soil4life

What is essential is invisible to the eye

SOIL MANAGEMENT TOOLKIT

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ROMA

ZELENA ISTRA

Author
Kate Curtis
www.greenhearted.net

Design, Illustration, Photos
Kate Curtis (Unless other source is sited)

To know more about our work:

CCIVS.ORG	secretariat@ccivs.org
FACEBOOK	/secretariatccivs
INSTAGRAM	@ccivsvolunteer
TWITTER	@ccivs_volunteer

To know more about the Soil4Life Project:
www.soil4life.eu
info@soil4life.eu
#soil4life

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CONTENTS

INTRODUCTION

"Land is not merely soil, it is a fountain of energy flowing through a circuit of soils, plants and animals."

Aldo Leopold, Author, philosopher, scientist and conservationist

Soil is literally the foundation of all civilization and life as we know it. The latest results of studies on the state of soil on our planet are extremely alarming. We are losing topsoil at a rapid rate, faster than it can be created and restored. The factors that cause this are numerous and complex: broad scale, standardised agricultural practices play a large role, as does the growth of urban sprawl which leads to soil sealing*. The consequences of the degradation and loss of soils are frightening and innumerable because soils are the basis on which all our food systems depend. Not only does soil play a vital role in maintaining a balanced and clean water cycle, but living, healthy soils offer us the potential to hold and store carbon as organic matter and in living plants, and therefore are a potential solution to contribute to the offsetting of carbon emissions and regulate the current climate crisis we are facing.

The dirt below our feet plays a critical part in our interconnected and living planet´s ecosystem. There are many solutions, large and small and this Soil4Life Toolkit aims to support learning and motivate people to take actions (however large or small) that positively contribute to the regeneration and restoration of our soil and greater environments.

*Soil sealing can be defined as the destruction or covering of soils by buildings, constructions and layers of completely or partly impermeable artificial material (asphalt, concrete, etc.). It is the most intense form of land take and is essentially an irreversible process.
https://www.recare-hub.eu/soil-threats/sealing#what_is_soil_sealing

"Essentially, all life depends upon the soil... There can be no life without soil and no soil without life; they have evolved together."
Dr. Charles E Kellogg, Soil Scientist & Chief of the USDA's Bureau for Chemistry & Soils

