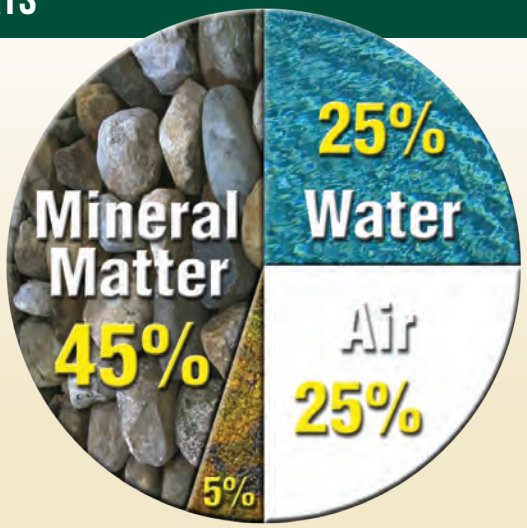
SOIL

USES: agriculture, construction, art, filtrating and purifying water, landfills

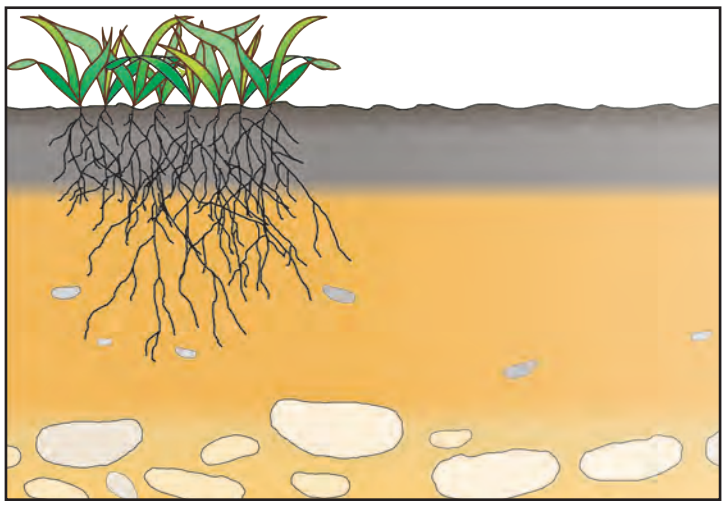
WHAT IS SOIL AND WHY IS SOIL IMPORTANT?

One of Earth's most important natural resources is soil. There are many different soil types. It takes, on average, 500 years to form one inch of topsoil. Although soil takes a long time to form, it can be destroyed very easily. Most life on Earth depends upon the soil for food. Plants are rooted in the soil and get nutrients (nourishing substances) from it. Animals also get nutrients from eating the plants that grow in the soil. Soil is home to many organisms such as seeds, spores, insects, and worms. We build sidewalks, roadways, and homes on the soil. Soils also help filter out pollutants that could contaminate our drinking water. Everyone must take an active role in improving and preserving our Earth's soil.

SOIL PARTS



About one-half of soil is made up of pores full of air and water. Roots need oxygen from the air, and they need water because plants are made of mostly water. The other half is minerals and organic matter (humus). Minerals and some of the nutrients in the humus dissolve in the water so plants can absorb them.



VOCABULARY

CLAY SOIL: has mostly clay, some organic matter, silt, and a little sand. Clay particles are very fine and are the smallest of the three types of soil particles. Clay is sticky when wet and hard like bricks when dry.

CROP ROTATION: the system of growing a sequence of different crops on the same ground so as to maintain or increase its fertility, to avoid depleting the soil, and to control weeds, diseases and pests.

EROSION: the process by which the surface of the earth is worn away by the action of water, glaciers, winds, waves, etc.

GREEN MANURING: the sowing, growing, and plowing down of some vegetable crops while they are still green (living and growing) to benefit or improve the soil.

PARENT MATERIAL: this is the bottom layer, about three feet below the surface in the Midwest. It is more compact and often has stones and rocks in it.

SANDY SOIL: soil is made up of mostly sand. Sandy soil feels gritty and allows water and air to move through it.

SILT: feels like flour when dry and is very smooth and soft when moist. Silt particles keep the soil softer and easier to plow than soils with too much clay.

SUBSOIL LAYER: this layer is about one foot below the surface. Deeper tree roots and earthworms live here.

TOPSOIL: here is where the plants grow. Wind or water erosion can wash away this valuable layer if farmers don't protect it. Most nutrients, organisms, and roots are in this layer.

STATE SOILS

Bama, Stuttgart, Windsor, Hilo, Drummer, Miami, Tama, Hazleton, Antigo

THE GREAT ICE AGE IS IMPORTANT TO AGRICULTURE

The Great Ice Age began approximately 1.6 million years ago during the Pleistocene Epoch. Mountain glaciers formed on all continents, the icecaps of Antarctica and Greenland were larger and thicker than today, and massive glaciers spread across northern North America and Eurasia. The last major ice sheet to spread across the North Central United States reached its maximum extent about 20,000 years ago, and lingered in Canada until about 6,000 years ago, when it finally melted. Mountain glaciers are the only remnants of the massive glaciers on the mainland of North America.

