SOIL ACTIVITIES

Know Your Soil

Soil is the medium for plant growth. Its physical, chemical and biological properties determine the degree of workability, suitability to specific crop varieties, physical and chemical capacities as well as productivity. The physical capacities of a soil are influenced by the size, proportion, arrangement and composition of the soil particles. The physical and biological properties of soils need careful study because they give mechanical support to plants. The ideal soil for agricultural use is loam, which combines good aeration and drainage properties of large particles, with the nutrient-retention ability of clay particles. The soil texture depends upon the percentage of clay, silt and sand particles in the soil. Human hands are sensitive to the different size of soil particles, so we are able to determine some properties by "feeling" the soil.

Subject
Science, Geography

Place
Outdoor

Duration
Field visit (30 minutes)

Group size
Entire class

Materials
Soil sample, water, soil texture chart

Objective

To determine the texture of soil through simple experiments.

Activity

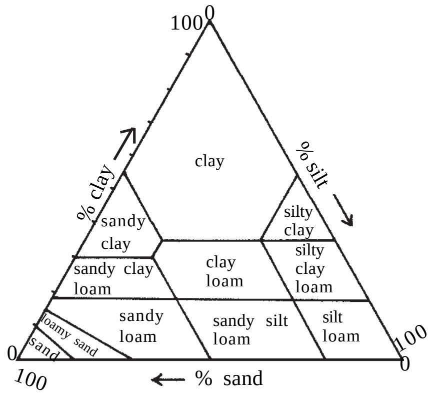
Take the students to a nearby field. Ask them to take a sample of soil and add enough water to moisten it till the moisture glistens on the surface.

Rub between fingers and assess grittiness, smoothness (silkiness) and stickiness. Sand feels gritty and if present in large amounts, makes a rasping sound when particles are rubbed together. In contrast, silt feels silky and smooth, and when dominant it produces a feathery feel. Clay is sticky and plastic (has the capacity to form moulds), and the particles stick to each other as well as to the skin.

Rub the thumb over moist soil to determine whether it leaves a smooth, polished surface. This distinguishes soil with moderate amounts of clay (20 per cent or more)

Try to form a cube with the soil. Cohesive cubes may be formed from soils with about 5 per cent or more of clay.

Soil Texture Chart



Roll the soil into a thread. This is possible if clay is present in significant quantities, usually 15 per cent or more.

Bend the thread into a ring. This is possible if clay is abundant (over 25 per cent), and the higher the clay content, the firmer the ring.

Assign the sample to the appropriate texture class.

Extension/Variation

What are the types of plants and animals found in the soil and general area around your site?

What are the general climatic conditions at your soil site? Is it sunny, shaded, hot, cold, moist, dry?

What is the recent land use in this area? Has it been stable for a long time, or has it been ploughed, its trees cut, constructed upon, or undergone some other disturbance recently?

On an India map with state boundaries, highlight your state. With the help of an atlas find out which type of soil is found in your state. Is your state dominated by black soil, red soil or alluvial soil? Shade appropriate areas with different colours to show the different soils found.

Test the pH

Activity

Soil can be acidic, alkaline or neutral, depending upon its pH value. The pH may be determined using a pH paper. pH influences what can grow in the soil, and is the product of the kind of parent material, the chemical nature of the rain and other water entering the soil, land management practices, and the activities of organisms (plants, animals, fungi, etc.) in the soil. For example, needles from pine trees are high in acids, and as they decay over time, they lower the pH of the soil. Soil pH is an indication of its chemistry and fertility. It is important to know the pH of the soil because it affects the activity of the chemical elements in the soil, and so affects many soil properties. Different plants grow best at different pH values. The pH of the soil may affect the pH of the groundwater or of a nearby water body.

Subject
Science

Place
Indoor or Outdoor

Duration
20 minutes

Group size
Entire class

Materials
Soil sample, water, pH paper booklet (broad range for pH 2-10)

Objective

To determine the pH of soil.

Activity

Ask the students to mix a small amount of soil in water.

Let the particles settle down. Dip a piece of pH paper into the mixture. Do not touch the part of the paper that is being dipped with fingers, as it may lead to an erroneous reading.

Tell them to dry the pH paper.

Ask them to compare the colour that emerges, with that of the pH paper booklet, to determine the pH of the soil.

Observation

A pH value of seven indicates that the soil is neutral; below seven indicates acidic; above seven indicates alkaline soil.

Discussion

Soils contain minerals. Most of the minerals found in the soils are salts—sodium, calcium, magnesium and potassium chlorides, sulphates and carbonates.

Not all salts dissolve in water. When rainwater percolates through soil, it dissolves mineral salts in the soil and washes them downwards through the soil. This process is called leaching. The more solube a substance is, the more easily it is leached. Heavy rainfall causes a lot of leaching. In places where the rainfall is low and where very little leaching happens, salt builds up in soil. Water from the soil surface evaporates, leaving the salt to form a white crust. This is a big problem in dry, arid lands, where rainfall is scanty.

Highly acidic soil retards plant growth by affecting the efficiency with which the plant absorbs nutrients from the soil.

Can you find out ways how to decrease salinity or acidity?

Soil Permeability

Water is essential for plant growth. Plants meet their water requirement from water stored in soil. Soil is capable of being a storehouse of water and is the main source of water for land plants. Soil water plays a significant role in several natural processes—evaporation, infiltration and drainage of water, diffusion of gases, conduction of heat, and movement of salts and nutrients are all dependent upon the amount of water present in soil.

Infiltration capacity is the maximum amount of water that can enter a soil in a given time. This is influenced by the soil type, structure and moisture. The rate of infiltration is determined by measuring the time it takes for a known quantity of water to be absorbed by the soil. Water flows downward through soil is by the force of gravity, but two forces help soil hold on to water. These forces are adhesion (the attraction of solid surfaces to water molecules), and cohesion (the attraction of water molecules to each other). Adhesion is more likely to happen in a soil with small particles like clay, than in one with large sand particles. This is because the smaller-sized particles offer more surface area to which water can stick, or adhere. Silt and clay soils, therefore, have higher water-holding capacities than sand. When the pores in one layer of soil gets filled with all the water that they can hold, the water moves downwards to the layer below.

