# Sorting Out Soils

## Grade K

## Standards
GPS.SKE2.b,c HEK.1.a;
NGSS.K.ESS3.A

## Time
(1) 45 minute period

## Supplies
- Paint brushes (1 per student)
- Small paint containers (6) such as muffin pans, recycled yogurt cups
- Artist shirts or aprons (optional)
- Optional- Paint fixers: linseed oil or gum Arabic or clear acrylic
- Book: Jump into Science: Dirt by Steve Tomecek
- Soil samples brought in by students in zip top bags
- Map of U.S.
- Yarn (approx. 25 yards)
- Trowels (1 for every 2-3 students)
- 12 containers or zip bags for soil sample collection
- 6 water-tight jars with lids
- Various containers for observing and feeling soil (plastic / foil tubs)
- Magnifiers

## Garden Connection
Students will collect and analyze soil samples from the garden and other locations in the schoolyard. Investigation Stations may be set up outside, if workspace exists, or in the classroom if not.

### Overview
Students collect soil samples and discover that soil is different from place to place and that it is made up of living and non-living components. Students observe and sort soils samples according to physical attributes and make the connection between healthy soils, healthy plants, healthy vegetables, and healthy people.

### Guiding Questions
What is soil?
How does soil affect food we grow in the garden?
What does soil have to do with my health?

### Engaging Students
Students will paint with soils to discover that soil has different characteristics depending on where it is found, and listen to a book about soil composition to learn that soil is composed of living and non-living parts.

### Exploration
Students will bring in soil samples from family trips and add them to a classroom exhibit of soils showing where each sample was found. Students will also collect soil samples from the school garden and different parts of campus, looking for areas where soil appears to be different.

### Explanation
Students will be able to articulate that soil consists of living and non-living components, and explain how soil quality or health affects plant health and therefore human health.

### Environmental Stewardship
Students will improve soil health in the garden by composting lunch leftovers and adding completed compost to the soil.

### Evaluation
Students will draw the different components of soil and explain their drawings to demonstrate understanding that soil includes living, once-living, and non-living matter. Students will also be able to make a connection between healthy soils, healthy plants and healthy people. A rubric is provided to assist in assessing student proficiency in these concepts.

## Standards

**Georgia Performance Standards in Health**

HEK.1 Students will comprehend concepts related to health promotion and disease prevention to enhance health.

a. Name healthy behaviors

Identify healthy food choices

**Georgia Performance Standards in Science**

SKE2. Students will describe the physical attributes of rocks and soils.

b. Use senses to observe soils by physical attributes such as smell, texture, color, particle or grain size, etc.

c. Recognize earth materials— soil, rocks, water, air, etc.

**Next Generation Science Standards**

K.ESS3.A: Natural Resources

Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do. (K-ESS3-1)

## Background Information

Soil is made up of living things (animals, plants, fungi) and once-living things (decomposing bits) together called "organic matter" as well as non-living things including bits of rock (mineral soil), water, and air. The top layer of soil, which includes a mix of living and non-living components, is fertile, thin compared to the deep bedrock below, and fragile. It takes many years for healthy, fertile soils to be formed yet poor farming or gardening practices can deplete the nutrients in soil and even cause soil to blow away or erode. Soils are a valuable natural resource we must protect. Most plants need soil to hold them up and to provide the water and nutrients (provided by decomposed organic matter) that plants absorb through their roots. Soil quality can be hurt by toxins and pollutants that make it unhealthy, or by overuse for gardening and farming which can remove nutrients and encourage pests, or by heavy use of artificial fertilizers and pesticides. Fortunately, people can also improve soil health in the garden by adding compost to restore nutrients, rotating crops, growing legume (pea or clover) cover crops in alternate seasons to restore nitrogen, and other certain garden practices. Students will learn about soil in this lesson and have the opportunity to improve soil health in the school garden by composting their lunch leftovers and adding completed compost to garden beds.