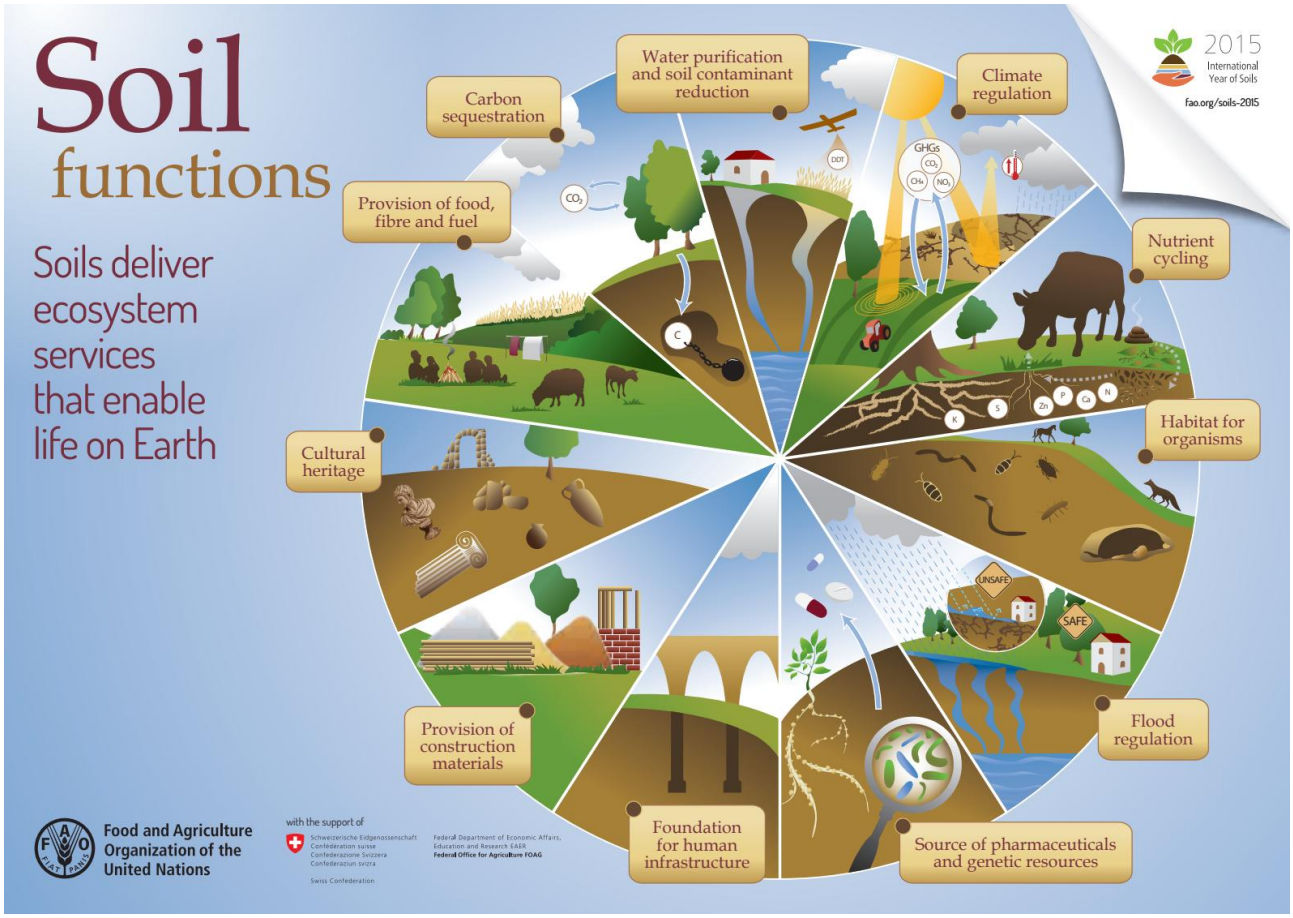
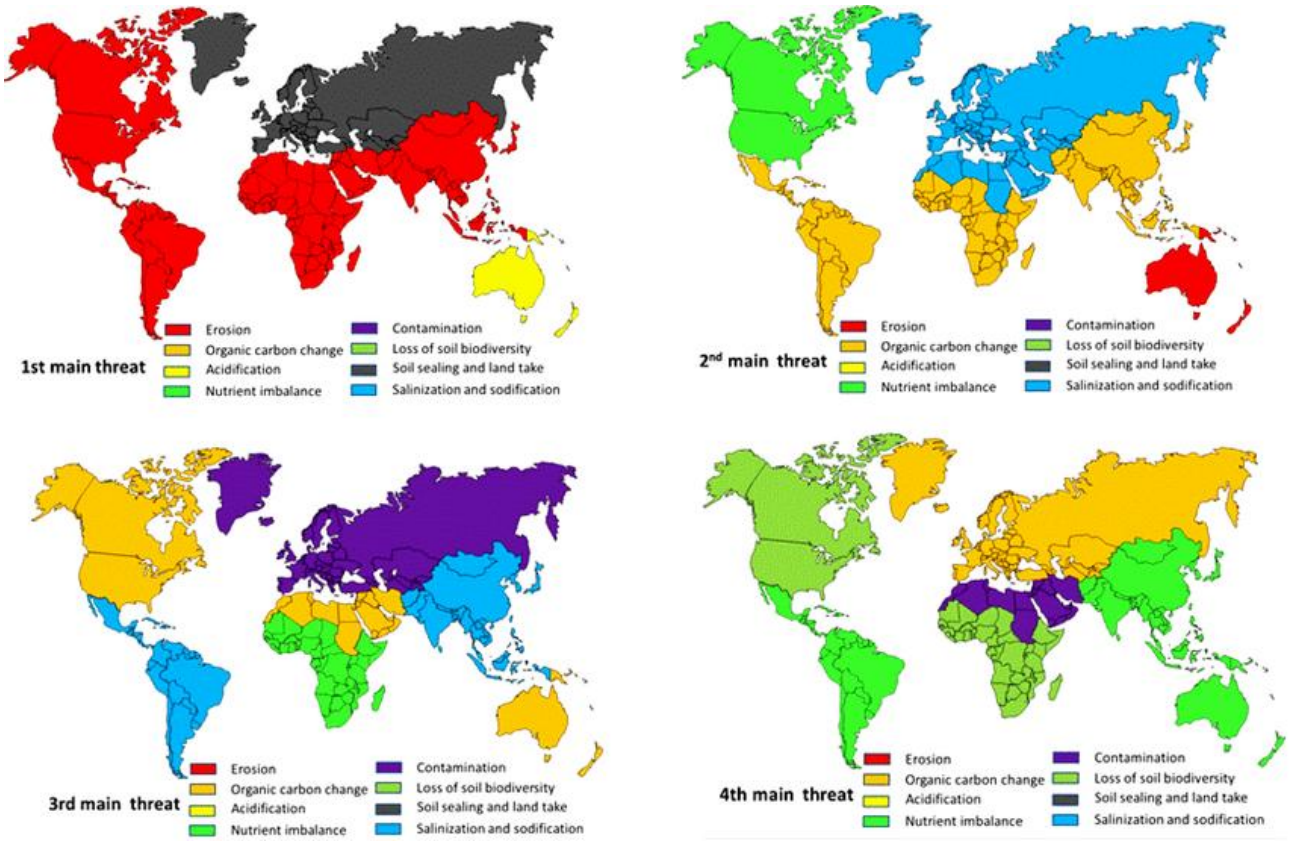


