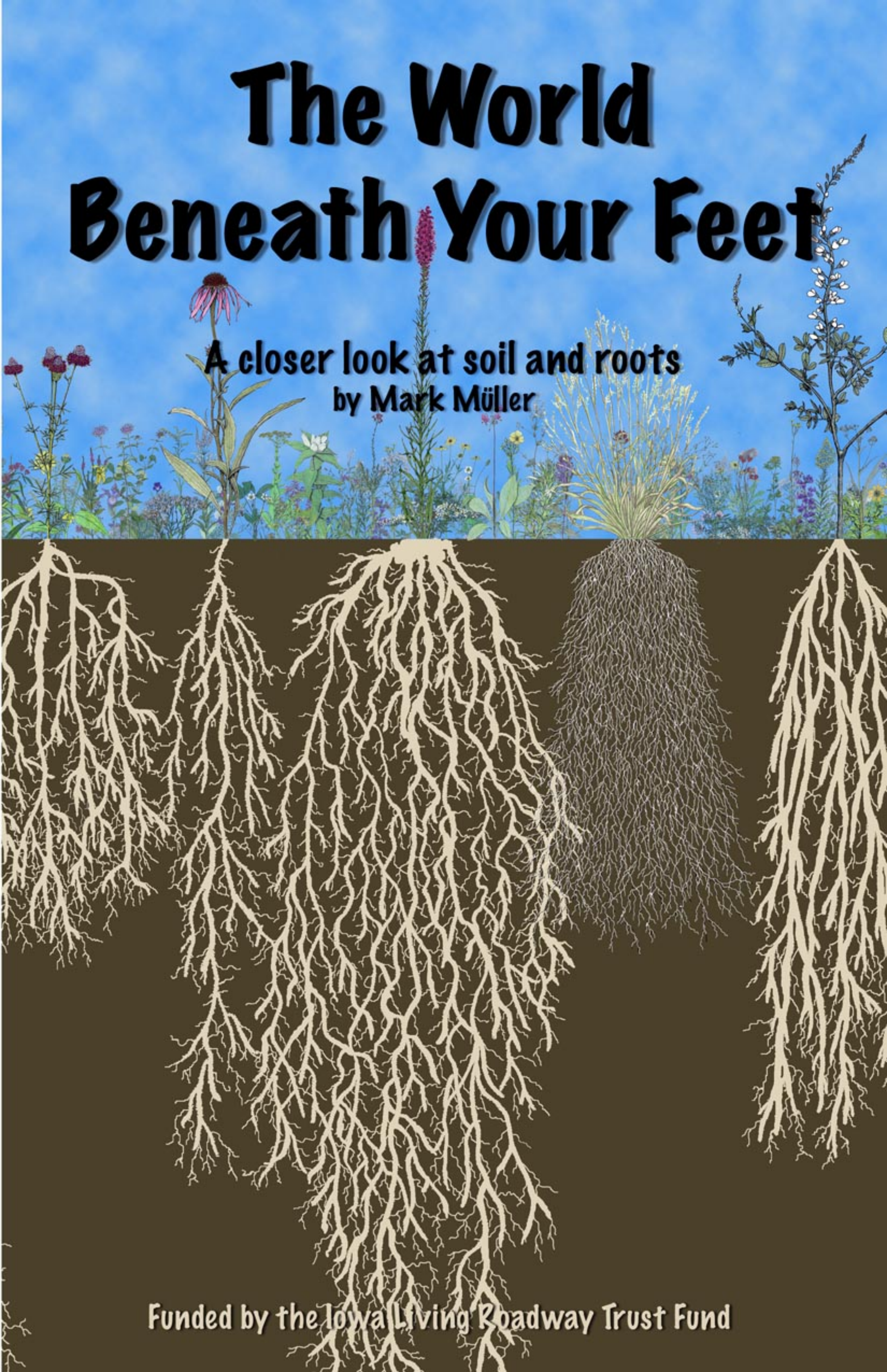
The World Beneath Your Feet

A closer look at soil and roots

by Mark Müller



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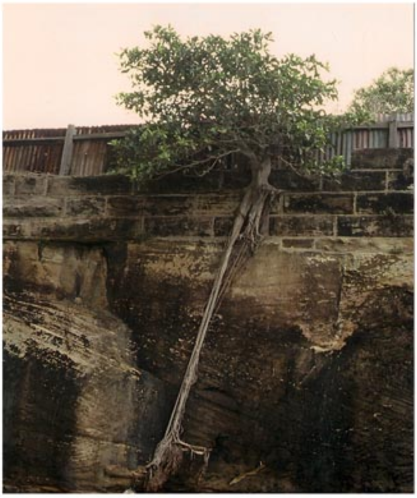
Isn’t soil just dirt ?

Dirt is something you wash off or vacuum up; you want it to go away. Dirt is inert, it’s lifeless. Soil, on the other hand, you hope stays in place; it is teeming with life. Soils are complex, fascinating ecosystems. Soil scientists have identified over 100,000 different soil types around the world. One trait all soils share is that they are the primary source of the food that sustains life on Earth: plants. An Iowa Beef Council bumper sticker reads, “ The West Wasn’t Won On A Salad. ” One might argue whether the West was actually “won” or not, but for sure the steaks that early settlers were eating came from cows that ate salad: plants that grew in soil. Most life on Earth would not be possible without soil. It is as important to life as air and water.

**Rich, healthy soil smells sweet and has a crumbly texture.
A diverse community of creatures live in the soil, nourishing and replenishing it through their activities. Unfortunately, humans have treated soil like dirt for centuries. Many modern farming practices often cause tons of soil to be lost annually from erosion. Compacted and exhausted soils require synthetic fertilizers to grow crops. These soils no longer function as a sustainable ecosystem; they closely resemble dirt.**

Many plants are extremely adaptable. They can survive in poor soils or none at all. But surviving is not the same as flourishing and growing to full potential season after season. In order for plants to thrive sustainably without outside input, they require all of the components of a healthy soil ecosystem. These include both living and nonliving elements.



Tree growing out of a retaining wall

Some soils are dark and deep or light and shallow. Some are fluffy, gritty or sticky. Soils do not have to be deep to be productive. Rainforest and mountain soils have very shallow topsoil compared to the prairie soils of the North American Midwest. If soils have not been compacted or exhausted, they will be able to support productive plants.

Plants growing in an ancient lava bed

The ground may appear solid as you walk on it but healthy soil is quite porous. Ideally it has 50% pore space: 25% air and 25% water. Solids in the soil consist of 40% mineral particles and 10% organic matter. Ample pore space allows plant roots and soil creatures easy access to air and water. This is why excess compaction is so deadly to a soil ecosystem. Ideally, when we see soil as a complex, living entity, we will treat it with a little more respect—not like dirt.