Subject
Social Studies, Science

Place
Outdoor

Duration
1 hour

Group size
Entire class

Materials
An iron rod (one meter long and 3–5 cm broad pointed at one end); 1.5 litre tin can open at both ends

Objective

To determine the rate of infiltration, and understand how soil conditions influence it.

Activity

Divide the class into four groups. Select four sites. The first site can be from an area with thick vegetation or a forested area. The second site can be an agricultural area. The third site can be a built-up area (a school playground or road side). The fourth site can be devoid of any vegetation.

1. Ask the students to mark off study plots, each 2 m x 2 m, on each site. Let the students observe the natural cover in each study plot.
2. Ask them to measure the soil compaction on each site by recording the average depth to which a light iron rod (approx. 1 m long, 3 cm diameter and pointed at one end) penetrates the soil when dropped several times from a height of 1 to 1.5 m.

Permeability indicates the relative ease of movement of water i.e. the characteristics that determine how fast air and water move through the soil.

Infiltration refers to the downward movement of water into the soil surface.

3. Ask the students to record the water infiltration rate on each site. This may be done with the help of a 1.5 litre tin can open at both ends. Ask them to place the tin can into the soil. Fill it with a known quantity of water and record the time necessary for all the water to penetrate into the soil.

   Compaction and infiltration measurements should be taken at several locations within each of the study plots.

Tabulate the data obtained from the study sites as given below.

Study site	Description of the study site	Description of the natural vegetation	Depth to which, a one metre rod penetrates into the the soil	Time taken for one litre of water to penetrate into the soil	Soil condition
Site 1					
Site 2					
Site 3					
Site 4					

Evaluation

Compare the data obtained from the study sites and discuss:

- Why are the soil conditions different in the four study areas?
- What is the course of water that infiltrates through the soil?
- What effect does the degree of soil compaction appear to have on infiltration?
- How does soil compaction influence run off?
- What is the role of vegetation in increasing water infiltration into the soil?

Discussion

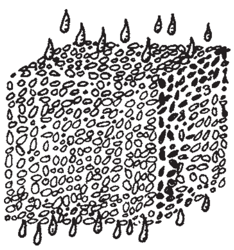
The movement and retention of water in the soil is primarily affected by soil characteristics such as texture, structure, nature and amount of organic and inorganic collaidal materials, kind and quality of exhangeables cations or anions (the balancing ions that balance the negative and positive charge associated with minerals and organic matter by electrostatic attractions), and size and total volume of pore space.

Permeability is basically dependent on the pore-size distribution in the soil. The larger the number of macro-pores (non-capillary pores), the greater is the permeability.

If the soil is too compacted, water may not be able to infiltrate the ground and reach the roots of plants. The infiltration capacity is influenced by the soil type, soil structure, and the soil moisture. The more water that enters the soil, the less is the runoff and erosion. Soil surfaces with vegetative cover have more infiltration rate than bare soils. Warm soils absorb more water than cold ones. In clayey soils, craking caused by drying also increases infiltration in the initial stages until the soil again swells and decreases infiltration. The amount of water initially present in the soil also affects infiltration. In general, infiltration rate is comparatively lower in wet soils than in moist dry soils.

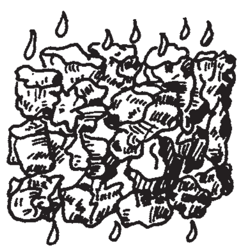
Soil Structure and Infiltration Rate

Single grain



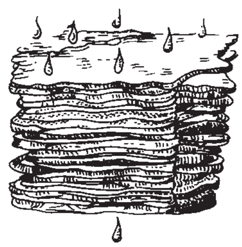
Rapid

Blocky



Moderate

Platy

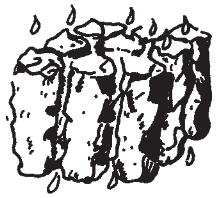


Slow

Granular

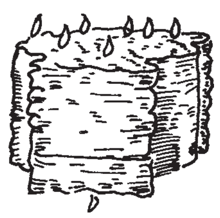
Rapid

Prismatic



Moderate

Massive



Slow

Conserving Soil in Nature

Subject
Science, Social Studies

Place
Outdoor or indoor

Group size
Entire class

Duration
Two weeks to prepare the vegetated tray and 30 minutes for activity

Material
Two trays or cardboard boxes, plastic sheet, piece of tin for spout, one tin can with a perforated base, brick pieces, pebbles, ordinary soil, mustard or jowar seeds, two glass jars (one litre capacity water)

Every soil is unique. What makes each soil unique is the way the soil forming factors work together at any particular place. Because each soil is unique, the water holding capacity is also unique. The amount of water held depends on many factors like the rate of precipitation, temperature, property of soil, plants, etc. Soil allows water from the surface—rains, streams, rivers—to slowly trickle through its porous body. Without soil, all surface water would run off to the sea. Soil helps water to be absorbed, percolated and stored underground, thus helps in increasing groundwater table. Soil absorbs heavy rains and reduces the fury of flash floods. It also provides water continually in the dry season to keep plants and animals alive.

Objective

To help students understand the importance of conserving soil and to demonstrate the role of vegetative cover in conserving soil in nature.

Activity

Ask the students to take two cardboard or wooden boxes or trays approximately 90 cm x 50 cm x 15 cm. Line them with a plastic sheet to make them leak proof. These sheets could be made by cutting open old plastic bags and fusing the edges together with the help of a candle. At one end of each box cut a 'V' notch 10 cm deep and fit it with a tin spout to draw the run-off water into a glass jar.

Ask them to fill each box with 3-4 cm layer of brick pieces and pebbles, followed by 3-4 cm layer of ordinary soil, followed by 3-4 cm layer of manured soil. Sow mustard seeds or any other quick growing plant seeds in one box. Leave the other box bare. Sprinkle water on Box 1 regularly till the plants are 8-10 cm high.

Now set the boxes on a table so that the spouts extend over the edge. Place a brick or a stick under the other end to give them slope. Place empty glass jars on stool beneath the spouts (as shown on page 9).