Image from FAO United Nations, Free International Soil Day campaign materials

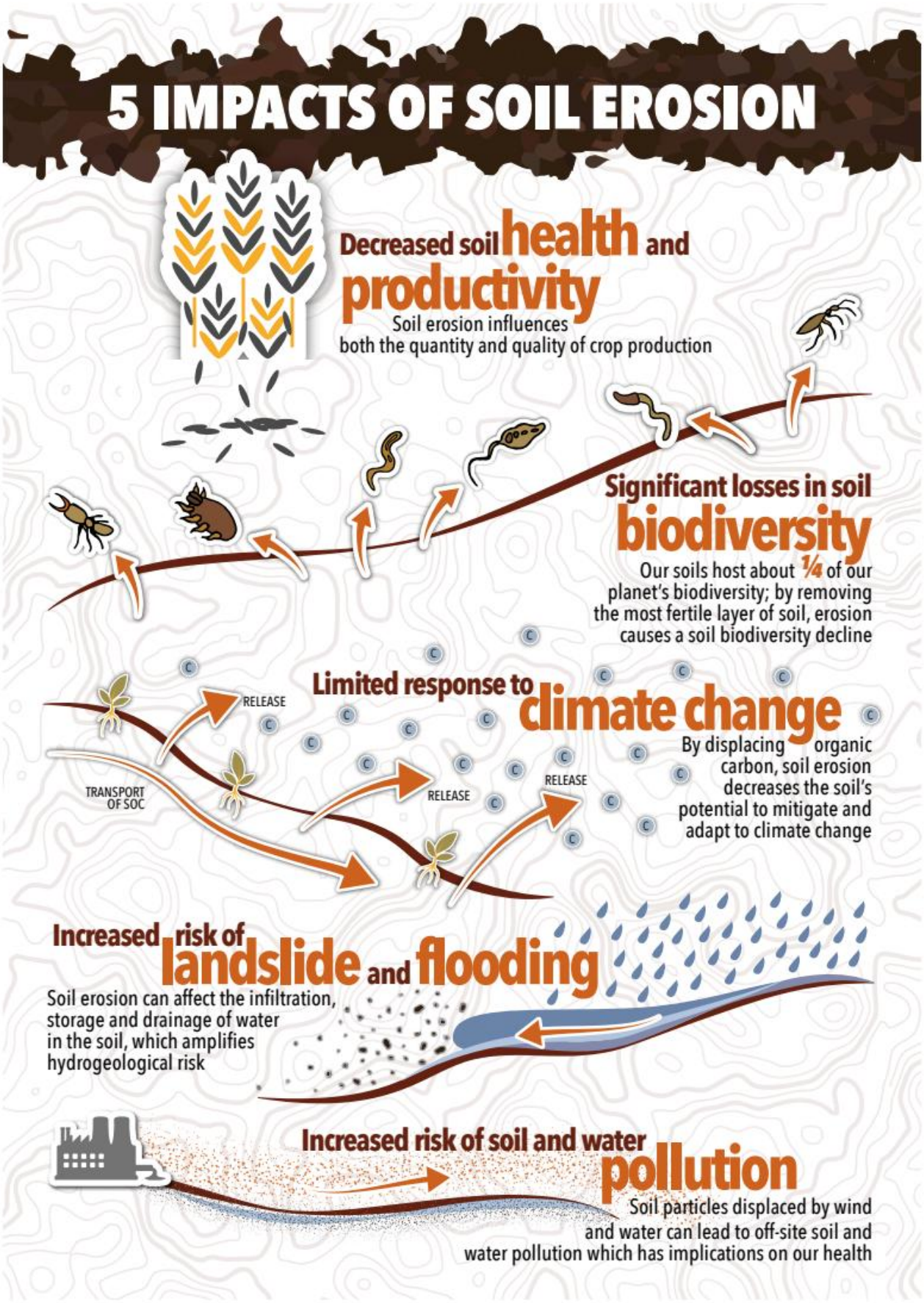
MAIN THREATS TO SOIL

It is essential to note that soil is a non-renewable resource. Soils need to be conserved, protected and restored in order for life to continue.
Soil health and protection are intrinsically linked with the healthy and balanced functioning of the water cycle. As all life depends on these cycles it is of utmost importance to recognize that erosion, loss of biodiversity, pollution, soil sealing and other issues that negatively impact soil on our planet affect ALL life and food systems.