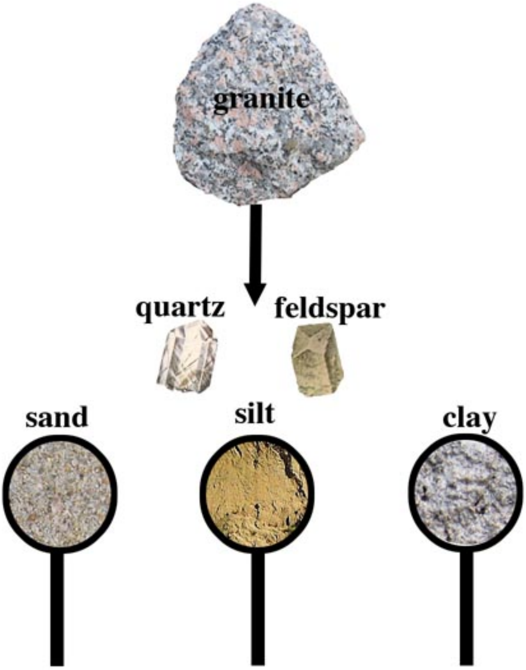
How soils form

When the Earth was a youngster billions of years ago, it was a hot, violent place. Meteorites were slamming into it and volcanoes were constantly erupting and heaving up material from inside the new planet. When things cooled down a bit, a crust formed on Earth's surface. There was no soil, just bare rock. Earth's solid layer—bedrock—was the parent material for most soils. For eons, wind, water, glaciers and other forces split the bedrock into large boulders. Over time the boulders weathered into smaller and smaller pieces that eventually became some of the main components of soil.

Granite glacial erratic in Iowa

Granite is a common bedrock. The granite boulder in the photo above, called an erratic, was dragged to Iowa long ago from as far away as Canada by a glacier. Lichens growing on rock secrete weak acids which slowly begin to break it down. As cracks form, water seeps in and freezes, exerting enough force to split parts of the rock. Lichens, water, wind, freezing and thawing eventually break down the granite to sand, silt and clay particles—the three major components of soil. Keep in mind that these weathering processes take millions of years.

Granite breaks down to both of the minerals quartz and feldspar, which further break down to smaller and smaller pieces. These smaller pieces, depending on their size, we know as sand, silt and clay. These particles also contain calcium, alumina, potash and other nutrients essential for plant growth. Different rocks yield other minerals, resulting in many different types of soil.



The process of slowly weathering parent material like granite and limestone into its mineral components is still going on today. Sand, silt and clay are still being moved around and deposited by wind, water and glaciers.

This has been a simplified version of how soil forms. And these minerals are just the raw components of soil—not much use to plants without the activities of living soil creatures. We will look at the ecology of soil in later chapters.

To dig more deeply into the intriguing details of Earth's early history, check out the reference section for more reading.

Soil texture

The texture of a certain soil is determined by the size and the proportion of particles it contains. Sand, silt and clay are the predominant particles in soil. These are size terms more than anything else. For example, the most common sand is usually made of quartz but there are also gypsum and coral sands. But all sand particles are .05 to 2 mm in size by definition. Silts are smaller and clay particles are the smallest. Soil texture affects the size and number of pore spaces, aeration, water drainage and the ability to hold water and nutrients.

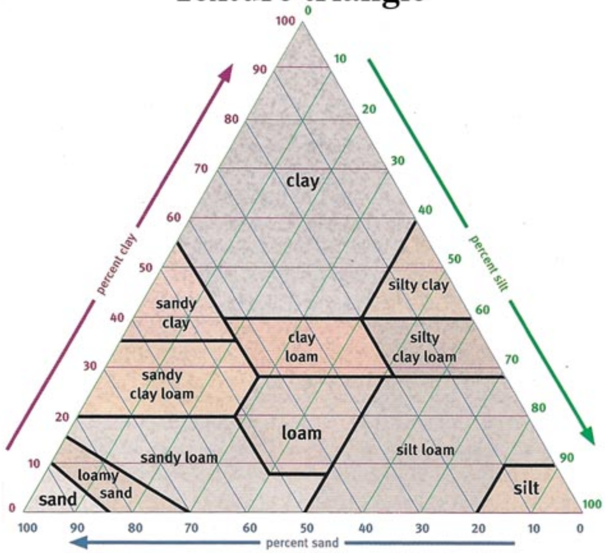
Sand doesn't hold water or nutrients very well because it has many large pore spaces or macropores. Think about pouring a glass of water on a sand beach—it drains away immediately. Sands have a gritty texture.

Silt particles are microscopic. 1,000 particles of silt would fit on a grain of sand. Silty soils have many small pore spaces or micropores. Silt holds water and nutrients better than sand and drains less quickly. Silts have a smooth, talc-like texture.

Clay particles are the smallest, with extremely small pore spaces. One million clay particles would fit on a grain of sand. They have so much surface area that a spoonful can contain the surface area the size of a football field. The layers of flat clay particles slide across each other making clay soils feel greasy and sticky when wet.

Very few soils are pure sand, silt or clay. They usually contain a mixture in varying proportions resulting in many different textures with different properties. Soils with 70% or more sand will be dominated by the properties of sand. Soils with more than 40% clay particles will basically act like clay. Loams are soils with a desirable combination of sand, silt and clay. Loamy soils have a good balance of large and small pore spaces, allowing air and water to flow and moisture and nutrients to be retained.

Texture triangle



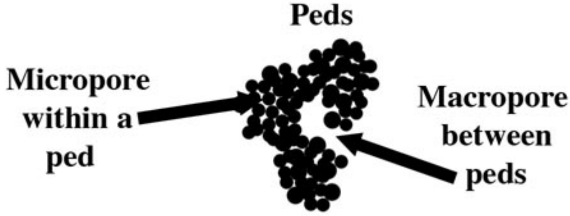
USDA texture triangle

Although loams are ideal soils, any soil texture can grow plants. Some plants have adapted to grow in light sandy soils and some in heavy clay soils.

Soil structure

The shapes of soil particles when they are clumped together in aggregates—peds—define the soil structure. Clumping is the result of freezing and thawing, growing roots, the sticky secretions of bacteria and fungus and soil burrowers like worms. Peds are not clods. Clods are caused by tilling and compacting wet soil. Soils with excellent structure are crumbly or granular. There is a good balance of macropores between the aggregates and micropores within an aggregate. These soils are said to have good tilth. Tilthy soils are easy to work and great for root growth.

Peds



Glaciers in Iowa

Front edge of a glacier

The formation of most of Iowa's soils was influenced directly or indirectly by glacial events. Glaciers slowly plowed across Iowa several times thousands of years ago. As they advanced from the north they dragged frozen soils and rocks with them. Some of this mixture of sand, clay, gravel and boulders was pressed into the ground by the immense weight of the glaciers. These deposits made directly by the glaciers are referred to as glacial till. When glaciers melt, vast amounts of glacial meltwater washes out even more unsorted deposits. Together, the till and deposits are called glacial drift. Glacial drift in varying depths blankets nearly all of Iowa's limestone bedrock. Northeast Iowa has virtually no drift but it is over 600 feet thick in west central Iowa. Most of northern Iowa's soils were formed from glacial till.

