Soil Sampling Lab

Introduction

The three major soil-related problems are erosion, nutrient depletion, and changes in soil pH. Solutions to these problems include changing farming practices, conditioning soils, and preventing erosion and pollution. Many jobs exist to deal with these problems.

One factor that determines a soil's ability to hold water and resist erosion is soil texture. Soil texture refers to the ratio of different-sized mineral particles in the soil. Based on size, mineral particles are referred to as clay, silt, or sand. Clay particles are small and electrically charged and attract and hold water molecules. Thus, it is important that soils used to grow crops have some clay content. Clay also helps make soil resistant to erosion. Like clay, silt particles are also small enough to hold water in the soil. But exposed silt washes away easily, taking nutrients with it. A soil with too much sand content allows water to pass through very quickly and does not hold enough moisture to support most plants. Exposed sandy soils may be subject to erosion if the angle of the land, the slope, is too severe.

In this lab, you will conduct tests that evaluate the texture and chemical composition of soils. Two of the tests used to help determine the texture of a soil sample are based on the fact that the rate at which soil particles settle out of a liquid depends on their size. Larger particles settle faster than smaller particles. Other textural tests are based on the behavior of a soil sample in a simple hand test. Chemical analysis of soil samples will be conducted using a standard commercial soil test kit. The most common elements tested for in soil are the three primary plant nutrients (N, P, and K) usually present in the soil. Most standard soil test kits also test the soil's pH.

Materials

Materials are listed before the procedures for each of the experiments.

Safety

- General lab safety procedures should be followed.
- Students should wear lab aprons and protective eye-wear as instructed.
- Take care in handling corrosive reagents.

Chemical Analysis Safety Precautions

- DO NOT point stoppered test tubes toward anyone. The solutions in the test tubes may be under pressure and blow the stoppers off.
- If vigorous bubbling occurs in the test solution, loosen the stopper slightly to release pressure.

Preparation
Be sure that cleanup instructions are well understood before beginning any of the test procedures.

- Remember not to pour any water containing soil directly down the drain.
- Dump any soil left in test tubes or collection containers into a paper towel for appropriate disposal.
- Rinse test tubes until all soil particles are removed, always pour the rinse water through a newspaper funnel into a collection container to sift out the soil.
- Wash all glassware in soapy water—then rinse, air dry, and store in proper places.

Experimental Procedures

Collecting Soil Samples

1. Identify and locate the assigned site where the soil sample will be collected. Be sure to obtain the permission necessary to collect samples.
2. Dig a one foot by one foot hole, observe the profile, and collect the needed samples (approximately one gallon-sized plastic zip bag full).
3. Be sure to backfill holes so that they do not pose as a hazard (tripping, etc.)
4. It is important to find good soils to sample. Be sure to collect from mature soils and not fill material.
5. Label the sample with the following information:
    a. Students' names
    b. Collection date
    c. Collection site
6. Record collection site features in the Data Collection Form:
    a. Slope
    b. Amount and type of vegetation
    c. Moisture level
    d. Temperature
    e. Current land use

Munsell Soil Chart Identification

1. Follow the directions in the Munsell Soil Chart notebook.
2. Using the charts, identify the hue, value, and chroma of the soil sample.

*Note: Munsell charts are intended for use with moist samples in natural sunlight.

Weighing and Drying Samples

1. Students will need to prepare about 300 g of dried sample soil for some of the experiments. Be sure to weigh soil samples before drying to obtain percent moisture data.

2. Fill a paper bag or small aluminum tray with a pre-weighed amount of the soil sample. Be sure to record the weight of the sample.
3. Samples can be air-dried by being spread out onto a clean surface with good ventilation or the samples can be placed in a drying oven (the heat should not be higher than 104°F).
4. After samples have been dried, the oven dry weight should be calculated for use in later experiments. Record this data in the Data Collection Form.

Analyzing Soil Chemistry – Using a Test Kit to Determine NPK and pH

Materials and Equipment Needed

Soil sample

Safety goggles

Soil test kit

Lab apron

Paper towels

Dropper

Spatula or small spoon

Newspaper

Procedures

*Note: Usually a 1:1 soil-water solution is used for tests in a commercial soil test kit.