Soil is a collective concern and a collective responsibility.



Global assessment of the four main threats to soil by FAO regions


5 IMPACTS OF SOIL EROSION
Decreased soil health and productivity
Soil erosion influences both the quantity and quality of crop production
Significant losses in soil biodiversity
Our soils host about ¼ of our planet's biodiversity; by removing the most fertile layer of soil, erosion causes a soil biodiversity decline
Limited response to climate change
By displacing organic carbon, soil erosion decreases the soil's potential to mitigate and adapt to climate change
RELEASE
TRANSPORT OF SOC
RELEASE
RELEASE
Increased risk of landslide and flooding
Soil erosion can affect the infiltration, storage and drainage of water in the soil, which amplifies hydrogeological risk
Increased risk of soil and water pollution
Soil particles displaced by wind and water can lead to off-site soil and water pollution which has implications on our health

#1 SOIL EROSION

Soil erosion is the removal of the most fertile top layer of soil from the land surface through water, wind and tillage.

SOIL ACIDIFICATION

Lowering of the soil pH caused by the buildup of H+ and Al3+ ions in the soil and the leaching of base cations such as Ca2+, Mg2+, K+ and Na+. The main causes of soil acidification are long term rainfall, draining of potentially acid sulphate soils, acid deposition, excessive application of ammonium-based fertilizers, deforestation and land use practices that remove all harvested materials.

SOIL BIODIVERSITY LOSS *Soil is Alive!*

Decline in the diversity of organisms present in soil (See page 13 The Soil Food Web) that affects multiple ecosystem functions, including plant diversity, decomposition, nutrient retention and cycling, plant and animal health, soil carbon sequestration and greenhouse gas. emissions.

SOIL COMPACTION

Increase in density and a decline of macro-porosity in soil that impairs soil functions and impedes root penetration and water and gas exchange.
Soil compaction can reduce crop yields by as much as 60%. Agricultural mismanagement (80%)and overgrazing (16%) are the two major causative factors of human induced soil compaction.

SOIL CONTAMINATION

Increase in toxic compounds (heavy metals, pesticides, etc.) in soils affects human health and/or the provision of soil ecosystem services. The three major pathways for diffuse soil contamination are atmospheric deposition, agriculture and flood events. Soil contamination can reduce food security by decreasing crop yields and rendering crops unsafe for consumption.

SOIL SEALING

Permanent covering of the soil surface with impermeable artificial materials, leading to non-reversible loss of soil and most of its ecosystem services. The main negative impacts on ecosystem services include losses of food and fibre production; significant decreases or total loss of the soil's water retention; reduced neutralization and purification capacities and reduction of carbon sequestration capacity.