Glacial drift (till shown here) is a deposit of sand, silt, clay and gravel left by glaciers or their meltwater streams many thousands of years ago.
Photo by Timothy Kemmis.

Alluvial deposits.
Photo by Timothy Kemmis.

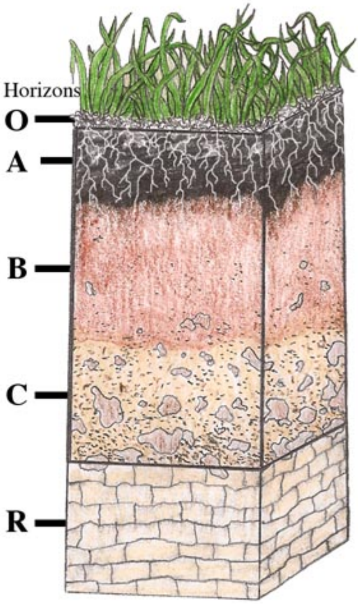
Glacial till was deposited in uplands and ancient river valleys, burying them far beneath present-day land surfaces. New streams formed as enormous amounts of water and sediment flowed from the melting glaciers. Along with silt, large amounts of sand and gravel were deposited. These deposits are still being quarried today. Over time, river courses, volume and velocity changed and more clay and silt were deposited. These water-sorted deposits are called alluvial deposits.

Eolian deposit
of loess

During melting, the temperature contrast between ice-free and ice-covered areas created fierce, consistent winds. The winds picked up the pulverized glacial debris that was concentrated in meltwater river valleys and deposited it across several midwestern states. Windblown deposits are referred to as eolian deposits. One such deposit of windblown, yellowish silt is called loess. One of the deepest deposits of loess in the world, up to 200 feet thick, lies along Iowa's western border. Most of southern Iowa is covered with loess but it generally gets thinner as you travel east.

Loess Hills in western Iowa

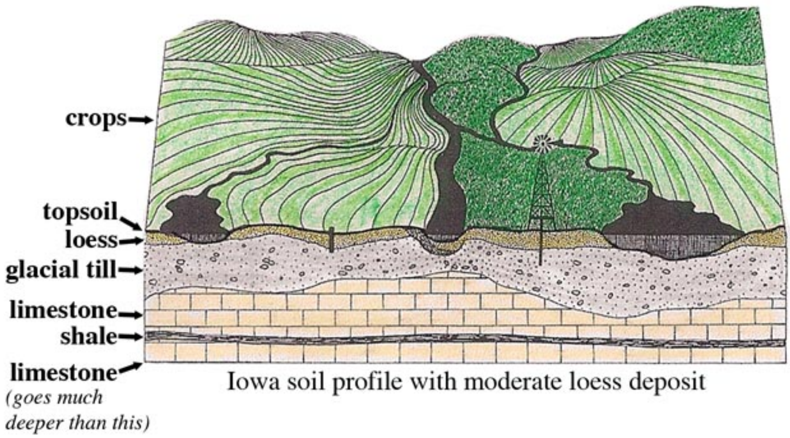
Soil profiles



Soil profile over limestone bedrock

The top part of a soil profile is called the organic layer. It is made up of plant material in various stages of decay. Soil scientists call this layer the O horizon. The A horizon lies below and is referred to as topsoil. This layer is enriched with organic material from the O horizon above. Biological activities in the topsoil mix the organic material with the sand, silt and clay. This mixture is called humus. It is usually dark in color and roots are concentrated here. Topsoil is the most fertile and active layer of the soil. The B horizon or subsoil has less organic matter and less biological activity but is important as a nutrient and water reserve. It has less pore space than the A horizon and contains more clay. Subsoil often contains iron oxide giving it a reddish brown color. The C horizon is chunky with partly weathered, unconsolidated rocks—like glacial till. There is no organic matter or biological activity at this level. In mature soils, the C horizon extends down many feet all the way to the underlying bedrock which is the R horizon.

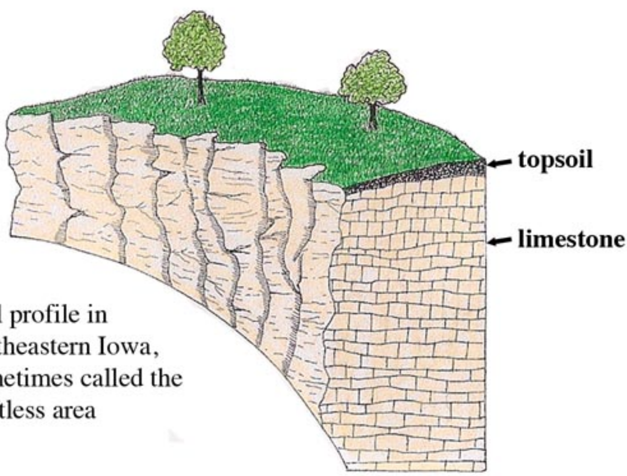
Not all soil profiles will clearly show these horizons. Different parent materials, climate, living organisms, topography and time all have an effect on what a soil profile looks like. In some thin soils the topsoil practically sits on top of the bedrock. In tallgrass prairie soils the topsoil may be measured in feet. Much of Iowa's rich prairie soils have been lost through erosion since they were plowed. Today prairie soils have less organic matter and are unable to infiltrate significant rainfall. This leads to more runoff, water-quality problems and flooding.



Iowa soil profile with moderate loess deposit

Iowa has actually been under shallow seas longer than it has been dry land. Deep limestone bedrock was formed when seas covered the state. Although limestone is a parent material for soil, glacial drift is the parent material for most Iowa soils. About 95% of Iowa soils were formed from the previously weathered rocks that the glaciers brought here. These loess-derived soils are some of the most productive in the world. About 5% of Iowa soils were formed from limestone bedrock. A few rare soils in northern Iowa were formed from organic deposits such as peat beds.