To learn more about soils before teaching this lesson, check out the following resources:

- Recipe for Soil
  http://school.discoveryeducation.com/schooladventures/soil/recipe_soil.html

- BLM soil activity web site for kids
  http://www.blm.gov/nstc/soil/Kids/soilimpt.html

- Soil Layers diagram / worksheet
  http://www.enchantedlearning.com/geology/label/soillayers/

- Understanding the connections between healthy soils, healthy plants and healthy people (reproduced on page 7):
  http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_010795.pdf

- How healthy soils in an organic garden nourish plants (and therefore people) better than artificial fertilizers:
  http://www.soilsforlife.org.au/announcements/soil-health-human-health

- Facts about soils
  http://www.epa.gov/gmpo/edresources/soil.html

Recommended books to read with students:

- Jump into Science: Dirt by Steve Tomecek
- Dirt: The Scoop on Soil by Natalie Rosinsky
- Soil Basics by Mari Schuh
- Soil: A True Book by Christin Ditchfield
- Deep Down Underground By Olivier Dunrea (available from re-sellers / out of print)

## Teacher Preparation

- Obtain materials needed for this lesson.
- Approximately one week in advance, ask each student to bring in a zip top bag of soil from home and request zip top freezer bags and 6 glass jars with lids.
- At the beginning of the school year, ask families to bring soil samples back from their travels during the upcoming year, in zip top bags labeled with the locations. Obtain a map of the US and post on the wall, next to which the soil sample bags can be pinned with yarn lines connecting soil samples to their places of origin.
- Before the lesson, scout out good locations where students can collect a variety of soil samples on school grounds.
- Recruit parents or other volunteers to help manage the Investigation Stations (6 would be ideal).
- Set up six Investigation Stations outdoors or in the classroom. If indoors, cover area appropriately to protect from possible spilled soil.
- During the Engagement stage, the stations will be used for painting with different soils. Groups of four students will rotate among the six stations to try out six different soil paints.
- While students are listening to the teacher read a book and looking at a web site with LCD projector or Smartboard, volunteers will need to put away the painting supplies and set up stations for investigation of a different soil samples
- .Volunteers will also go outside with teacher and students to help manage the class while samples are being collected for the Investigation Stations.

## PROCEDURES FOR LESSON ACTIVITIES

### **Engagement** (in the garden or classroom)

Students will paint with different soils, to discover that soil is not all the same. Then they will listen to a book about soil composition to learn more about living and non-living things in soil.

Set up about six soil paint stations. Prepare the following materials *in advance of lesson.*

- From soil samples brought in by students, select six colors of mineral soil (collected from layers beneath topsoil)
- Make six colors of soil paint by any of the following methods:
- Easy version: Remove worms and debris from soil samples, mix small amount of water with cleaned soil => DONE!
- OR Crush each soil sample with a mortar and pestle, hammer, or spoon
- Place powdered soil from each sample into a flour sifter (or jar covered with a stocking secured by rubber band)
- Shift or shake soil over a paper and collect powdered soil

On the morning of the lesson:

- Add a drop at a time of linseed oil OR liquid gum Arabic OR clear medium-weight artist acrylic to powdered soil
- Stir into a paste; thin with a little water if necessary to make paints
- Place each color of paint in a separate cup, muffin tin, recycled yogurt cup, or other container
- Place one color of paint and four brushes at each of six stations (assuming class of 24 and 4 students per group)

Prepare students to paint with soils.

- Divide the class into small groups (no more than four students each)
- Give each student a paint brush and a piece of watercolor paper OR copy of puzzle template paper (reproduced on page 6, copyright free and courtesy of Tim's Printables) and a clipboard
- Tell students to clip paper on clipboard.
- Optional: using masking tape to fasten paper to clipboard for flat drying
- Optional: Provide each student with a painting apron or over-sized button-up shirt, to protect clothing.

Painting with soils

- Tell students they will be painting with soils to see if soils are all the same color or different.
- Divide groups among paint stations and invite students to paint one section of paper with the color at each station
- Rotate student groups among stations, until everyone has used the paint color at each station (6 colors)
- Set paintings aside to dry

Ask students some questions about soil:

- What is soil? What are some of the things we would find in soil? Is soil the same everywhere? Were all the soil paints the same color? What might make soil different, in different places?