SOIL ORGANIC CARBON LOSS

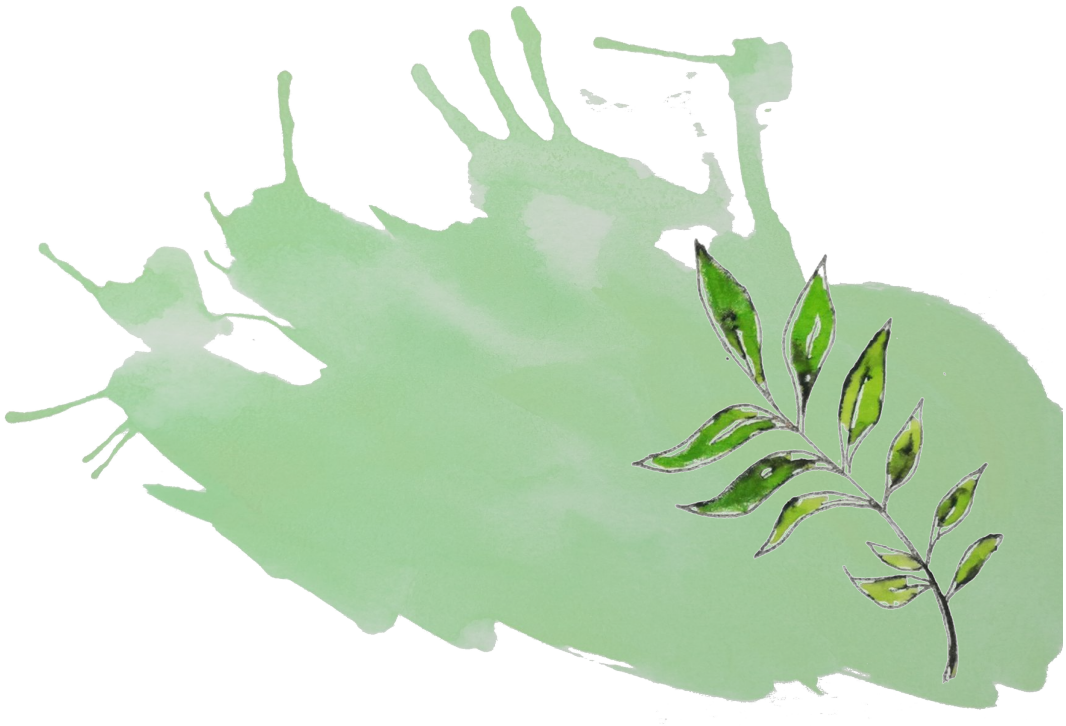
Decline of organic carbon stock in the soil affects its fertility status and climate change regulation capacity. Approximately 1 417 billion tonnes of SOC are stored in the first meter of soil and about 2 500 billion tonnes at two meters soil depth. The global loss of the SOC pool since 1850 is estimated at about 66 billion tonnes (±12), mainly caused by land use change. ***There is more organic carbon in the soil than there is in the vegetation and atmosphere combined.***

SOIL SALINIZATION and SODIFICATION

Increase in water-soluble salts in soil, including potassium, magnesium, calcium, chlorine, sulphate, carbonate, bicarbonate (salinization) or high sodium content (sodification). It negatively affects plant growth, reduces crop yields and can make soils unproductive.

SOIL NUTRIENT IMBALANCE

Incorrect land use and management may result in an excess of nutrient causing soil contamination and contributing to water quality deterioration and greenhouse gas emissions. Conversely, a lack of nutrients may lead to low soil fertility. ***Increasing soil organic matter can boost soil fertility and balance the soil nutrient cycle***.