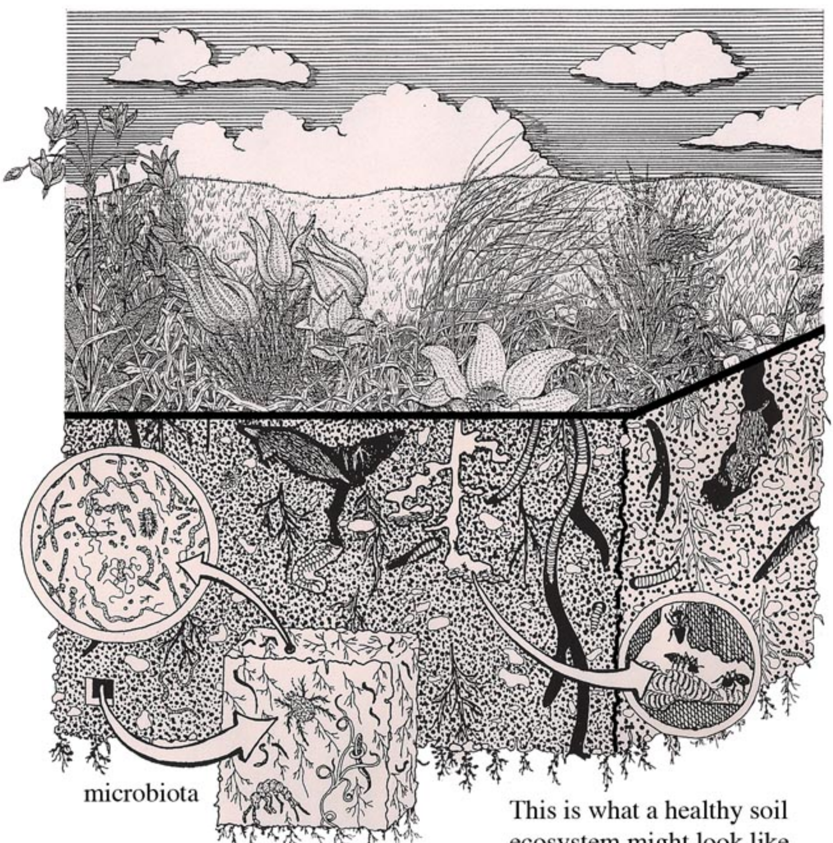
Now that we have an understanding of the raw, nonliving components of soil, it's time to investigate the ecology of soil.



Soil profile in northeastern Iowa, sometimes called the driftless area

Soil ecology

An ecosystem is a community of living creatures interacting with their nonliving environment. Ecology is the study of ecosystems. Healthy soils are home to thousands of different species of living organisms. Even though soil ecosystems require a microscope or a magnifying glass to be fully appreciated, they are just as wild and dynamic as the easily observed ones on the surface. Predators and prey, life and death, sex, chemistry, deceit, disease, cooperation, warfare and magic exist right below your feet. You will only find functioning ecosystems in soils with adequate pore space. Just like plants, soil creatures need air and water to thrive.



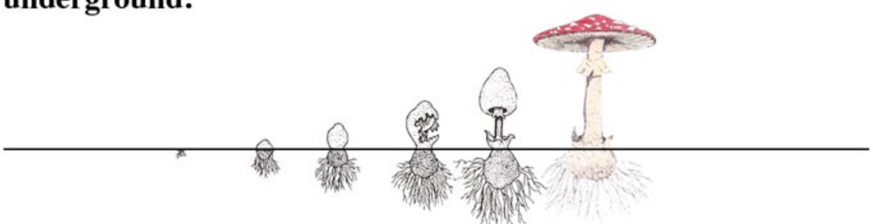
This is what a healthy soil ecosystem might look like beneath a patch of tallgrass prairie

Microbiota are creatures like bacteria, fungi, nematodes, protozoa and springtails that are too small to be seen with the naked eye—microscopic. Macrobiota like worms, ants, centipedes and moles are easily observed without a microscope.

Primary consumers, decomposers, in the soil food web are mainly bacteria and fungi. They feed on and break down organic matter like leaves and other plant material. When they die or are eaten by predators, the nutrients they absorbed are released into the soil and used by plants.

Bacteria are the smallest members of the community and the most numerous. There may be a ton of bacteria in one acre of soil. If counted out in $1000 bills, a billion dollars would be 358 feet tall but a billion bacteria would fit on your fingertip. In addition to plant material, certain bacteria can break down pesticides. They also secrete sticky enzymes that aid in creating optimal soil structure. Some types of bacteria transform nitrogen gas from the air into nitrogen compounds that plants are able to use. Two types of bacteria are responsible for the earthy smell of soil and they also release antibiotics that keep other bacteria populations from exploding.

Fungi include molds, mildews, yeasts, mushrooms, rusts and smuts. They typically grow by sending out slender filaments called hyphae. Some fungi can be hundreds of years old and their hyphae can cover hundreds of acres if not disturbed. They can break down tough plant materials like cellulose and lignin. Several species capture and feed on nematodes that parasitize plant roots. Individual hyphae are so thin they are practically microscopic but they often form a mass that is easily seen. Mushrooms are usually seen when one pushes through to the surface to form spores and reproduce, but most growth is underground.



Secondary consumers feed on primary consumers. Thousands of species like amoebae, springtails, diplurans and nematodes eat bacteria and fungi. They excrete nitrogen waste like ammonium that plants absorb directly. Their undigested waste becomes part of the soil's organic matter and is digested further by bacteria and fungi. While not as small as bacteria, many secondary consumers are microscopic. Thousands of different species and billions of individuals may live in a handful of soil.

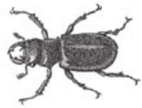
An amoeba is just one of the many thousands of single-celled protists that eat bacteria and fungi.

Springtails are tiny, abundant soil insects. They have a special appendage that allows them to jump many times their own body length.

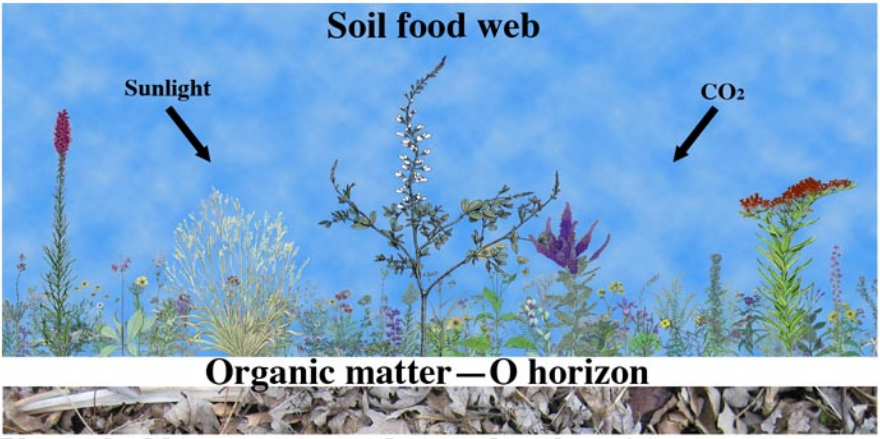
Nematodes, roundworms, are the most numerous multicellular animal on Earth; more than 20,000 species have been identified. They are typically thinner than a human hair and 1/20 of an inch long or less. Some feed on fungi or bacteria; some feed on other nematodes or protists. Several species are plant parasites but most are not harmful to plants. When they eat other consumers, the ammonium released enriches the soil. Free-living nematodes live in the water film in pore spaces. Parasitic nematodes live on plant roots.

Tertiary consumers eat the secondary consumers. These are generally larger organisms like beetles, spiders, ants, centipedes, millipedes and earthworms. Their fecal pellets are eaten by the primary consumers, which again enriches the soil. These larger creatures also aerate and mix the soil when burrowing.