Read aloud a book on soils, such as any of the following:

- Jump into Science: Dirt by Steve Tomecek
- Dirt: The Scoop on Soil by Natalie Rosinsky
- Soil Basics by Mari Schuh
- Soil: A True Book by Christin Ditchfield

To increase student understanding about living and non-living components of soil, an LCD projector or Smartboard can be used to display pages from this Bureau of Land Management web site for children on soil communities, including the Incredible Journey section. http://www.blm.gov/nstc/soil/Kids/incred.html

## Exploration

Students will go outside to collect three soil samples and then visit the Investigation Stations to explore differences among specimens by observing soil with a magnifying lens, identifying any living things or once-living components, feeling its texture and attempting to form shapes with it, and conducting a soil shake layering activity (first station only).

Before taking the class outside, ask students for ideas about three totally different places to collect soil. Ideally, choose places that appear different from each other. For example, the vegetable garden, ornamental planting beds, and a playing field or pathway.

Soil Sample Collection

- To collect a sample, first scrape away any grass, leaf litter or organic matter covering a small area (about 6" diameter) and put that organic matter in *two* zip top bags or other containers. Mark both containers 1-O for organic layer at first location.
- Then dig down up to 6" and collect deeper soil and place in two additional containers. Mark those containers 1-A for the A soil horizon. Make sure not to not leave a hole in the ground that could trip someone.
- Collect two samples this way from all three places, letting several students help dig with trowels each time. (Mark both samples from the organic layer at the second location 2-O, and mark both deeper soil samples from the same place 2-A. In the third location, collect two samples labeled 3-0 and two deeper samples labeled 3-A).

Investigation Station Set-Up and Logistics

Set up two identical sets of three different Soil Investigation Stations, so the class can be divided in half and each half can rotate among three stations in groups of four students. Each station should receive two samples collected from different depths at the same location, such as 1-O and 1-A.

Divide the class in half: one half of the class will go through a set of three stations, and the other half will go through three identical stations. This number of stations will allow students to work in manageably-sized teams of four. Each team of four students will rotate to three stations to observe the soil samples using sight, smell, and touch. Soil samples can be wetted slightly to make it easier to feel the texture. At each station, students should observe both the O and A layer samples. If the samples collected in the schoolyard do not provide enough variability, considering adding or substituting a sandy soil sample, a clayey soil sample, and loamy or compost sample. Soil from packaged potting or garden soil will not contain living organisms.

Soil Investigations

Engage students in the following activities, when they visit each station:

- Observe both O layer and A layer soil, using magnifiers. Look for evidence of critters, decaying leaves, etc.
- Smell soil samples.
- Touch dry and wet soil samples and see if each type of soil can be shaped into a cone? A ball?
- Volunteers working at the stations should ask and encourage students to use words to describe observations.
- At each station, do a Soil Shaker activity with the first group of students. Place part of the soil sample in a jar with water, put lid on, and let each student shake it. Then set the jar aside and let it settle for a day before looking to see how different types of soil components separated into different layers. Directions: http://www.soil-net.com/sm3objects/activities/Activity_JamJar.pdf

After visiting the Investigation Stations, bring the group back together to talk about their observations.

- Ask where students found the most living things (plants and animals)—in which soil sample, and in the organic layer or

deeper soil layer?
- Refer back to students' original ideas about what can be found in soil, and revise.
- Ask students to divide the things that can be found in soil into two categories: living/once-living (animals, plants and organic matter) and non-living (mineral, water and air) components.
- Conclusion discussion: Different soils have different properties. Soils with high organic matter have more nutrients, making them preferable for growing vegetables. Organic matter can be increased through adding compost. This is one way to help grow healthy, strong vegetables, consumption of which helps make kids healthy and strong.