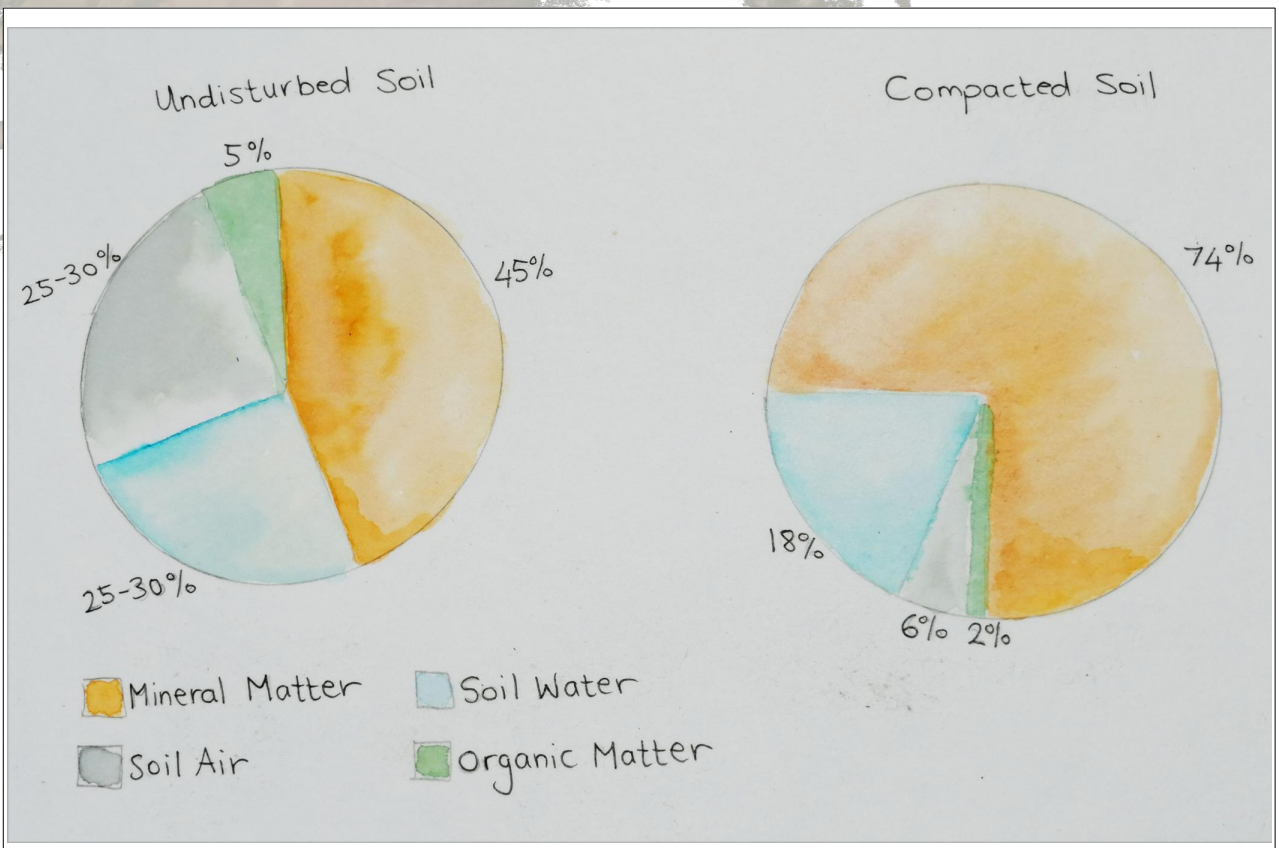


WHAT IS SOIL?

Soil is alive!

Healthy soil mass is made of approximately 50% water and air, plus a vital 5% or organic matter. This air, water and organic matter is what makes it possible for a living, functioning soil food web. The complex relationships between bacteria, fungi, micro and macro-organisms, plants and their root exudates plus decaying organic matter, provides conditions for life and an exchange of minerals and compounds.

When soil is compacted (ie, heavily plowed, left uncovered to be exposed to rain and sun, walked over, driven over, etc) we literally loose space for air and water between the mineral particles. As water and air content decreases, so does the possibility for living organisms in the soil. The health and abundance of these living organisms directly affects the health of roots and plants.



Undisturbed soil shows balance compared to compacted soil

MINERAL CONTENT:

Soil particle size and shape define the kind of soil you have in your garden or area and will effect its texture, water holding capacity, porosity and ability to retain nutrients.

