5

LOW AVERAGE HIGH

ACIDIC BASIC

ECe dS/m — INCREASING SALINITY →

36.6 CEC meq/100g

Lime Presence

5.9 pH

Buffer pH: ← INCREASING NEED FOR LIME

Soil Fertility Guidelines

CROP: ORNAMENTALS **RATE:**** lb/1000 sq ft **NOTES:**

Dolomite (70 score)	Lime (70 score)	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B	
	90			0.8										

COMMENTS

MAGNESIUM: If levels are very high (generally, they increase with depth), one may encounter drainage problems and potassium uptake may be hindered. Extra calcium may provide some benefit.
QUICK CONVERSION: Divide fertilizer grade on the bag by 10, IF applying 10 lb/1,000 sq ft. (e.g. 10 lb of a "triple 15" fertilizer would provide 1.5 lb each of nitrogen, phosphate and potash).
AVOID unnecessary pruning of mature trees, shrubs and vines by restricting nitrogen applications to less than about 1.5 lb/1000 sq ft per season. Avoid applying late, prior to winter freezes.
PREPLANT FERTILIZATION must be conducted with caution if salt damage is to be avoided. Young roots should not be in direct contact with high rates of soluble fertilizer.
HIGH levels of organic matter should have a beneficial effect on growth and "soil" pH may not be as critical. However, watch carefully as amendments and extra nitrogen may still be necessary.
LOW SOIL pH: Unless "acid-loving" plants are being grown, a liming program is advised. If unable to mix into the soil, spread no more than 50 lb per 1000 sq ft within a 6-month period.

Please call if you have any questions.

Curriculum Resources

- Soil Stories - https://www.plt.org/wp-content/uploads/pdf/PLT_Act70_Soil_Stories.pdf
- Creatures in the soil handout - https://cdn.agclassroom.org/media/uploads/2015/11/03/Creatures_in_the_Soil.pdf
- Teacher guide - soil not dirt - https://www.soils4teachers.org/lessons-and-activities/teachers-guide/its-not-dirt/
- Soil texture analysis - https://www.soils4kids.org/files/s4k/soil-texture-experiment.pdf
- Sample lesson plans on soil: https://www.nature.org/content/dam/tnc/nature/en/documents/nature-lab-lesson-plans/NLGardens-Soil.pdf
- Soil shake
    - English: https://www.plt.org/wp-content/uploads/pdf/EYE_3-5_Soil-Builders_StudentPage_Making-a-Soil-Shake.pdf
    - Spanish: https://www.plt.org/wp-content/uploads/pdf/EYE_3-5_Soil-Builders_StudentPage_Making-a-Soil-Shake_hacer-un-batido-de-suelo.pdf
- General activities for K-12 - https://envirocenter.org/wp-content/uploads/2021/11/SOIL-HEALTH-ACTIVITIES.pdf

QR code for post workshop survey

https://arcg.is/18S1CD0