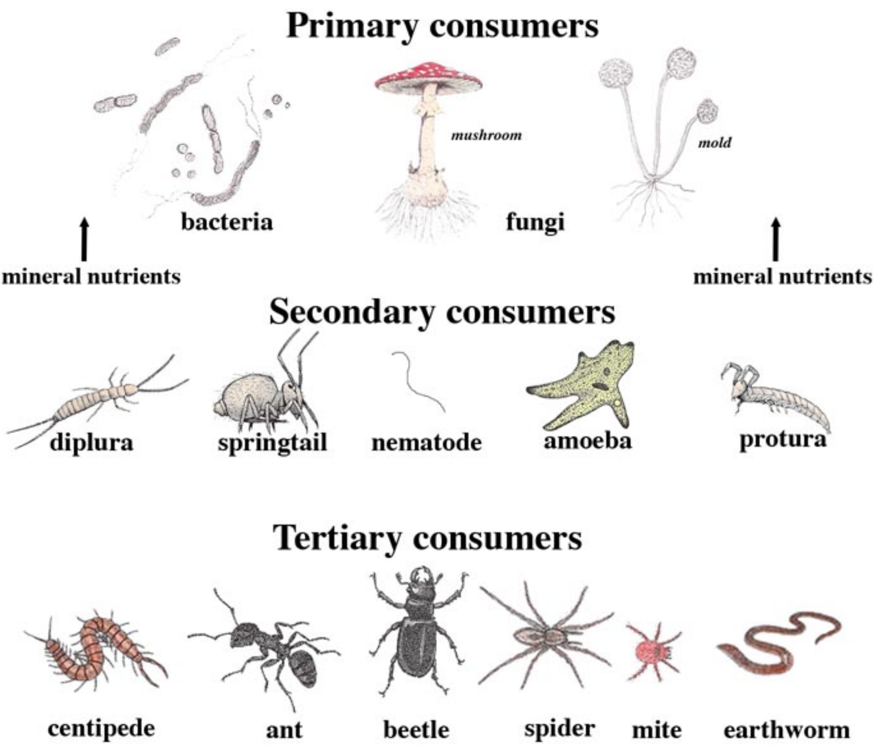



In some instances secondary consumers eat tertiary consumers and sometimes bacteria and fungi will parasitize both secondary and tertiary critters—that is why we call this a food web instead of a food chain.



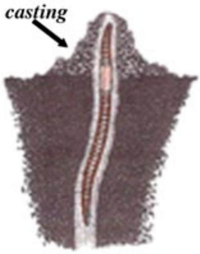
Plants shed leaves, stems and roots that the primary consumers feed on and break down to create humus. The activities of all the consumers serve to create a nutrient-rich topsoil with excellent texture and structure that sustains the consumers as well.



Food web is not to scale

Surface predators

The soil ecosystem does not stop at the surface. Most of the tertiary consumers move in and out of the soil and are eaten by mammals, birds, reptiles, amphibians and insects.



Earthworms spend much of their time underground but come to the surface occasionally, especially after a heavy rain. They plow through and eat soil by the mouthful. The decomposing organic matter they eat makes them primary consumers. But they also ingest primary and secondary consumers, making them tertiary consumers as well—the web again. After they extract food from the soil they swallow, they excrete a casting. Castings are extremely rich in nutrients. You may see castings as little mounds on the surface. Earthworms burrow extensive tunnel systems. In one acre, a million earthworms may turn over 10 tons of organic matter and aerate 40 tons of soil per year.


Shrew eating a worm


Human eating a worm

You have probably seen a robin yank a worm from its burrow near the surface but shrews and moles will burrow down after them. Even some humans enjoy a tasty worm baked in a Mother Earth cake.


ground squirrel


mole


badger


gopher

Burrowers such as ground squirrels, moles, badgers and gophers are often a curse to farmers and gardeners but they are good indicators of a healthy soil ecosystem. They would not be in your yard or field if there wasn't an adequate supply of earthworms, insect larvae and other edibles. Their burrowing activity also mixes organic matter with lower levels and brings mineral nutrients up. And of course their burrows help aerate the soil.

A deer decomposing

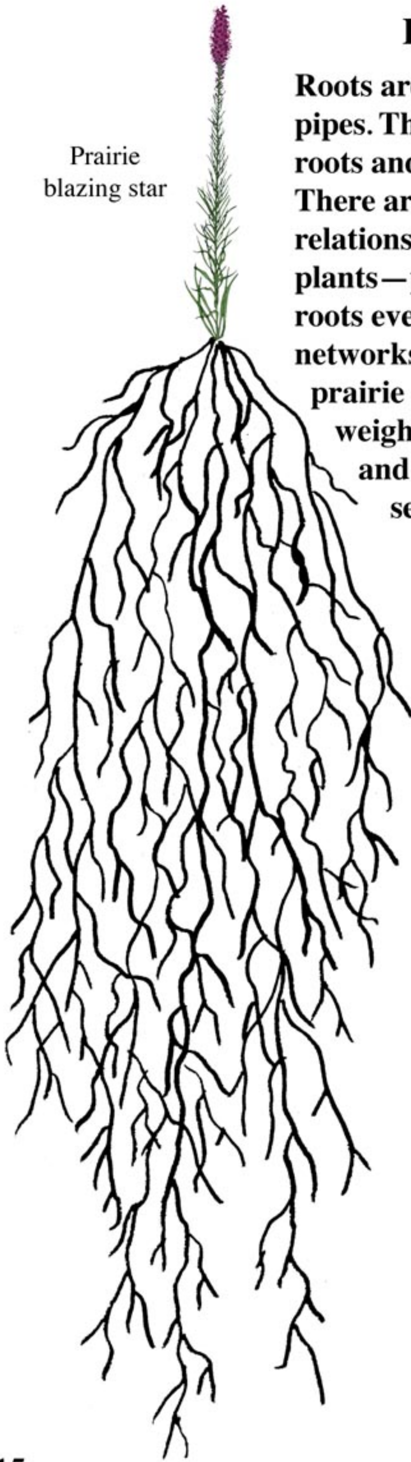
The organic matter in soil is not just plant material. Most animals eventually become part of the soil too. Within hours after an animal dies, flies will smell the decay and lay their eggs on the dead body. When the eggs hatch, the larvae, maggots, begin to eat the carcass.

Maggots on a dead deer

In the meantime, bacteria and fungi also help break the body down. It can be a smelly, gruesome business but if not for these decomposers we would be buried in feces and dead bodies. This process is part of the big web. After a couple of seasons, another deer will graze on the plants that grow in the soil nourished by the dead deer's body—it's the ultimate recycling plan. For an ecosystem to function properly, we need the good, the bad and the ugly. Not only is a diversity of life vital for a healthy planet, it also makes our lives more entertaining and enjoyable.