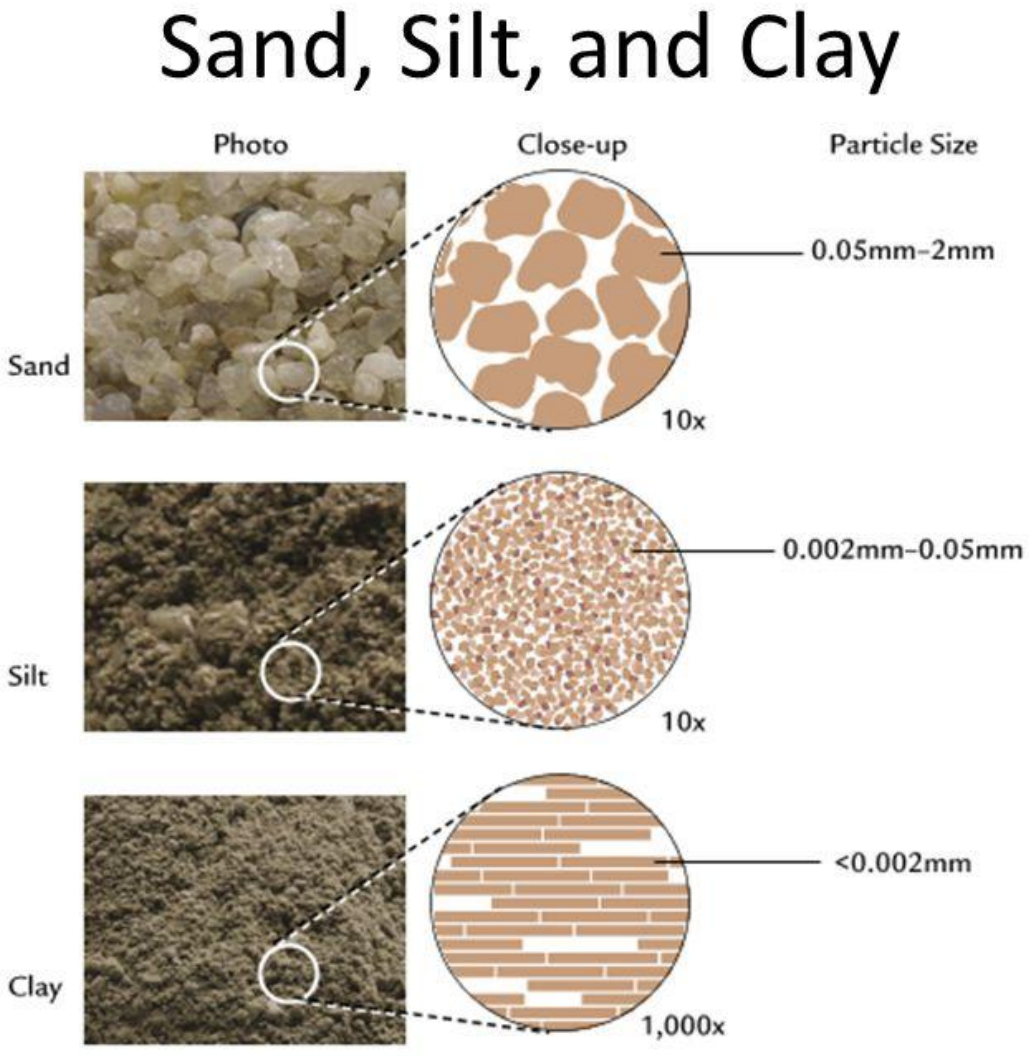


Image source: https://theconstructor.org

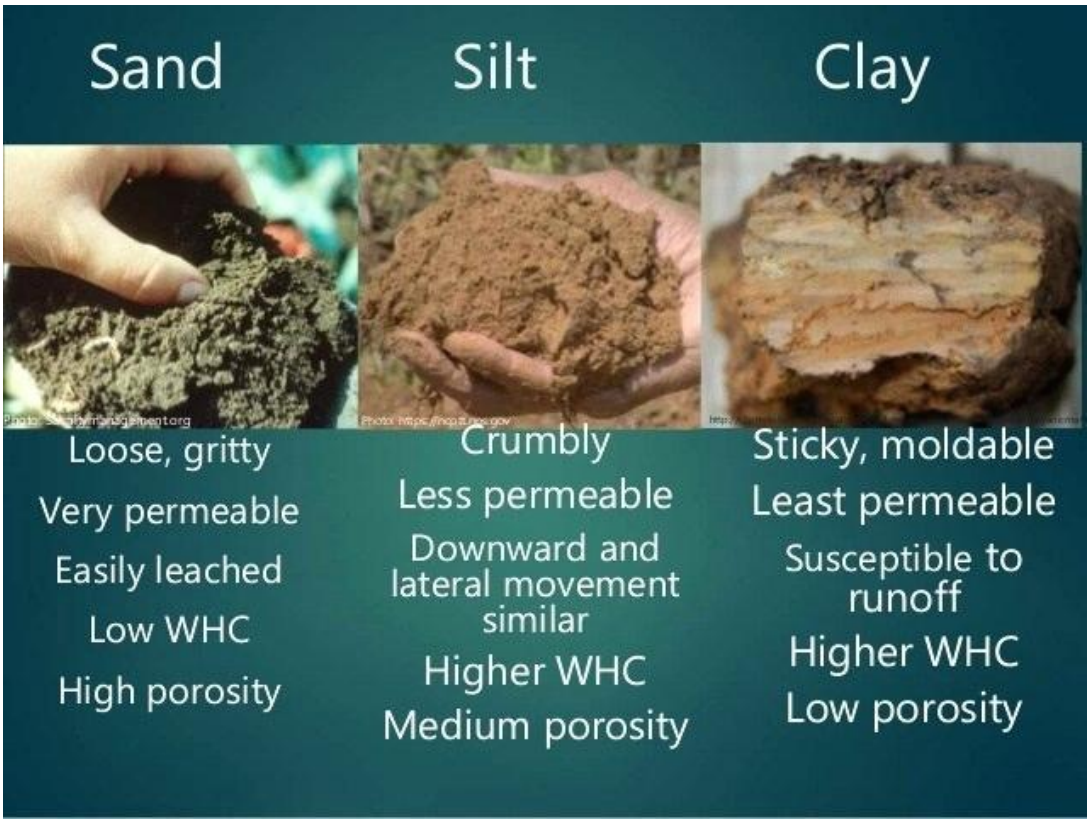


Image Source: www.gardengrimoire.wordpress.com

What is a soil profile?

