

Soil nutrient testing

Focus questions	What nutrients are found in soil? What effects do the nutrients in soil have on plants?
Learning target	Students will test soil samples for nutrients and pH. Students will connect soil nutrients to plant health.
Vocabulary	pH, phosphorus, nitrogen, potassium

MS-ESS3 Earth and Human Activity

Performance expectation MS-ESS3-1	Classroom connection: This lesson works in tandem with Lesson 2; however, the explanation for soil nutrients is not solely determined by a geologic event, but more likely by human intervention.
---	--

Science and engineering practices

Constructing Explanations and Designing Solutions	Classroom connection: Students test soil samples for pH, nitrogen (N), phosphorus (P) and potassium (K). Classroom connection: Students research the effects of pH, nitrogen, phosphorus, and potassium on plants in soil.
Analyzing and Interpreting Data	Classroom connection: Students determine ways that pH, N, P, and K can be adjusted in soil.

Disciplinary core ideas

ESS3.A: Natural Resources	Classroom connection: Humans have used soil resources to increase the production of food. Technological advances allow nutrient levels in soils to be manipulated to meet the demand for higher yields.
ESS3.C: Human Impacts on Earth Systems	Classroom connection: Human activities have impacted soils. The amount of soil nutrients are affected by the crops/plants that grow in them; the soil structure is affected by tillage or cultivation; the soil microbiome is affected by the amount of disturbance to the soil as well.

Cross-cutting concepts

Cause and Effect	Classroom connection: Students can attempt to amend soils to see the effects of the changes.
-------------------------	---

Background

The three major nutrients found in soil are nitrogen (N), phosphorus (P), and potassium (K). N and P usually occur in the form of compounds (Nitrate and Phosphate) while K is generally available in soil solution only. pH can play an important role in soils as it controls nutrient uptake by roots. If the soil is too acidic, other ions can leach out of the soil and create additional problems with run off.

Soil is best conserved when covered or anchored with plant roots. Loose soil can be easily eroded by wind, rain, ice and snow. When soil erodes, it may enter into waterways, carrying nutrients with it that can impact the health of streams.

Organic matter in soils can vary greatly. Generally, the darker the soil, the more organic matter found in the soil. "Properties influenced by organic matter include: soil structure; moisture-holding capacity; diversity and activity of soil organisms, both those that are beneficial and harmful to crop production; and nutrient availability. It also influences the effects of chemical amendments, fertilizers, pesticides and herbicides." (FAO) Large amounts of organic matter may indicate that there are naturally occurring decomposers that will cycle nutrients through the soil.

Humans have made use of soils in order to efficiently plant and raise crops for food, not just for people, but animals as well. In the hundreds of years humans have farmed, there have been many developments in technology. Most farmers have soils on their farms tested following a grid pattern, every 2.5 to 5 acres, and based on the results, they will apply only the inputs of fertilizer that the soils need.

Prior knowledge

Students need to know the three major nutrients found in soil are nitrogen (N), phosphorus (P), and potassium (K). Students may compare organic matter (colors) in their soil samples.

Materials

- 100 ml of soil
- Soil sieve or wire mesh colander
- LaMotte complete soil test kit

Teacher preparation

This lesson will take place over two days if you ask students to prepare the samples. The samples collected for the soil texture activity (lesson 1) are appropriate to use for this activity. If the soils were left to dry after the texture activity, Day 1 should be spent having students move their samples through a wire screen sieve or mesh colander, being sure to break up the soil particles for testing in the small test tubes that come with the Lamotte kits. Re-mix all soil particles from the samples, not just the smallest particles.

If samples are collected specifically for this activity, it will take 12–24 hours for soils to be dry enough to use for testing nutrients. Do not bake samples to accelerate drying. This will remove the organic matter and potentially change the nutrient levels in the samples.

Students will test their soil sample and make recommendations to amend the soil to grow a specific crop.

Provide information on reading a fertilizer label and the differences between compost, manure, and synthetic fertilizer for students to compare each source. See:

- ag.umass.edu/crops-dairy-livestock-equine/fact-sheets/plant-nutrients-from-manure
- thespruce.com/how-to-make-sense-of-a-fertilizer-label-1402466
- youtu.be/EWPNm2DNdSw

Refer to **Comparing fertilizer types** lesson for additional information about fertilizer sources and use.

Student handout

Reflection

1. Choose a crop or plant that you would like to plant. Research the best growing conditions for that crop/plant. What soil amendments may need to be added to make your soil fit for that crop/plant?

Answers will vary depending on their soil tests.

2. What form of nutrients would you add? (compost, manure, synthetic fertilizer) Which is better? Use evidence to support your answer.

Again, answers will vary depending on their soil tests.

3. How might you change the pH of your soil, if needed?

Adding lime or calcium carbonate will increase the pH and make soil more basic; adding sphagnum peat or peat moss, will make the soil more acidic.

Rubric for self-assessment

Skill	Yes	No	Unsure
I measured the amounts of all soil nutrients.			
I was able to determine the needs of a specific plant and make recommendations for amending the soil nutrients to help it grow.			

Differentiation

Other ways to connect with students with various needs:

- **Local community:**
 - Students may investigate the soil types for their local community by visiting websoilsurvey.nrcs.usda.gov/app and comparing the nutrient levels in various locations. Determine if there is a pattern when comparing soil textures and amounts of nutrients.
 - Watch this video on 4R Nutrient Stewardship (youtu.be/1ftF5eBYA7k) that helps explain choices for nutrient management.
- **Students with special needs (language/reading/auditory/visual):** Students can be paired for the activity to allow for team choice of plant to investigate and methods to be followed for amending soil.
- **Extra support:** Watch this video on how farmers can adjust nutrient use efficiency: youtu.be/BFBVd0oJh8g.
- **Extensions:** Ask students to research how to adjust the pH of soil and the impact of soil pH on nutrient uptake by plant roots. In addition, students may want to research which plants/crops are best suited for growing in the climate with the soil nutrients found.

Assessments

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Construct an explanation for the differences in soil nutrients found in different locations.	Student can construct an explanation for the difference in soil nutrients only related to location.	Student can construct an explanation for the difference in soil nutrients related to past geologic events and human impact.	Student can construct an explanation for the difference in soil nutrients related to past geologic events and human impacts specific to the locations of the samples.
Research for specific plant/crop	Student chose a crop/plant, but did not determine what soil amendments would be necessary to his/her sample to grow it.	Student chose a crop/plant, researched the needs of the plant, and was able to make recommendations about soil amendments needed for it to grow.	Student chose a crop/plant, researched the needs of the plant, and was able to make recommendations about soil amendments needed for it to grow in amounts specific to an area where it might grow (amount in lbs/acre).

Rubric for self-assessment

Skill	Yes	No	Unsure
I measured the amounts of all soil nutrients.			
I was able to determine the needs of a specific plant and make recommendations for amending the soil nutrients to help it grow.			