1. Wear goggles and lab apron while conducting these procedures.
2. Locate and review the instruction booklet provided inside the soil test kit.
3. In the booklet, find the procedures for the following four tests:
    - pH test
    - Nitrogen test
    - Phosphorus test
    - Potash (potassium) test
4. For each of the four tests, follow your soil test kit's instructions.
5. Be sure to record your observations in the Data Collection Form.
6. When all tests have been completed, return the reagents, test tubes, and associated equipment to the soil test kit as instructed by the instructor.

Analyzing Soil Chemistry – Measuring Soil pH using a pH Meter and pH Paper

Materials and Equipment Needed

Soil sample

Safety goggles

Lab apron

Spatula or small spoon

Newspaper

pH meter with appropriate electrode(s)
pH paper testing strips
Pipettes
Graduated cylinder
Balance
Paper cups or equivalent
Distilled water

Procedures
*Note: Usually a 1:1 soil-water solution is used for soil pH testing.

1. Be sure the pH meter is appropriately calibrated and rinsed clean before each use.
2. Measure a 5 g sample of soil into a paper cup.
3. Add 5 mL of distilled water to the sample in the cup.
4. Stir the sample thoroughly, then let it sit for 10 to 15 minutes.
5. Place the pH test strip into the mixture.
6. Record the pH of the mixture in the Data Collection Form.
7. Place the pH meter electrodes into the mixture.
8. Record the pH of the mixture in the Data Collection Form.
9. Be sure to rinse the pH meter once the experiment is completed.

Analyzing Soil Texture - Sieve Test

Materials and Equipment Needed
Balance
Weighing paper
Soil sieves
Dry soil samples

Procedures
1. Weigh out 100g of your soil sample using a balance.
2. Place your soil sample into sieve number 1 and shake it into sieve number 2 for two minutes.
3. Find the mass of whatever soil is left in sieve number 1 using a balance. Record the mass on the Data Collection Form as mass of sand particles (be sure that you have accounted for the weight of the weighing paper in your calculations).
4. Shake sieve number 2 into sieve number 3 for two minutes.
5. Find the mass of whatever soil is left in sieve number 2 using a balance. Record the mass on the Data Collection Form as mass of silt particles (be sure that you have accounted for the weight of the weighing paper in your calculations).
6. Find the mass of whatever soil is left in sieve number 3 using a balance. Record the mass on the Data Collection Form as mass of clay particles (be sure that you have accounted for the weight of the weighing paper in your calculations).

7. Complete the calculations as directed in the Data Collection Form.

Analyzing Soil Texture – Settle Test

Materials and Equipment Needed

Graduated half-pint bottle with cap
Distilled water
Soil sample
Newspapers
Large funnel
Spatula or spoon
Cardboard
Gallon sized plastic zip bags

Procedures

1. Be sure the soil sample has been crumbled to small pieces, breaking up any large clods.
2. Spoon enough loose soil from the sample to fill the graduated bottle half full.
3. Fill the bottle almost to the top with distilled water.
4. Cap the bottle and shake it.
5. When the sample is well mixed, place the bottle upright on the lab table.
6. Describe the appearance of the soil sample in the Data Collection Form.
7. Allow the mixture in your half-pint bottle to settle until distinct layers of soil have formed beneath the water.
8. Measure the layers of soil using the graduated marks on your half-pint bottle.
9. Perform the calculations as directed below and record the data in the Data Collection Form.
   a. Using the formula below, calculate the % of each type of soil (sand, silt, clay) in the soil column of your half-pint bottle.

$$\%\ \text{type of soil} = \frac{\text{Depth of type of soil layer in mm}}{\text{Total depth of soil in mm}} \times 100\%$$

   b. Using the percentages calculated in the previous step, use the soil triangle handout to determine the soil type for your sample as follows:
      i. Find each % on the proper axis of the soil triangle.
      ii. Follow the dotted lines from each % to the point where they intersect inside the soil triangle.
      iii. Identify your soil type by identifying the region of the soil triangle that contains the point of intersection. (For example, for a soil with 50% sand, 30% silt, and 20% clay, the three dotted lines intersect inside the region marked “loam.”)
      iv. If the dotted lines intersect on the boundary between two regions, assign the soil type of the graph region of greater area.

v. Record the result in the Data Collection Form.