Now let the students gently pour equal amounts of water over the two boxes. Let them check the rate of flow and collect the water that flows out from the two boxes in the glass jars. Let them note the difference in the quantity and quality of water collected in the two jars.

Observation

Why is the amount of water that flows out from the vegetated box less than that from the bare box?

How do plants help in conserving soil erosion?

Why is it necessary to cover and protect the soil by natural means?

> Is there any part of the surface on the earth which has no soil at all?
>
> Yes, large areas of the Arctic and Antartic continents are covered by ice and snow, not soil. The snow-covered areas at high altitude have no soil.

Soil Alive

Subject
Science

Place
Outdoor

Group size
Groups of 5-6 students

Duration
30 minutes

Material
Sheets of newspaper, a ruler, a small spade, a magnifying glass, soil life chart

A soil that is high in organic matter is very much alive. A handful of soil may contain billions of living organisms that are so tiny that they cannot be seen with the naked eye. Yet these microscopic organisms as well as larger soil creatures perform tasks that are vital to all life forms on earth. A variety of organisms inhabit the soil. Soil harbours bacteria, actinomycetes, fungi, algae, protozoa, nematodes, worms, insects and rodents. Specific groups of organisms are responsible for specific activities in the soil. They decompose organic matter, fix atmospheric nitrogen, cause denitrification and plant disease. Organic matter is decomposed by these microscopic organisms and they supply nutrients needed by growing plants. For example bacteria decompose the organic matter and release plant food nutrients like nitrogen, phosphorus, etc. Fungi help in breaking down the resistant parts of the organic matter like cellulose, lignin, gums etc. Algae help to add organic matter to soil, improve the soil aeration and fix atmospheric nitrogen.

Objective

To help students realize that soil contains living things.

Activity

Select three different sites and if the study site falls under some administration, take necessary permission. The suggested sites are: lawn of the school, public parks; near pond; a badly eroded field; a good agricultural field.

At each site do the following:

1. Measure and mark off an area of land approx. 30 cm x 30 cm.
2. Gently sort through the leaf litter, and collect any creatures you find there. Record your findings in the chart given.
3. Dig the soil to a depth of 4-6 cm. observe and record the presence of roots. Are there any?
4. Take out the soil and spread the soil onto a sheet of newspaper.
5. Carefully sort the soil, watch closely for small living things with a magnifying glass. Watch for worms and other animals. You may also find other signs of animal life such as burrows or eggs of insects which may be single or in masses or pods. Count the different kinds

of animal life belonging to each of the groups shown on the following chart. After examining and counting, return the living things to the soil.

Soil Life Chart

Section 1: Plants **Site:** ________________

1. In the soil, there are

   ☐ No roots ☐ few roots ☐ many roots

2. Other signs of plants include: __________

Section 2: Animals

1. I observed ________ different kinds of worms. (e.g. earthworms, which have no legs)

2. I observed __________ different kinds of larvae of insects. (e.g. thick worm-like creatures)

3. I observed _________different kinds of snails. (e.g. soft bodies animals; snails have shells, slugs do not)

4. I observed __________different kinds of insects. (e.g. animals with 3 pairs of jointed legs)

5. I observed __________different kinds of spiders, mites, ticks. (e.g. animals with 4 pairs of legs)

6. I observed ________different kinds of animals with more than 4 pairs of legs. (e.g. centipedes, millipedes)

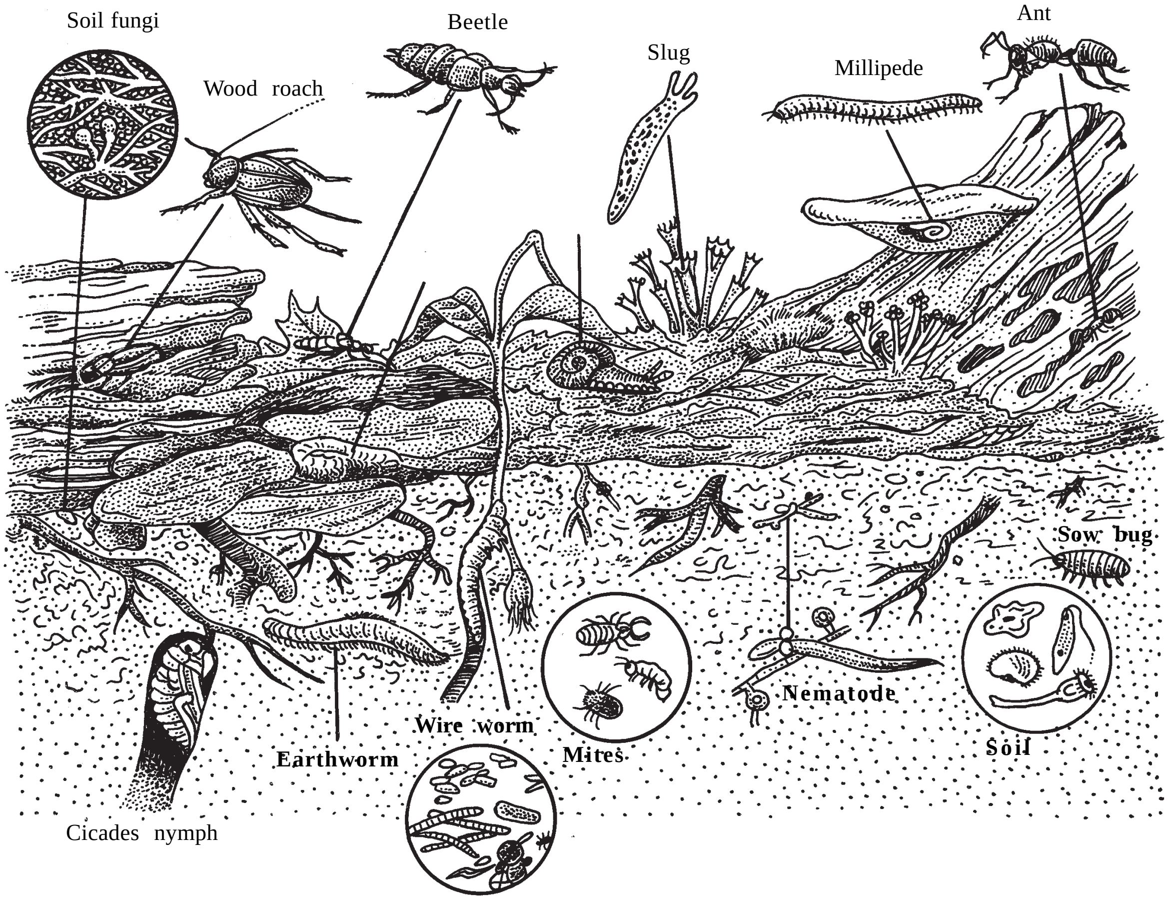
7. Other creatures I found are: (any animal not included in one of the above groups)

   ____

   ____

   ____

   ____



Soil organisms rearrange soil particles and recycle dead organic matter

Observation

Ask the students whether all the soil samples look the same. If no, what was the difference between various samples.