Glaciers formed when the climate grew colder and snowfall did not melt during the summer, but continued to accumulate and crystalize into ice. In Canada, an ice layer became up to 8,000 feet thick. Under this heavy weight, the ice began to flow outward. As glaciers advanced, they picked up rocks and boulders in their path, ground them up, and pushed them down to the front edge of the ice as it moved forward. The glaciers eventually melted when the climate became warm. The ice front receded leaving, on average, a 100-foot thick layer of sediment. As the ice sheet melted and receded, this sediment of clay, sand, gravel, pebbles, and rocks was dropped and packed down over the bedrock. This is called till, which is material directly deposited and covered by series of glacial ice sheets. The till was compressed into a heavy, but not rock-like consistency. Another type of deposit is called outwash. As the glaciers melted, the water formed streams that flowed away from the face of the ice. The streams carried debris with their current. The heavier debris, such as gravel or sand, sank to the bed of the stream very near the edge of the glacier. The lightweight debris, such as silt and clay, floated further downstream. The glaciers eventually flattened the land and left behind rich deposits that became the soils on which farmers have grown their crops for thousands of years.

SOIL HISTORY TIMELINE:

THE GREAT ICE AGE — Began approximately 1.6 million years ago during the Pleistocene Epoch. The last major ice sheet to spread across the North Central United States reached its maximum extent about 20,000 years ago, and lingered in Canada until about 6,000 years ago, when it finally melted.

450-350 BC — The discovery of green manuring crops is credited to Greek historian Xenophon.

1700s — Charles Townshend, a Whig politician under George I, is responsible for introducing to England the four-field crop rotation method, later known as the Norfolk Crop Rotation System. Wheat, clover, barley and turnips were grown in succession. The clover and turnips renewed the soil when grown after the wheat and barley. Both were also used as fodder crops for animals to graze, thus adding manure to the land which helped fertilize the soil. He was often known as Turnip Townshend because of his strong interest in farming turnips and his role in the British agricultural revolution.

1730s — Jethro Tull, an English agricultural pioneer, proves the value in cultivating soil, allowing the air and nutrients to reach the roots of plants.

1802 — Incan tradition of enriching soil with bat guano is rediscovered and practiced.

1843 — Sir John Lawes, an English entrepreneur and agricultural scientist, founded the commercial fertilizer industry by developing a process for making superphosphate.

1876 — The Morrow Plots were established at the Illinois Industrial University (now known as the University of Illinois). The Morrow Plots are the oldest agronomic experiment fields in the United States and the second oldest in the world. They include the longest-term continuous corn plot in the world. The experiments carried out at the Morrow Plots show the benefits of crop rotation to soil fertility.

1918 — Fritz Haber, a German chemist, wins the Nobel Peace Prize for his development of the Haber process. The Haber process was the first perfected method of capturing nitrogen from the air and using it to develop synthetic fertilizers.

1931 — A drought begins and the poorly-conserved soil of the Southern Midwest becomes loose and begins to blow. The region becomes known as the Dust Bowl.

1934 — Worst drought in U.S. history causes dense dust storms, also called “black blizzards,” across 27 states.

1935 — The worst of the dust storms takes place on April 14 which came to be known as “Black Sunday.”

1935 — To better protect land from damage, the Soil Conservation Service is created and promotes soil-conserving practices like crop rotation, strip cropping, and terracing.

1939 — The Dust Bowl drought comes to an end.

1946 —The National Association of Conservation Districts is established.

1960s — Sulfur coated fertilizer is developed to slowly release nutrients into the soil over time.

2000 — Phosphate fertilizer reaches new heights as an estimated 40 million tons are used world-wide.

2010s — Half the people on Earth are fed as a result of synthetic, Nitrogen-rich fertilizer.

SOIL

CAREERS: Education, Research, Mapping, Conservationist, Environmental Consulting, Agronomist, Field & Lab Technician, Soil Scientist

SOIL QUOTES

"A Nation that destroys its soil, destroys itself."
— Franklin D. Roosevelt, 1937

"We know more about the movement of celestial bodies than about the soil underfoot. — Leonardo DaVinci, 1500s

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"We are part of the earth and it is part of us….
What befalls earth befalls all the sons of the earth."
— Chief Seattle, 1854

"The soil is the source of life, creativity, culture and real independence." — David Ben Gurion, Hazon VeDerek, 1950's

SPOTLIGHT ON CAREERS:

SOIL SCIENTIST — Soil Scientists map and classify soils and provide interpretations for land planners and managers. They conduct research on soil degradation or erosion, or on movement of substances such as nutrients and pesticides through the soil profile. Sometimes they identify problems such as wetness and erosion that limit soil use. Often, they write soil descriptions and prepare maps and information about soils. Universities, private industries, USDA agencies, chemical companies, state and county governments, and environmental consulting firms all hire soil scientists. To be a soil scientist, you need a college degree in soil science or a related biological, physical, or earth science. People who become soil scientists usually like working outdoors and studying the sciences, especially physics, chemistry, geology, environmental science, and biology. In high school, take college preparatory courses in physics, biology, mathematics, and chemistry. Communications courses are also helpful. Take courses in earth science, environmental science, agriculture, or geology if they are offered. Try to get practical experience in these areas.