Analyzing Soil Texture – Textural Analysis Using a Hydrometer

Materials and Equipment Needed

Soil sample

2mm soil sieve

250 mL glass beaker

Glass sedimentation settling cylinder

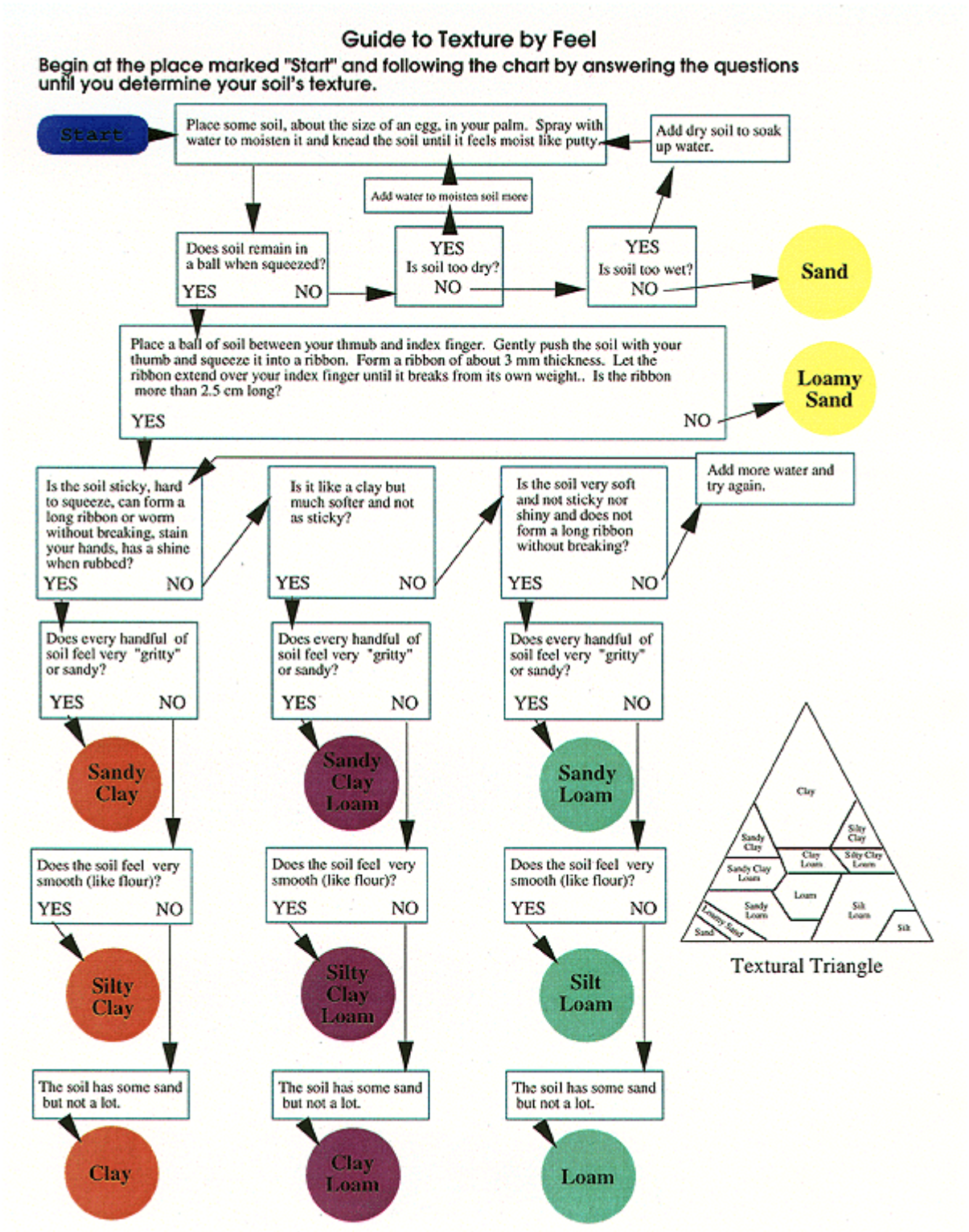
Hydrometer

Distilled water

Procedures

1. Pass the soil through a 2 mm sieve.
2. Weigh out 100g of the collected dried soil into a 250-mL glass beaker.
3. Add 20 mL of 5% sodium hexametaphosphate (a.k.a. Calgon) solution and stir thoroughly.
4. Transfer the entire mixture into a settling cylinder.
5. Fill the cylinder to the 1000-mL mark with distilled water.
6. Stopper the settling cylinder with a rubber stopper and thoroughly mix the contents by inverting it several times while shaking.
7. Set the cylinder down and quickly but gently place the hydrometer in the mixture and record the first hydrometer measurement in 40 seconds.
8. Record the hydrometer value in the Data Collection Form.
9. Place the thermometer in the mixture and record the temperature in the Data Collection Table.
10. Wait for two hours and record a second hydrometer and temperature reading.
11. Record the data in the Data collection Form
12. Calculate the percentages of sand, silt, and clay in the sample as described in the Data Collection Form.

Analyzing Soil Texture - Textural Analysis Using the "Texture by Feel" Test



Soil Science Education Home Page - NASA's Goddard Space Flight Center http://soil.gsfc.nasa.gov/index.html

Data Collection Form

Collecting Soil Samples

Collection site features:

Slope: _____

Amount and type of vegetation: _____

Moisture level: _____

Temperature: _____

Current land use: _____

Munsell Soil Chart Identification

Hue: _____

Value: _____

Chroma: _____

Weighing and Drying Samples

Percent Moisture Data:

_____

_____

_____

_____

Analyzing Soil Chemistry – Using a Test Kit to Determine NPK and pH

pH test: _____

Nutrient Concentration Tests

Nitrogen test _____ppm _____%