## Explanation

Students should be asked what they can find in soil and should be able to identify:

non-living things, including:

- crumbled bits of rock / mineral soil
- water
- air, and

living or once-living things, including:

- worm castings, rotting leaves and other decomposing bits of plants and animals (organic matter),
- living things including animals (moles, pill bugs, beetles, worms, larvae, microorganisms too small to see, etc.)
- other living things such as fungi and underground plant parts

## Environmental Stewardship

Over time, the soil nutrients in a garden can become depleted (used up by plants that are removed from the garden). Also, soil without sufficient organic matter does not have the structure to hold together and can easily be eroded by wind and water. Students can improve the quality of soil in the school garden by composting their lunch scraps and later mixing the completed compost with garden soil. If composting does not already take place on campus, a compost pile can be started in the schoolyard or a smaller indoor compost or worm bin can be set up in the classroom. Check out the composting information below and choose the best option for your situation.

Best Ever Compost Recipe from Cornell U
http://web.archive.org/web/20030621232553/http://www.cfe.cornell.edu/compost/outdoorbest.html

Simple two-story worm bin
http://whatcom.wsu.edu/ag/compost/easywormbin.htm

Indoor Composting and Worm Bins
http://web.archive.org/web/20030621191747/http://www.cfe.cornell.edu/Compost/indoors.html