AGRONOMIST — Agronomists deal with interactions among plants, soils, and the environment. They use sophisticated research tools and techniques to develop new crop hybrids and varieties that grow more efficiently and are more beneficial to society. Soil specialists conduct research in everything from the very basic to applied issues of soil and water management and land use. Agronomists research ways to produce crops and turf, and ways to manage soils in the most environmentally friendly way. Agronomists can be found teaching, conducting business, and doing research in food production and environmentally oriented industries around the world. Agronomists work for USDA, State Departments of Agriculture, the Natural Resources Conservation Service, and as agriculturists in foreign countries. They work for banks, farm co-ops, seed, ag supply and lawn care companies, and government agencies. Agronomists are also employed as weather forecasters, environmentalists, researchers, and teachers. To be an agronomist, you should have an interest in science and environmental issues. A bachelor's degree is necessary. In college, you should enroll in agriculture, biology, chemistry, mathematics, physics, and statistics courses, as well as broad-based general education courses, including English and speech. You should enjoy working with people and should have an interest in applying science to practical feed and food production issues. The high school college preparatory curriculum that includes biology, chemistry, physics, and mathematics will provide an excellent background. English, speech, and foreign language will strengthen your communication skills.

FACTS ABOUT SOIL

- There are more microorganisms in a handful of soil than there are people on Earth.
- Soil acts as a filter for underground water, filtering out pollutants.
- Approximately 10% of the world's carbon dioxide emissions are stored in soil.
- Soil provides all nutrients required for successful plant growth.
- The amount of sand, clay and silt is what gives different soil types their various textures. Most soils are a mix of all three.
- Soil is a living system.
- Soil has 6 layers called horizons (O, A, E, B, C and R). Horizon O is the topsoil and R is bedrock.
- Worms enrich topsoil by feeding on organic material in the soil and converting it into nutrients for plants. As they move through the soil, it becomes more absorbent and better aerated, too.
- Soil is at the bottom of the food chain, yet it is the cornerstone of life on Earth.

SCIENCE AT HOME

SOIL SLURRY

Materials Needed:

2 quart jars with lids

Masking tape, to label jars

Dishwashing liquid

Plastic rulers

Dry soil sample from garden, flowerbed or field

Soil sample from roadside, gravel pit or housing development, completely dry

** Samples for Soil Slurry are taken from the topsoil. Topsoil is the upper, outermost layer of soil, usually the top 2 to 8 inches. It has the highest concentration of organic matter and microorganisms and is where most of Earth's biological soil activity occurs.*

Directions:

1. Make sure that all dried soil clumps are crushed and that any rocks, roots and litter are removed from the samples.
2. Label the two jars using the masking tape.
3. Fill the first jar ¼ full of soil sample A.
4. Fill the second jar ¼ full of soil sample B.
5. Add water to the jars until they are about ½ full.
6. Add 1 teaspoon of dishwashing liquid to each jar.
7. Making sure the lids are on securely, shake them hard for about 3 minutes. Continue shaking until the particles have separated from each other.
8. Set the jars on a table. Observe them closely for 5 minutes. (The sand should settle to the bottom in approximately 1 minute.) Measure any layers and record the data.
9. Observe the jars again after 30 minutes, 24 hours, and 48 hours. Measure any layers and record the data.
10. The final sample should have a layer of sand on bottom, followed by silt, with clay at the top. Any floating material should be considered organic matter.

FERTILIZERS HELP PLANTS GROW:

Fertilizers are like vitamins for plants. They add different nutrients to the soil that plants need to grow stronger and healthier. The three most important nutrients needed for plant growth are nitrogen, phosphorus and potassium (NPK). Farmers typically add one or more of these as fertilizers to grow healthy food crops for us.

Nitrogen – Nitrogen is found in the air and soil. Many crops use nitrogen so fast that farmers and gardeners have to add more to the ground. One way farmers add nitrogen to the soil is to plant different crops, at different times, in the same field. A farmer will grow corn in the field one year and plant soybeans in that field the next year. This is called crop rotation. Growing corn takes nitrogen out of the soil, but growing soybeans puts nitrogen back into the soil.

Phosphorus – Phosphorus helps plants store and use energy from the sun to make food for themselves. This process is called photosynthesis. Plants need large amounts of phosphorus as they begin to grow and when the weather turns cold. Phosphorus is made from rock phosphate. Rock phosphate cannot be absorbed by plants, so it is processed to a form that farmers can apply to plants.

Potassium – Potassium helps plants survive droughts, diseases, and very hot and cold temperatures. It also helps plants produce starches, control root growth, and open and close pores for water. Potassium is found in the soil but only a small amount is available to plants. This is why farmers add potassium fertilizer to soil.

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