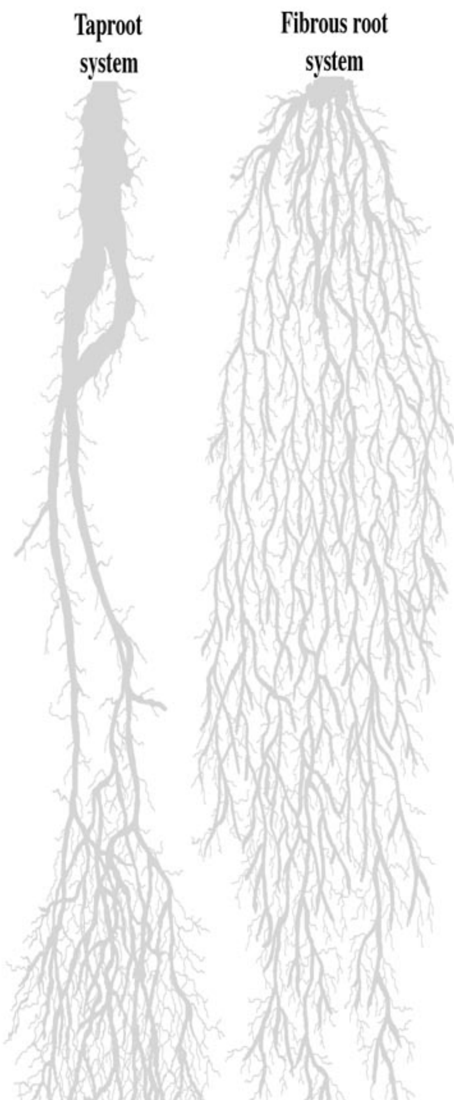
Wild Iowa

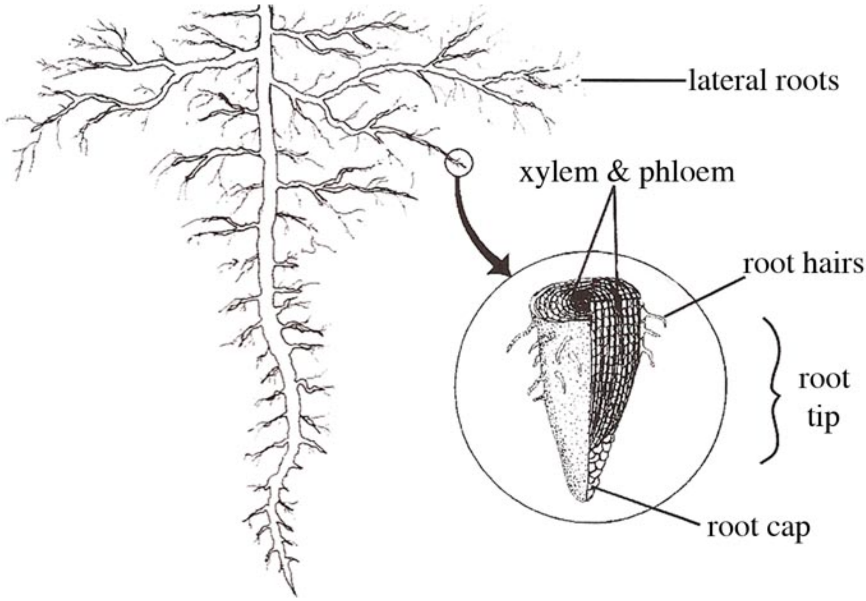
Roots



Roots are a plant's anchor and supply pipes. The soil holds a plant up by the roots and roots hold the soil in place. There are many such mutually beneficial relationships in the root world. Perennial plants—plants that grow back from their roots every year—can grow extensive, deep networks of roots. The root system of a prairie plant may make up to 70% of the weight of the plant. Roots grow down and out in search of food and water to send up to the vegetative part of the plant. In turn the leaves of the plant nourish the roots. Some individual prairie plants and their roots can be hundreds of years old. Even though some of the rootlets die every year, the main rootstock of perennials just goes dormant in the winter. As soon as the soil warms in the spring, the roots start pumping water and food and a plant springs to to life. Annuals have to start over every year from a seed but the prairie perennial's roots can go deeper every year—some go down 25 feet or more. These deep roots create excellent pore space, allowing even heavy rains to infiltrate the soil without runoff. Prairies did not suffer from erosion. It would be a good thing if we emulated the prairie ecosystem more in agriculture.

Roots come in many different shapes and sizes but there are two types of basic root systems: the taproot system and the fibrous root system. Grasses usually have fibrous roots that are fine and dense. The roots of wildflowers tend to be coarser, even if they don't have a true taproot. Roots come in different colors as well but the majority of prairie plant roots tend to be a dull white or tan. Their depth depends on the type and age of the plant, soil type, topography and climate.



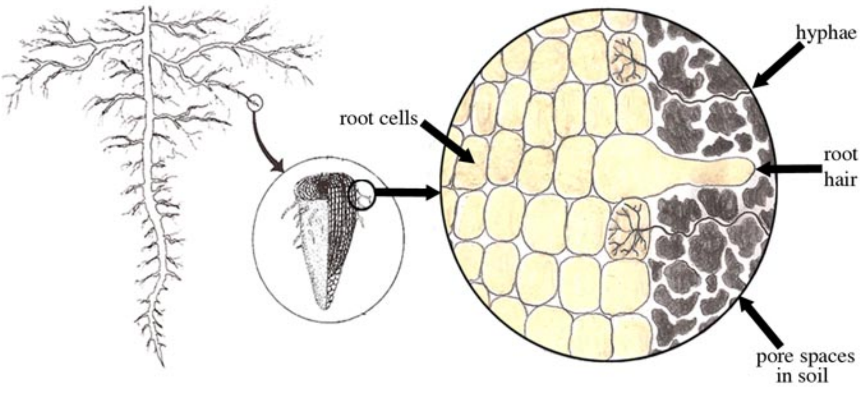


A seedling's first roots grow straight down. Its lateral roots grow out from the base of the plant in a crisscross pattern that anchors the plant in the ground. As the soil warms in the spring the roots grow millions of new root hairs that absorb water and nutrients from the soil. A square yard of big bluestem sod may contain over 25 miles of fine root hairs and rootlets. In one year the rootlets that decay along with surface litter may add up to 900 tons of organic matter per acre, returning nutrients to the soil and protecting it.

Each root tip has a root cap that protects the root as it grows, pushing forward into the soil. Roots are able to grow longer and wider thanks to special cells called cambium cells. As these cells divide, the root gets bigger. Cells on the outside of the cambium layer become phloem cells that transport nutrients in the plant. Cells on the inside of this layer become xylem cells that transport water in the plant—supply pipes. This growth by dividing cells in the root tip enables the root to spread down and out in its search for more water and nutrients. Growing roots also aerate the soil much like burrowing animals.