Did they find any evidence of plant life in the soil samples?

Which soil sample has the most small animal life?

Does the amount of animal life and the burrows the animals make, have any relation to the condition of the soil?

More About Soil

Soil is the thin layer on top of most of the Earth's land surface. This thin layer is a very precious natural resource. It holds nutrients and water for plants and animals. It provides the bed for plants to grow. If there were no soil, there would be no grass, no crop, no trees, no plants, and thus no nourishment for us and other terrestrial animals. We depend on soil for most of our daily needs—our food, clothing and other materials such as paper, building, etc.

Composition and Formation of Soil

What is Soil?

Soil is a complex mixture of inorganic materials (clay, silt, pebbles, and sand), decaying organic matter, water, air, and billions of living organisms.

Formation of Soil

Soil is formed when organic matter decays, solid rock weathers and crumbles, and sediments are deposited by erosion. The formation and the properties of soil depend on various factors. The key factors influencing the specific soil that develops are: parent material, climate, organisms, topography (natural features of the land), and time. Soils are dynamic and change over time.

1. **Parent material—**is the material from which soil develops through physical and chemical processes. This could be mineral or organic matter or a mixture of both. Materials from volcanoes, sediment transported by wind, water or glaciers, or minerals left behind by drying lakes are good examples of parent materials.

2. **Climatic factors—**parent material is broken down into smaller pieces by a process called weathering. Cycles of freezing and melting, wetting and drying, and the frequency of these occurrences, coupled with temperature and moisture levels of a region, play an important role in soil formation. Climatic factors such as heat, rain, ice, snow, wind, sunshine and other environmental forces break down the parent material and affect how fast or slow soil processes go. The smaller pieces formed are known as sand, silt or clay, depending on the size.

3. **Organisms—**include all plants and animals living in or on the soil. Both plants and animals help to create soil. As these die, organic matter gets incorporated with the weathered parent material and becomes part of the soil. Living organisms such as moles, earthworms, bacteria, fungi and nematodes move through or digest food found in the soil. All of these actions mix and enrich the soil.

4. **Topography—**is the hilliness, flatness, or amount of slope of the land. Soils vary with topography because of the influence of moisture and erosion. Moist, poorly drained soils are located in low areas, and depressions of the land. Soils on slopes directly facing the sun can be drier and better drained than the soils on slopes that do not face the sun directly. Soils at the bottom of a hill retain more water than soils found on the slopes.

5. **Time—**all the above factors assert themselves over time, often hundreds or thousands of years. It may take hundreds of years to form 2.5 cm of soil from parent material.

The result of all of these forces is the soil that develops into layers known as horizons.

Soil Horizons and Profile

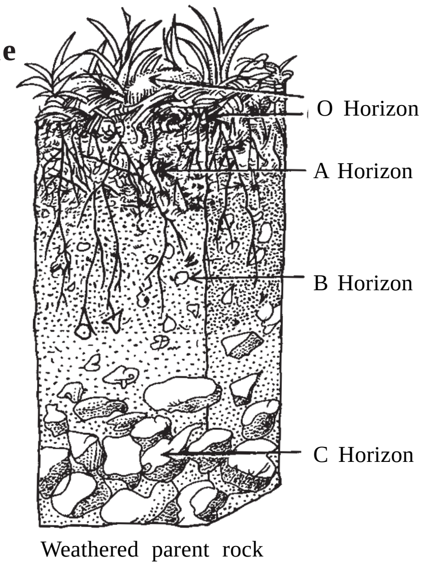
The soil profile is a series of horizontal layers in the soil. These layers differ in chemical composition, particle size, and amount of organic matter. Each recognizable layer is known as a horizon. The layers (horizons) in the soil profile, which vary in thickness,

Soil Properties	Time Period for Changes
Temperature, moisture content and composition of air in soil pores	These change in minutes, hours, or days
pH, colour, structure, organic matter content, fertility, microorganisms, density	These change happen over a period of months or years
Kinds of minerals found at a particular place, formation of different layers (horizon), particle size distribution	These change take place over a period of hundreds and thousands of years

may be distinguished by the physcial characteristics which include color, texture, structure etc.

The uppermost is called the **organic horizon or O horizon**. It consists of detritus, leaf litter and other organic material lying on the surface of the soil. This layer is dark because of the decomposition that is occurring. This layer is not present in cultivated fields.

Soil Profile



Weathered parent rock

Below this is the **topsoil or A horizon**. Usually it is darker than lower layers, loose and crumbly, with varying amounts of organic matter. In cultivated fields, the ploughed layer is the topsoil. This is generally the most productive layer of the soil. This is the layer on which soil conservation efforts are focused.

As water moves down through the topsoil, many soluble minerals and nutrients dissolve. The dissolved materials leach downward into lower horizons.

The next layer is the **subsoil or B horizon**. Subsoils are usually lighter in color, dense and low in organic matter. Most of the materials leached from the A horizon accumulates in this zone.

Still deeper is the **C horizon**. It is a transition area between soil and parent material. Partially disintegrated parent material and mineral particles may be found in this horizon.

At some point the C horizon will give way to the **final horizon or bedrock**.

Soil Basics

Soils properties include soil texture, structure, moisture, biotic content and chemical composition. Soil properties vary from place to place.