Phosphorus test _____ppm _____%

Potash test _____ppm _____%

Analyzing Soil Chemistry – Measuring Soil pH using a pH Meter and pH Paper

pH of sample using test strips _____

pH of sample using pH meter _____

Analyzing Soil Texture - Sieve Test

Total mass of sample: 100 g

Mass of sand particles _____ g

Mass of silt particles _____ g

Mass of clay particles _____ g

Calculations

Percent of Sand

Mass of sand divided by total mass times 100 = % Sand.

Percent Sand = _____ %

Percent of Silt

Mass of silt divided by total mass times 100 = % Silt.

Percent Silt = _____ %

Percent of Clay

Mass of clay divided by total mass times 100 = % Clay.

Percent Clay = _____ %

With the data above, use the "Soil Texture Triangle" Chart to determine the texture of your soil sample. _____

Analyzing Soil Texture – Settle Test

Appearance of sample:

_____

_____

_____

_____

_____

Calculations

Percent sand in sample: _____

Percent silt in sample: _____

Percent clay in sample: _____

Determination of soil type using "Soil Texture Triangle" Chart: _____

Analyzing Soil Texture – Textural Analysis Using a Hydrometer

Sample Weight _____		
	40 Seconds	2 hours
Hydrometer Reading		
Temperature		
Corrected Hydrometer Reading		
% sand: _____		
% silt: _____		
% clay: _____		

Calculations

For corrected hydrometer readings (temperature correction) use the following guidelines:

For each degree above 68°F add 0.2 g/L to hydrometer reading.
For each degree below 68°F subtract 0.2 g/L from hydrometer reading.

Using the temperature corrected hydrometer readings and the oven dry weight of the soil sample, calculate the percent sand, silt and clay.

Calculation A) Grams of sand = oven dry wt. - corrected 40 sec. reading.
Calculation B) Grams of silt + clay = corrected 40 sec. reading.
Calculation C) Grams of clay = corrected 2 hr. reading.
Calculation D) Grams of silt = corrected 40 sec. reading - corrected 2 hr. reading.