Mycorrhizae

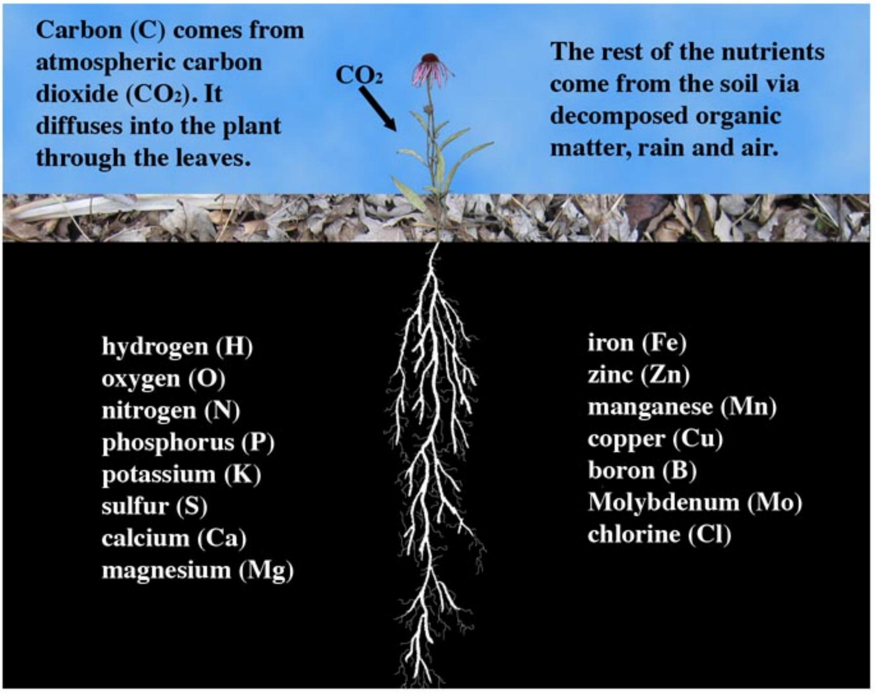
Roots interact with some soil creatures. Several species of fungi capture and feed on nematodes that parasitize plant roots. And some fungi form a mutually beneficial relationship with roots called mycorrhizae. The hyphae of the fungi penetrate root cell walls and branch out. The hyphae are so numerous that they greatly increase the surface area of the root system enabling the roots to absorb more water and nutrients. Mycorrhizae may also protect roots by blocking the growth of harmful fungi. In return, the plants feed the fungi sugars and amino acids. Plants in disturbed soils do not have the benefits of mycorrhizae and are not as robust or drought-resistant.



Obviously not all soil organisms are beneficial, and most plant pathogens happen to be fungi. That is why it is so crucial to have sufficient diversity in an ecosystem. In a diverse soil ecosystem, plant diseases are greatly reduced. If the soil doesn't contain species that eat fungi spores they will grow and spread out of control. Predators such as mites, spiders and centipedes feed on the eggs of pesky insects before they can do harm but pesticides often kill both the harmful and the beneficial species. Also, pests tend to build up resistance to chemicals while predator species often have a hard time recovering.

Nutrients

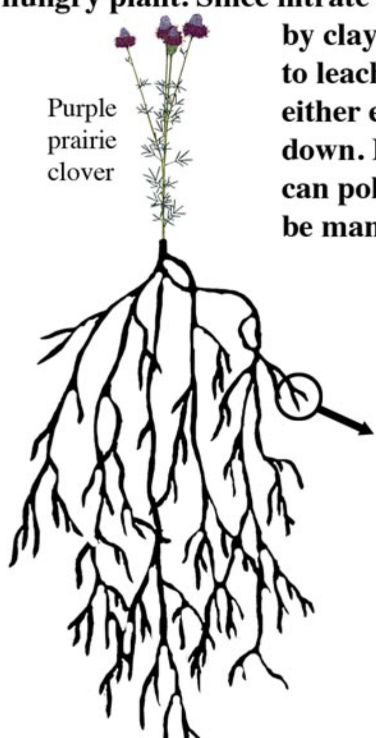
Nearly 90% of an average plant's living tissue is water that its roots absorb from the soil. The rest of the plant is made up of carbon, oxygen and hydrogen. The carbon comes from carbon dioxide that the leaves extract from the atmosphere. Hydrogen and oxygen come from water in the soil. Oxygen and hydrogen combine with carbon dioxide during photosynthesis to make sugars. Plants must absorb 13 other elements from the soil to reach maturity. The chemistry of nutrient absorption can get complicated but basically roots absorb the nutrients in the form of mineral ions that are dissolved in water. A lot of the nutrients are bound up in insoluble form in the organic matter and are not available to plants until the soil organisms decompose them. This is why it is so important to maintain an adequate amount of organic matter and soil creatures. When you rake leaves off a flower bed or remove a crop without leaving plant residue, you are removing potential nutrients. Without organic matter the soil becomes exhausted and will only grow plants with fertilizers.



Nitrogen fixation

Nitrogen is the nutrient needed in the largest amounts for plants to grow, but it is tricky for them to obtain it in a usable form. Nitrogen comes from the atmosphere, which is 78% nitrogen. It exists in a gaseous form that plants cannot use. When organic matter is decomposed by soil organisms, some nitrogen is released as ammonium, a soluble form that plants can absorb. Certain microorganisms convert ammonium to nitrate, another soluble form available to plants. Plants also get nitrogen from another mutually beneficial relationship between roots and certain bacteria called rhizobia. Rhizobia form nodules in the roots of certain plants; through these nodules roots are able to take gaseous nitrogen from the air into the soil and convert it to usable forms within the plant. This process, referred to as nitrogen fixation, is part of the wisdom behind crop rotation. Legumes such as beans, clover, peas and alfalfa are the primary hosts of rhizobia. An acre of alfalfa may fix between 100 to 200 pounds of nitrogen per year. Corn is a particularly nitrogen-hungry plant. Since nitrate has a negative charge, it is not held by clay or organic matter and is susceptible to leaching out of the soil. Excess nitrates either escape to the atmosphere or leach down. If nitrates leach deep enough, they can pollute groundwater. Nitrogen should be managed carefully to achieve a balance.

Purple prairie clover



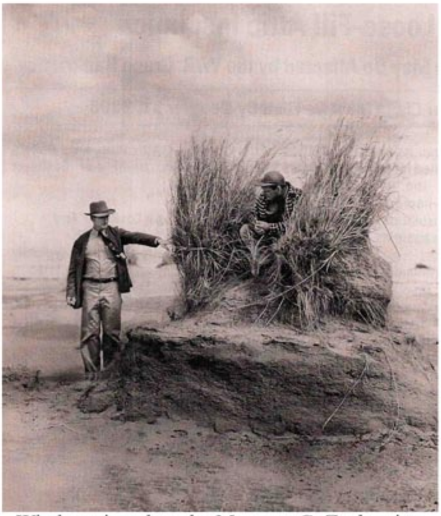
Nitrogen-fixing nodules on a root

Iowa's prairie legacy

Plowing virgin prairie with oxen. Archive photo.