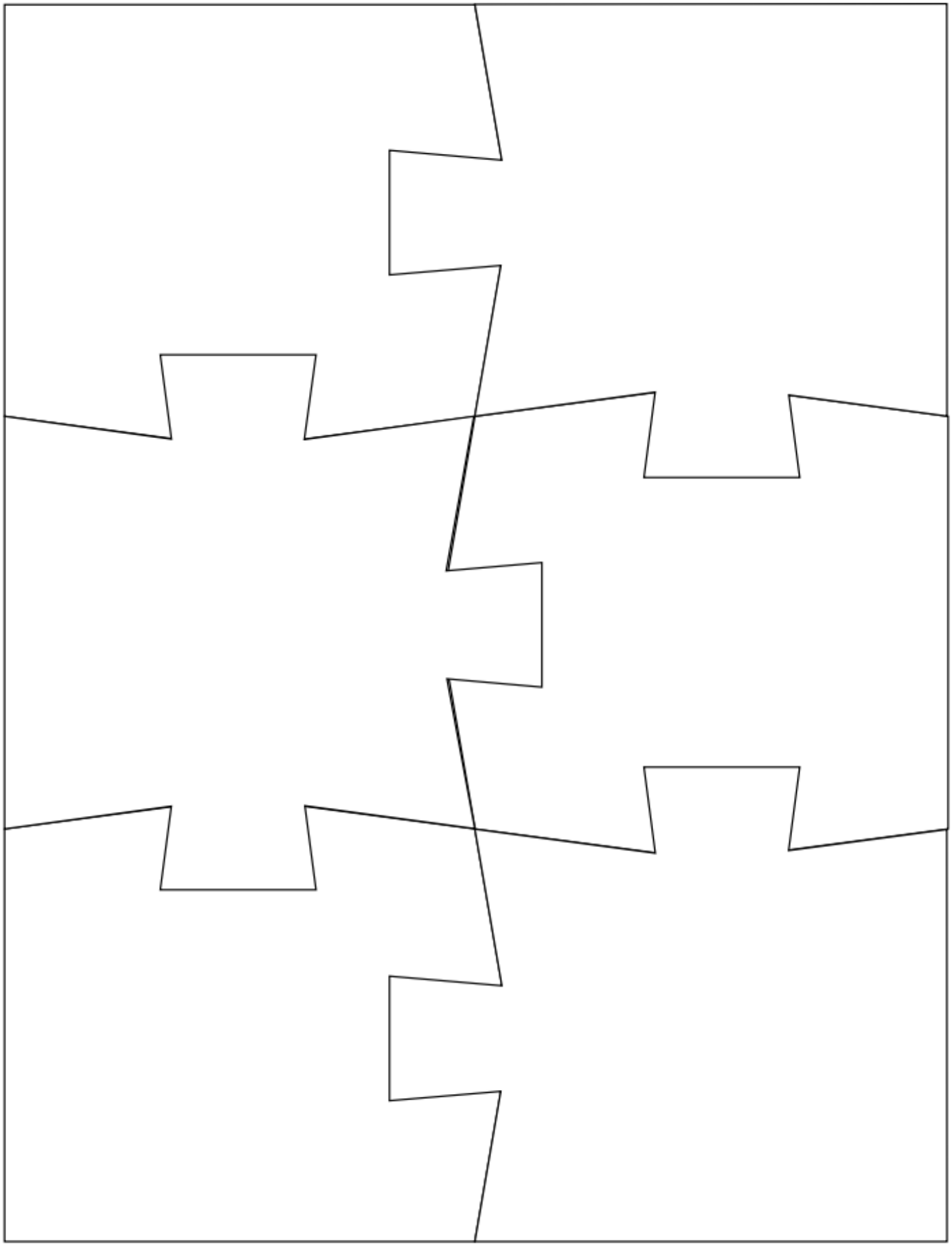
## Evaluation

Students will draw the different components of soil and explain their drawings to demonstrate understanding that soil includes living, once-living, and non-living matter. Students will also be able to make a connection between healthy soils, healthy plants and healthy people. A rubric is provided to assist in assessing student proficiency in these concepts.

## Extension

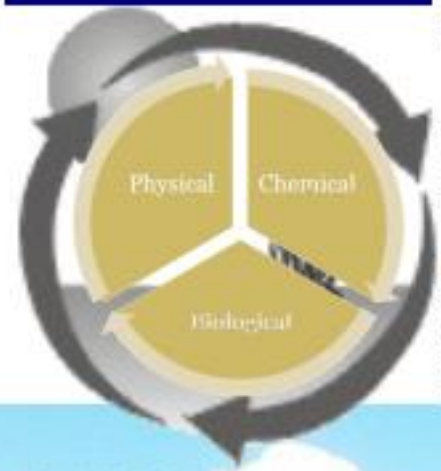
Turn composting into a project-based learning experience by continuing related activities throughout the school year and challenging students to think of ways they can compare different types of composting, or compare the growth of vegetables in different soils.

Do the Rot Thing composting lessons and activities
http://highfieldscomposting.org/sites/default/files/files/resources/do_the_rot_thing.pdf



# Soil Health is:

The Capacity of a Soil to Function




**Physical Properties:**
- Physical support of plants
- Aeration
- Soil water storage and movement
- Resistance to Soil Erosion
- Physical root proliferation and organism movement

**Chemical Properties:**
- Nutrient storage and release
- Soil reactions
- Energy (Carbon) storage

**Biological Properties:**
- Pest suppression
- Nitrogen mineralization
- Organic matter decomposition
- Support of microbial community

# Healthy Soil = Healthy Plants = Healthy People

### *6 Main Principles to Achieve a Balanced Soil*

1. Keep the Soil Covered by having a plant growing the year round (plant cover crops)
2. Grow as Many Different Species of Plants as practical (diversify crop rotation and cover crops)
3. Manage Plant Residues (avoid burning)
4. Mange for Active Biological Functions below the soil (count the earthworms: at least 10 per cubic foot)
5. Disturb the Soil as Little as possible (avoid excessive tillage)
6. Limit Physical, Chemical and Biological Disturbances (tillage, chemical fertilizer, pesticides, overgrazing)