To determine the percent of soil separates, use the formulas below

% sand = (Calculation A/oven dry wt.) x 100
% silt = (Calculation B/oven dry wt.) x 100
% clay = (Calculation C/oven dry wt. x 100

With the above data, use the “Soil Texture Triangle” Chart to determine the texture of your soil sample: _____

Analyzing Soil Texture - Textural Analysis Using the “Texture by Feel” Test

Determination of sample type: _____

Soil Texture Triangle Chart

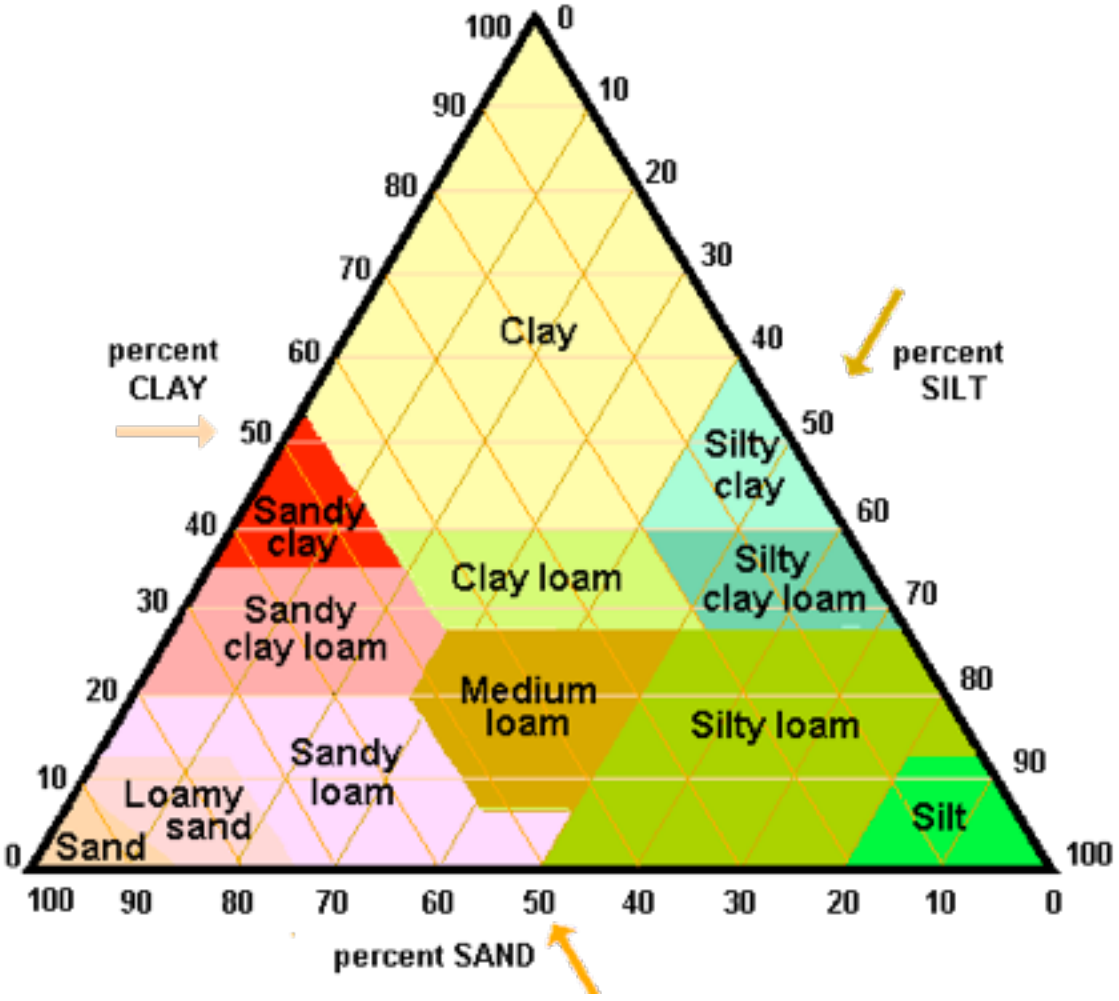


Image courtesy of The Idaho Association of Soil Conservation Districts and OnePlan.org