Texture: The texture is how the soil feels and is determined by the amount of sand, silt and clay particles in the soil, each of which is of a different size. Soils feel different partly because they are made up of rock particles of different sizes. Soil scientists (scientists who study soils are called pedologists) describe a soil by how much sand, silt and clay it contains. This is called soil texture. The texture of a soil is an almost permanent character, as texture does not change over a very long period of time. Texture of soil is determined by its composition. The most important way in which soil texture affects plant growth is its water retention capacity, and with it, the nutrient supply.

The water retaining capacity of soil is related to soil texture. The maximum retentive capacity of a soil is the moisture content of a soil when all of its pores are filled with water. Clayey soils show high water holding capacity, high plasticity, and stickiness and swelling, whereas sandy soils are conspicuous by the absence of these properties. Sandy soil contains larger-sized particles and larger pore spaces, thus water drains quickly through it. So this soil is said to be permeable. Loamy soil, which is a mix of sand, clay and mud, retains water in a way that is most ideal for growth of vegetation.

Particle size distribution: The amount of each particle size group (sand, silt, or clay) in the soil is called the soil particle size distribution.

Usually a combination of different size particles is found in a soil sample. On the basis of texture and size of particles, soils could be sandy, silt or clayey. Sand is the largest particle size group, and feels granular to touch. Silt is the next size or medium size group, and feels smooth. Clay is the smallest size group, and feels sticky and hard to squeeze.

Soil scientists focus on the physical characteristics such as texture (determined by the size and number of mineral particles such as sand, clay, silt and gravel), and structure (the way that these particles are arranged in the soil).

Size of Particles (in mm)	Name of the Soil
2.0-1.0	Fine gravel
1.0-0.5	Coarse sand
0.5-0.25	Medium sand
0.25-0.1	Fine sand
0.1-0.02	Very fine sand
0.02-0.002	Silt
0.002<	Clay

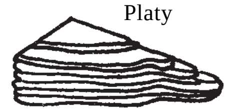
Structure: The natural shape of groups of soil particles or aggregates in the soil forms the structure. The structure affects how big the spaces between the soil particles will be. It is through these spaces that roots, air and water move.

The primary soil particles (sand, silt, clay) usually occur grouped together is the form of aggregates. The arrangement of these individual particles and their aggregates (also called peds) in certain defined patterns is called structure.

There are four main types of soil structure.

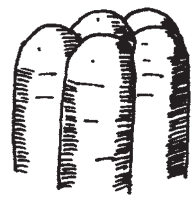
Plate-like: The horizontal dimensions are much more developed than the vertical giving flattened, compressed appearance to the peds. When the units are thick, they are called platy, and when thin, laminar.

Platy

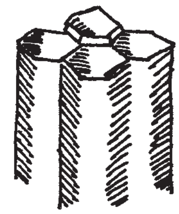


Prism-like: The vertical axis is more developed than others, with flattened sides, giving a pillar like shape. When the top of such a ped is rounded, the structure is termed as columnar, and when flat, prismatic.

Columnar

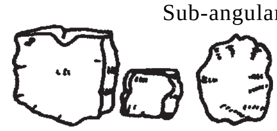


Prismatic



Block-like: All the three dimensions are of same size and the peds are cube-like with flat or rounded faces. When the faces are flat and the edges mainly sharp angular, the structure is named as angular blocky. When the faces and edges are mainly rounded it is called subangular blocky.

Sub-angular



Angular

Sphere-like:The faces are curved and irregular in spheroidal or rounded peds, with all axes approximately of the same length.

Spheroidal

The mechanism of structure formation is very complex. Soil particles are bound together into clusters by some binding, cementing or gluing material, such as plants, roots, lime, oxides of iron and alumina or colloidal organic matter. Polysaccharides and polyuronides which are synthesized and secreted by microorganims, for e.g. earthworms, are very effective in binding materials.

One of the characteristics of soil is the ease with which water permeates through it. This ability and readiness of soil to accept water and allow the movement of water is called **soil permeability**. This depends on three factors—the composition of the soil, its porosity, and the moisture content of the soil at the time of rain. The size of the pores affects the permeability of the soil. The larger the pores, the more permeable is the soil. A soil or rock that prevents water passing through it is called **impermeable.**

The size, stability and the space enclosed between and within aggregates determines retention and movement of water; and growth and development of roots in the soil. The aggregates are stabilized by organic and inorganic cements, clay or microbial films, and provide a large surface area to which plant nutrients adhere. The capacity of the soil to hold such nutrients is an indicator of the potential fertility of the soil.

Colour: Soils have various shades of black, yellow, red and grey colours. Parent material e.g. red sandstone, organic mater, presence of certain minerals e.g. titanium compounds—impart darker colour; hematite give red colour; limonite give yellow colour and indicates predominace of silica or lime. The colour of the soil changes, depending on how much organic matter is present. Soil colour is helpful in indicating many other properties of soils e.g. a dark brown or black coloured soil indicates its high organic matter content and fertility. A red or yellowish soil indicates good aeration and proper drainage. A white colour soil indicates low organic matter with high salinity and is unsuitable for normal growth of many crops.

Soils of India

Soils are classified by these characteristics and number of horizons that have developed in them. The horizons are distinguished by texture, kind of minerals present and presence of salts and alkalies. Soil contains four major components: mineral material, organic matter, water and air, the proportions of which vary with respect to time, site and depth.

Important Soil Groups

Alluvial soil has very fine particle of alluvium formed by the deposits laid by the numerous rivers and their tributaries. It contains sand, silt and clay. They are most fertile soils, rich in mineral contents like potash, phosphoric acid and lime, but are deficient in organic and nitrogenous content. In the drier areas, they are more alkaline. Such soils are characteristic of Northern plains of India. They are best to grow cereals and pulses.

Black soil has extremely fine clay materials and has the capacity to hold moisture. They are rich in soil nutrients like calcium carbonate, magnesium carbonate, potash and lime, but are poor in phosphoric content. They are derived from basaltic rocks, thus are rich in iron and magnesium. This type of soil is common in Maharashtra, western Madhya Pradesh, Gujarat and Tamil Nadu. They are suitable for the cultivation of cotton, groundnut rice, wheat, jowar, tobacco, sugarcane and oil seeds.