### *6 Rules for Biological Farming*

1. **Test and Balance Your Soil**—test for phosphorus, potassium, calcium, magnesium, sulfur, zinc, manganese, iron, copper and boron. Adjust calcium first.
2. **Use Fertilizers Which Are Life-Promoting and Non-Harmful**—use natural, mined fertilizers and small amounts of the highest quality manufactured fertilizers
3. **Use Pesticides and Herbicides in Minimum Amounts and Only when Absolutely Necessary**—try non-toxic methods first, if they fail and if crop damage is above the economic threshold, toxic chemicals might be considered. Try reducing the concentration, banding or spot-spraying and adding humic acid to the tank to balance the pH of the tank mix
4. **Use a Balanced Crop Rotation**—rotate crops regularly and incorporate diverse species of cover crops
5. **Use Tillage to Control Decay of Organic Materials and to Control Soil, Air and Water**—till raw organic matter (plant residues and animal manures) into the upper layer of the soil. Avoid inverting (turning over) the soil, but rather use equipment that slices and uplifts it. Never till soil that is wet. Consider tillage radishes to break-up a hardpan.
6. **Feed Soil Life**—adding rock phosphate or a little lime to compost piles will produce a more balanced fertilizer. Incorporate green manure crops, like rye, red clover, Australian field peas, alfalfa or buckwheat. Do not apply heavy applications of manure or raw organic matter (it is better to apply a lighter coat over more acres). Consider biological stimulants like kelp (seaweed), humic acids, enzymes, vitamins and hormones.

NRCS

# Soil Quality
## The Foundation of Air and Water Quality

**"The nation that destroys its soil destroys itself."**
**– Franklin D. Roosevelt**

For more information, see the NRCS Soil Quality web site at: soils.usda.gov/sqi

***6 Components of Soil Quality Management***
1. Enhance Organic Matter
2. Avoid Excessive Tillage
3. Manage Pests and Nutrients Efficiently
4. Prevent Soil Compaction
5. Keep the Ground Covered
6. Diversify Cropping Systems

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To enhance soil organic matter, use:
- Cover crops
- Crop rotations
- Reduced tillage
- Rotational grazing

**Did you know....**

You can get a Soil *Health* Test for not only Chemical, but also Physical and Biological Properties.

*Feed the Soil, Not the Plant*

# Assessment for Sorting out Soils

**Student Name(s):** _____ **Date:** _____

| **Level of Mastery** ⇒ **Benchmark or Performance Measure** ⇓ |  **EMERGING** **Not yet proficient** 1 point |  **COMPETENT** **Partially proficient** **4 points** |  **PROFICIENT** **Mastered tasks @ 80%+ 5 points** | **TOTAL POINTS** |
|---|---|---|---|---|
| **Student can identify soil as being made of non-organic matter (e.g. minerals, bits of rock, water, air) and organic matter (e.g. nutrients, decomposed bits of dead plants and living animals, bugs, insects, larvae, microorganisms, fungi, etc.)** | Student refers to soil as dirt; cannot name any component, and does not include any components s/he can identify in a drawing of soil. | Student drawing of soil shows it is made of different components and student can give one or two examples, but does not characterize soil as having living and non-living components. | Student drawing identifies soil as being composed of living components (organic matter) and non-living components (minerals, water, air); and student can give examples in both categories. | |
| **Student uses descriptive words to characterize soil appearance and texture.** | Student uses non-descriptive words such as “good” or “bad” to describe soil appearance and texture. | Student uses at least one descriptive word to tell how soil looks (e.g. “gray”, “cracked”) and one descriptive word to tell how soil feels (e.g. “slippery”, “rough”, etc) | Student uses 4 or more descriptive words to describe appearance and texture of different soils. | |
| **Student can explain the connection between healthy garden soils and healthy people**. | Student knows there is a connection between soils, plants and people but cannot define what makes soil healthy nor explain the connections among soils, plants, and human health. | Student can explain that healthy soils include organic matter which provides nutrients for plants. Healthy soils do not have pollutants. Plants grown in healthy soils are usually healthy. | Student can explain info in box to left AND can explain that since people eat plants (or people eat animals that eat plants), it is healthy for people to eat plants grown in healthy soils. | |
| **Student explains that garden soils can be improved (made healthier) by the way people garden (farm).** | Student explains that composting or garden (farming) practices can affect soil health but cannot give or show example. | Student identifies making or adding compost to the soil as a way of improving soil health but cannot explain how it works. | Student demonstrates making or adding compost to the soil and explains that compost (rotted organic matter such as leftover veggies from lunch) adds nutrients to the soil. | |