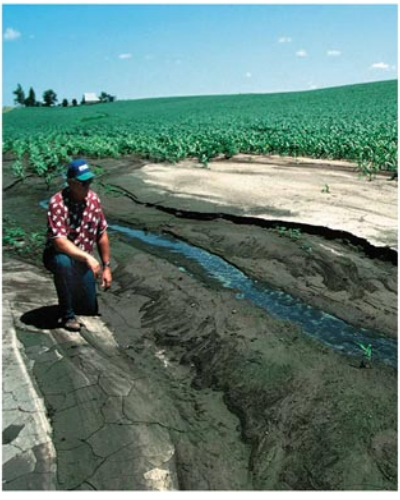
When early settlers ran the first plow through virgin tallgrass prairie, they soon discovered how deep and dense the prairie root system was. New Jersey tea was known as the pest of the plowman or rupture root because its huge taproot would damage plows. Leadplant was called prairie shoestring due to the sharp, snapping sounds made when a plow point tore through its rootlets. A regular plow and a mule could not cut the tough sod, it took a breaking plow and a team of oxen. But break it they did. A good team and a long day of backbreaking labor could plow up one or two acres. Within one generation, early farmers—without modern equipment—plowed 99% of the Iowa prairie into cropland and stopped the cycles of the tallgrass ecosystem. Over thousands of years the prairie had built soil so rich and deep that it has been productive cropland for decades. Iowa owes its productive agricultural economy to prairie soils.

Without soil there would be no roots and without roots there would be no soil.

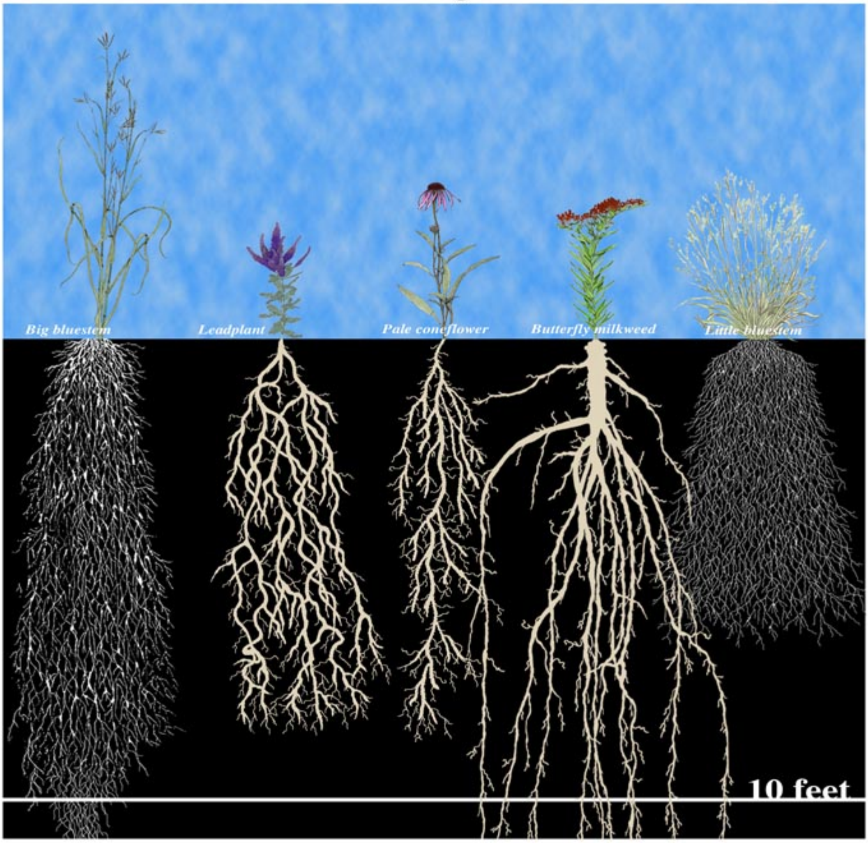

Wind erosion photo by Margaret G. Zuckowitz

A man measures the former ground level in New Mexico in 1957. Only the deep roots of native bluestem grass held this sandy soil together; winds had carved the rest away. "Back then farmers here used clean tillage, the practice of clearing the soil surface of plant debris," says agriculture extension agent Patrick Kircher. "They also broke down the ground to make way for a very fine seedbed. Now we know to leave crop residue on the surface to help keep things in place."

Unfortunately we still lose tons of soil every year to wind erosion and we lose even more when rain hits unprotected ground. Prior to the 1830s, Iowa's prairies absorbed about 90% of rainfall with 10% runoff from melting snow and rain on frozen ground. Today's landscape sheds runoff after very little rain. The results are erosion, flooding and water pollution. Eroded soil chokes rivers and lakes with a load of sediment and chemicals. This not only contaminates Iowa waters but has contributed to a massive dead zone in the Gulf of Mexico. Deep roots and ample organic matter are necessary to infiltrate rain and prevent erosion, flooding and pollution.


Water erosion. NRCS photo.

Alternative agriculture



The beauty of a perennial system like the tallgrass prairie is that it continually recycles nutrients and builds more soil every year instead of losing it. The prairie is a self-maintaining system.

People at the Land Institute in Kansas have been working to develop a perennial crop plant with a yield and protein content comparable to soybeans. If they succeed, we may see a perennial row crop emulating prairie. Instead of planting traditional crops like corn and soybeans season after season, we would plant a perennial crop once. The soil would not be laid bare for half the year the way it is now. There would be less compaction, no tillage, no erosion, no need for pesticides or fertilizers—all for less cost. Soil would be replenished and wildlife would benefit from the additional habitat.

Iowa Living Roadway Trust Fund

Roadside planting photo by Kirk Henderson

The Iowa Living Roadway Trust Fund and Integrated Roadside Vegetation Management have been putting deep prairie roots to use in Iowa's roadsides for more than 20 years. Over 30,000 acres in 83 counties have been planted in prairie. There are approximately 750,000 acres of roadside in Iowa. Using prairie plants has reduced maintenance and has saved money. There is a lot less mowing and no need for blanket spraying of herbicides. The deep roots control erosion and infiltrate stormwater more effectively than brome. It usually takes a few years for a prairie planting to become established but older plantings can control noxious weed outbreaks as well. Surprisingly large numbers of wildlife take advantage of these corridors, and the colorful diversity is a welcome sight for many road-weary travelers.

The prairie was plowed up one acre at a time. Some of it is being replanted one acre at a time.

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Coyote pup in a den

The world beneath your feet is home to countless creatures from microscopic bacteria to full-grown mammals. They live, work and die in cycles that allow plants to grow and provide all living beings on Earth a food source. Life as we know it would not be possible if not for healthy soil. Dig into this wild world, you will be amazed.