Red soil is rich in iron. This soil is best for Kharif crop cultivation; some varieties of rice and other cereal crops. Potato and sweet potato may also be grown in such soil. It is found in vast areas of Tamil Nadu, Karnataka, Goa, Daman and Diu, southeast Maharashtra, east Andhra Pradesh, Madhya Pradesh, Orissa and Chotanagpur.

Laterite soil: Laterite soil is the result of intense leaching owing to heavy tropical rains. Laterite soils are porous soil, coarse in texture and rich in minerals like iron, aluminium, manganese and titanium but poor in nitrogen, phosphoric acid, potash and lime. It is generally reddish or yellowish-red in colour. This soil is common in the low hills of Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Orissa and Assam.

How Earthworms Help Soil

Earthworms are farmers' helpers because they digest organic matter, and help create humus. They fertilize the soil with their droppings. The tunnels or burrows created as worms move soil particles help to loosen and condition the soil. When earthworms tunnel deeply into the soil, they bring subsoil closer to the surface, and mix it with topsoil which has organic matter.

As worms mix soil and create burrows, they create channels in the soil, providing passages for air or water to get next to roots deep in the ground. The more porous a soil, the more rain can soak into the ground, especially in a heavy downpour.

Slime, a secretion of earthworms, helps to hold clusters of soil particles together in clumps called peds. When a soil is clumped together in this way, it has a good structure. It helps to make soil porous, allowing air and water to pass between the clumps.

Earthworms are farmers' friends. The more worms present in the soil, the more fertile the soil is likely to be.

So think about this:

How can you encourage worms to live in your soil?

What effect do you think chemical pesticides and fertilizers might have on a worm population?

Desert soil is coarse, sandy, saline, porous and lacks humus. This soil is not at all suitable for cultivation as it lacks organic matter. They are found in the arid zone in the north western region in the states of Rajasthan and Punjab. These soils are composed of sand to a depth extending beyond 50 cms. Their A Horizon is weakly developed or absent, as on shifting sand dunes. The soil shows no or only a weak B Horizon. The pH of such soil is fairly high and they have varying amounts of calcium carbonate.

Soil Sustains Life

People are dependent on soils and good soil depends on people. Soils are the natural bodies in which plants grow. They are the habitats for countless species. They provide the starting point of successful agriculture. Soil serves many purposes. It underlies the foundations of houses and factories. They are the beds for roads and highways. Soil absorbs wastes from sewage systems, wastes from industrial and animal sources. Great civilizations have depended on good soil. The fertile valley soils of the Tigris and Euphrates rivers in Mesopotamia and of the Indus, Yangtze and Hwang Ho rivers in India and China were the sites of flourishing civilizations. The fertility of these was frequently replenished by natural flooding. These valley soils provided abundant food supplies which made possible organized, stable communities.

Soils are home to many burrowing animals, bacteria, fungi. One of the most important of these is the earthworm. One hectare of soil may support a population of 500,000 earthworms that can process as much as nine metric tonnes of soils a year. These animals literally eat their way through the soil, thus mixing organic and inorganic material, which increases the amount of nutrients available for plant use.

Soil Fertility

The fertility of soil is determined by how many nutrients it has stored. The three soil nutrients important for the growth of plants are: nitrogen in the form of nitrates, phosphorus, and potassium. These nutrients need to be maintained at a suitable level in the soil. These nutrients are found in the topmost (uppermost) layer in the soil arrangement. This layer contains decayed plants and animals remains, also called humus. This humus makes the soil productive.

Soil Nutrients

Plants make their own food using energy from sunlight, carbon and oxygen from the air and hydrogen from water, but they also need essential nutrients from the soil. Plants require some soil nutrients in large amounts. These are called macronutrients. Macronutrients include nitrogen (N), phosphorus (P) and potassium (K), calcium (Ca), magnesium (Mg) and sulphur (S). They also need other nutrients from the soil but in less amounts. These are called micronutrients. These include manganese, iron, zinc, copper, molybdenum and boron. Nutrient depletion and loss of organic matter have direct influence on decline in soil fertility and microbial biomass.

Threats to Soil

Just as good soils helped to build flourishing civilizations, soil destruction or mismanagement was a factor for their downfall. Cutting of trees results in erosion and topsoil loss; lack of maintenance results in the accumulation of harmful salts. Thus once productive soil becomes barren and useless. Some of the threats to soils are discussed below.

Soil Degradation

The primary cause of degradation is the demographic pressure on land, leading to loss of vegetative cover through deforestation. Harvesting of timber, collection of firewood, overgrazing, shifting cultivation and encroachment of forest areas are some of the reasons for deforestation. Besides, lack of proper soil conservation practices, not practising crop rotation, non-judicious use of fertilizers and pesticides, faulty irrigation and water management, discharge of industrial effluents, sewage/sludge are also responsible for soil degradation.

Soil Erosion

Soil erosion is the loss of topsoil. As the topsoil is blown away either by wind or washed away by water, gullies and cracks start appearing, and valuable nutrients stored below the topsoil are removed by the wind and water. This precious topsoil is a rich source of nutrients. Lack of nutrients in the soil results in the loss of vegetation. Thus soil erosion may lead to famines and desertification.

Though soil erosion by water and wind is a natural process, there are human induced factors which contribute to increasing the scale and intensity. Activities such as farming, logging and construction have greatly increased soil erosion. Without plants to hold soil in place, nutrient-rich topsoil is more easily swept away by wind or carried down slopes by water, and thus the land becomes less productive.

Heavy rainfalls and wind, loss of vegetative cover, growth of weeds; etc. are some of the factors that lead to soil erosion. Growth of weeds utilizes water and nutrients from the soil and thereby affects the growth of other plants. Excessive grazing, extension of agriculture to marginal areas, depletion of organic matter because of unsuitable cropping patterns are some of human activities which have resulted in loss of vegetative cover and thereby has been a major cause of accelerated wind erosion.

Soil Degradation in India

Type of degradation	Area (Mha)
Water erosion	148.9
Wind erosion	13.5
Saline and alkali soils	10.1
Water logging	11.6
Decline in soil fertility	3.7
Total	187.8

Source: Sehgal and Abrol 1994, State of the Environment, India, UNEP 2001

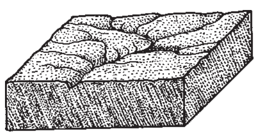
Erosion due to water is greater in regions which receive heavy rainfall over short periods than in places with low rainfall.

Erosion by water takes place in different ways.

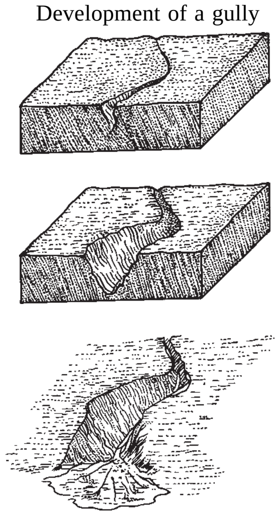
Splash erosion when the rain falls at an approximate speed of 9.1 m per second, it is capable of creating a force of almost 14 times its own weight. With this falling force, the raindrops beat up the bare soil surface into flowing mud which can splash as much as 0.6 m high and 1.5 m away. Splash erosion is the forerunner of other types of water erosion.

Sheet erosion is the removal of a thin layer of a soil from the entire surface of an area lacking vegetative cover. The rain water that the ground does not absorb runs off the surface, carrying topsoil with it.

Rill erosion



Development of a gully



Rill Erosion happens when the silt-laden run-off starts flowing along the slopes through small finger-like channels. It is the intermediary stage between sheet erosion and gully erosion.

Gully erosion generally occurs on steep slopes where there is no vegetative cover to arrest the flow of water. The water cuts channels into the land and carries away soil with it.

Soil erosion degrades the soil, making it unfit for cultivation, and reduces the seepage of water through the ground. The soil that is washed away gets deposited in river beds, reservoirs, tanks and ponds, raising their level and reducing their capacity to hold water. This may result in greater frequency and intensity of floods.

When trees are cut down to an extent that there are not enough trees to anchor the topsoil in place, the topsoil diminishes, as the sun, the rain and the wind deplete it slowly. Due to heavy rains, the rain drops beat the soil surface. Rain washes mud down hillsides and flow into rivers. The land left does not have the ability to produce any plant life, and erosion of the land follows. Plants and vegetation protect soil from such raindrop splashes, and slow down movement of runoff, allowing water extra time to soak into the soil.

Saline and Alkali Soil

Saline soil represent a group of soils that are characterised by the occurence of a high proportion of soluble salts, usually the chlorides and sulphates of the alkali bases. Alkali soils have pH between 9.0 and 10.5. These can occur in a variety of soils and are found among the groups of Red, Black and Alluvial soils. Some of reasons for this salinity is:

- High salt deposits inherited by the soil from the original parent material during soil forming process.
- Salt contained in the irrigation water applied.
- More salts in water inflows (seepage) from upslope.
- Back water flow or intrusion of sea water in coastal area.

Salinization

The process of accumulation of salts in soils is called salinization. High salt concentrations in soil decreases the osmotic potential and hence prevents the uptake of water and essential nutrients by plant roots. This, in turn, restricts plant growth and reduces crop yields. From where does salt come into the soil? Salts occur naturally in many bedrock deposits and in some deposits that lie on top of the bedrock. Groundwater flowing through these deposits dissolves and transports the salts. Under certain conditions, groundwater rises to the soil surface where the water evaporates, leaving salts behind. Over time, the salts accumulate on the soil surface.

A white salt crust forms where the salt concentration is very high. 3,000 – 6,000 ppm salt results in trouble for most cultivated plants. Only salt-tolerant plants grow in this visibly saline area. The land around the visibly saline area will also have saline subsoil, resulting in reduced crop yields. In arid areas, the volume of rainwater dissolving the salts generated by the soil is low. Processes like extraction of water from the soil, evaporation and evapotranspiration tend to increase salt concentrations.

Problems of salinization are most commonly associated with irrigation. All irrigation water contains salts that it dissolves as it passes over and through the land. These salts are generally in very low concentration in the water itself. If too much irrigated water is used and excess water is not drained properly, the field becomes waterlogged. When it is hot and dry, the water evaporates quickly, leaving salts behind in the topsoil.

Salinity directly affects the productivity of soils by making the soil unfavourable for good crop growth. According to some researchers the loss in crop production due to salinity in India amounts to over nine million tonnes.

Soil Pollution

Most of the world's food is produced on soil. If there were no productive soil, farmers will be unable to grow enough food for all. Good and productive soil depends on bacteria, fungi, and small animals (such as worms) to break down wastes in the soil and release its nutrients which help plants grow. The overuse of fertilizers and pesticides can limit the ability of soil organisms to process wastes, which in turn makes the soil less productive, or, in the worst case scenario, useless or even poisonous. Agriculture runoff from the fields treated with agrochemicals like fertilizers and pesticides, along with sewage sludge, leads to the contamination of soil and water with toxic substances and heavy metals. The soil also gets polluted due to improper disposal of industrial effluents, domestic and municipal waste. Mining and quarrying disturb the physical, chemical and biological features of the soil.

Salt-tolerant Crops

Most crops cannot grow in high salt concentration. Yet there are some plants which are adapted to grow in salty soils. Of the grain crops, the most salt-tolerant is barley. The leucaena tree (*Leucaena leucocephala*) has been grown on coastal sandy soil in Pakistan. Saline irrigation water is used for growing these. Jojoba (*Simmondisa chinensis*) can tolerate saline soils. Brackish irrigation water is used to grow jojoba near the Dead Sea in Israel.

Desertification

Desertification is the conversion of productive rangeland or cropland into desertlike land. It is not the expansion of desert. It is usually caused by a combination of climate-related factors such as prolonged drought, less rainfall, and human activities like overcultivation, overgrazing, soil erosion. Moderate desertification causes a 10 per cent to 25 per cent drop in agricultural productivity, whereas severe desertification can result in a loss of 50 per cent or more.

Desertification takes place in dryland areas where the soil is especially fragile, where rainfall is low and the climate harsh. The result is the destruction of topsoil, followed by loss of the land's ability to sustain crops, livestock or human activity.

There are numerous reasons for desertification to occur. Drought dries up the land, and makes it infertile, and plants can no longer be supported because of the lack of nutrients, and desertification soon follows. Human activities like overcultivation, overgrazing and deforestation cause desertification.

When the land is overcultivated, that area loses its valuable nutrients, and soon no life can be supported by that area because of the lack of nutrients in the soil. Plant life soon withers away, and the area begins to degrade, which leads to desertification.

The world loses nearly 6 million hectare of land each year to desertification, which could be caused by soil loss through wind or water erosion, salinization, water logging, over grazing of rangelands or urban encroachment.

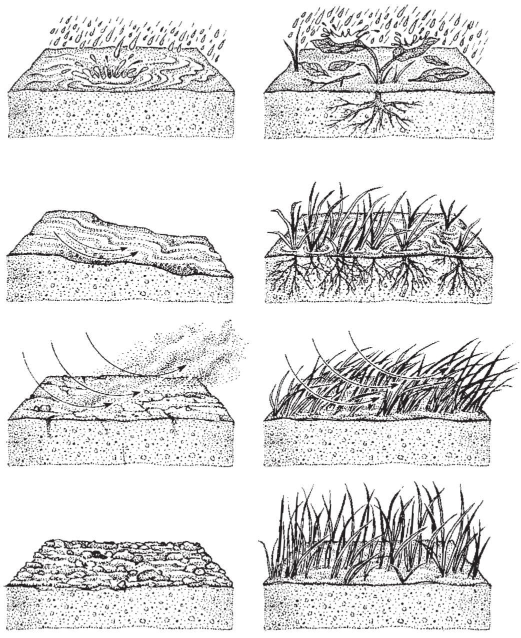
Source: The Economic Times dated 10 February 2003

Overgrazing occurs when the land is forced to feed too many animals. When the amount consumed by the animals becomes more than the amount that can be grown, the vegetation depletes, and soon patches of land without any plants begin to appear. The topsoil is not longer held in by any type of anchorage, and it blows away, leaving the dead, useless dirt underneath. Moreover, the movement of so many cattle over land compacts the soil and makes it difficult to grow anything. As the animals move on to another area the same thing will happen again, and theses patches of dead soil will began to increase, resulting in desertification.

Soil provides the resting place to seeds and roots of plants and home to many microscopic and small creatures. Most of our primary food resources are grown in the soil. The plants grown provide timber, fuel and paper. Soil is also used as raw material for making bricks and mortar, pottery and other materials. Soil is an important resource and sustains life on earth. Thus it is vital that we take care of soil and conserve it.

More on Conservation of Soil

Whenever soil is lost by water or wind erosion, the topsoil, the most productive layer, is the first which gets removed. When the topsoil is lost, the soil's fertility decreases. Thus, proper soil conservation measures need to be employed to minimize the loss of topsoil.



Some of the measures to conserve soil are discussed here:

In Agriculture

Healthy soil produces healthy crops and plants. Some of the methods to protect and enhance the productivity of soil include using compost and/or manures, maintaining soil cover with plants and/or mulches.

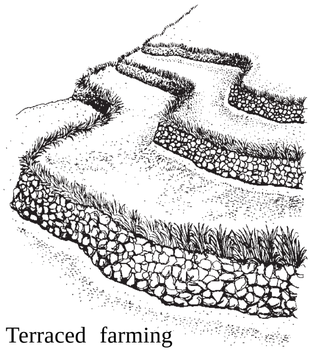
The kind of agricultural activity that can take place on a particular piece of land are determined by soil structure, texture, drainage, fertility, slope of the land, amount and nature of rainfall and other climatic conditions. In agriculture there are many techniques that assist in protecting soil from erosion.

The types of soil, steepness and the length of slope determine what type of farming needs to be applied.

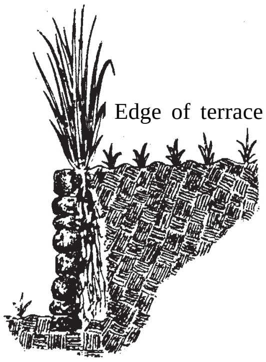
Contour farming—is a tilling (turning over) at right angles to the slope of the land. This practice is useful on gentle slopes and produces a series of small ridges at right angles to the slope. Each ridge acts as dam to hold water from running down the incline. This allows more water to be soaked into the soil.

Strip farming—alternate strips of closely sown crops like wheat or other small grains, with strips of row crops like corn, soyabeans are grown. This is done when a slope is very steep or very long, where contour farming alone may not prevent soil erosion. Thus a combination of contour and strip farming is applied. The closely sown corps retard the flow of water, which reduces soil erosion and allows more water to be absorbed into the ground.

Terracing—is one of the oldest and most efficient means of conserving soil within agricultural land. A terrace is a flattened area that catches and temporarily stores or slows water run-off on moderate to steep slopes. By slowing down the rate of surface water run-off, terracing can significantly reduce soil erosion.



Terraced farming



Reducing Water Erosion

When soil is not protected from the effects of running water, the topsoil is removed and gullies result. Slowing the flow of water over sloping land could prevent this.

Even with soil conservation practices such as contour, strip or terracing, the movements of water must be controlled. Waterways (where water collects and flows off the lands) should be maintained. Measures to check the speed of water should be taken.

Reducing Wind Erosion

Wind erosion is another problem. The best protection to soil from wind erosion is to plant layer of vegetation over the surface. Windbreaks are plantings of trees or other plants that protect bare soil from the full force of the wind. Windbreaks reduce the velocity of wind, thereby decreasing the amount of soil that it can carry away.

Proper Disposal of Wastes

Domestic and municipal wastes, sludges, pesticides, industrial waste, etc. need to be disposed with utmost caution to avoid the possibility of pollution of soil through heavy metals and other toxic substances.

Nature takes centuries to produce this precious soil. Increase in industrialization, urbanization, mining and infrastructure development is taking away considerable areas of land from agriculture, forestry, grassland and pastures, which impacts the soil availability and the quality. Developmental activities need to be harmonized and made compatible with land use patterns to guard against any form of land and soil degradation. Soil has to be cared for—it is difficult to replace.