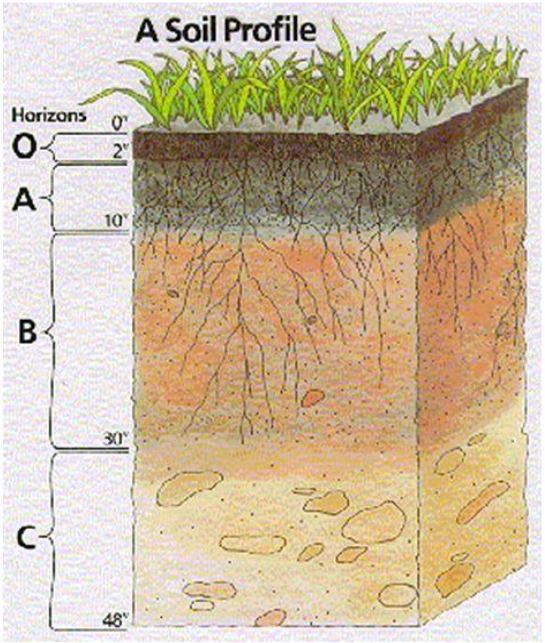
A soil profile consists of several **soil horizons**.

O horizon
- humus on the ground surface.

A horizon
- Top soil.
- Rich in organic matter. Typically dark color.
- Also called zone of **leaching**.

B horizon
- Subsoil.
- Also called zone of accumulation.
- May contain soluble minerals such as calcite in arid climates (caliche).

C horizon
- Weathered bedrock (rotten rock).
- Bedrock lies below the soil profile.



ACTIVITY 1:
A SIMPLE SOIL TEST

STEP 1: Take a sample of soil from your land (or different parts of the land) about a handful is fine. Make sure to take soil from the top, middle and deeper layers if possible.

STEP 2: Crush up the soil so it is mixed well.

STEP 3: Put it in a clean glass jar.

STEP 4: Fill the jar with water.

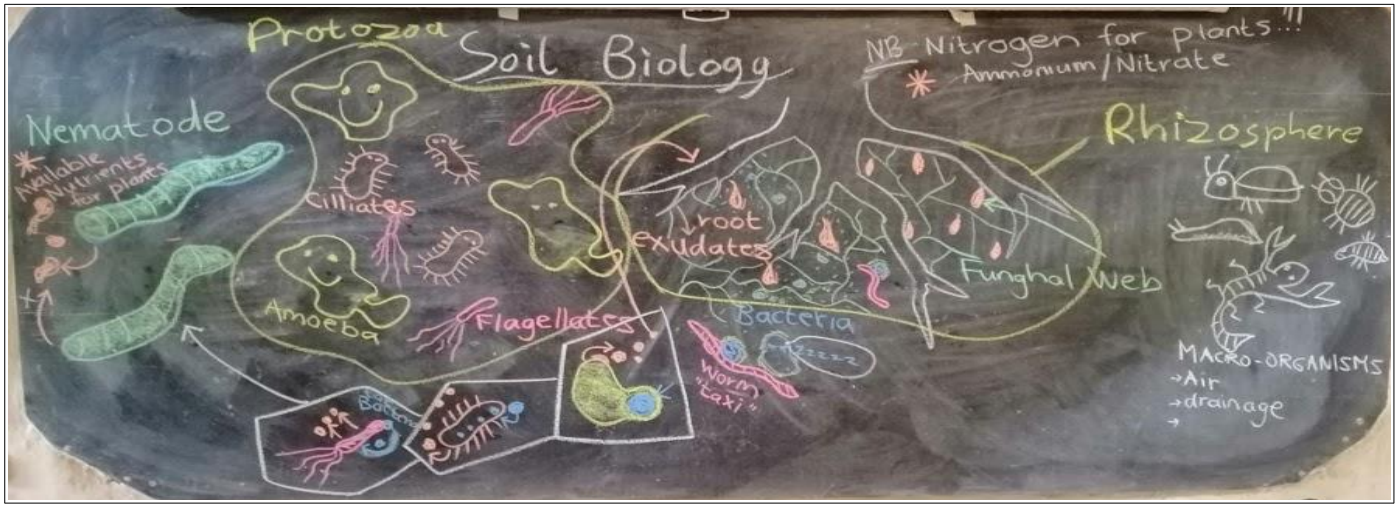
STEP 5: Shake the soil and the water until it is well mixed (about a minute).

STEP 6: Let the water/soil mix settle over night (or 24 hours).

STEP 7: Identify your soil layers and ratios. Holding the jar up to the light will help you to see the layers: organic matter will float on top, the finer clay particles will be the top later, silt in the middle while the larger, heavier sand particles will sink to the bottom.

Image from
https://www.waldeneffect.org/blog/Jar_test_to_measure_soil_texture/

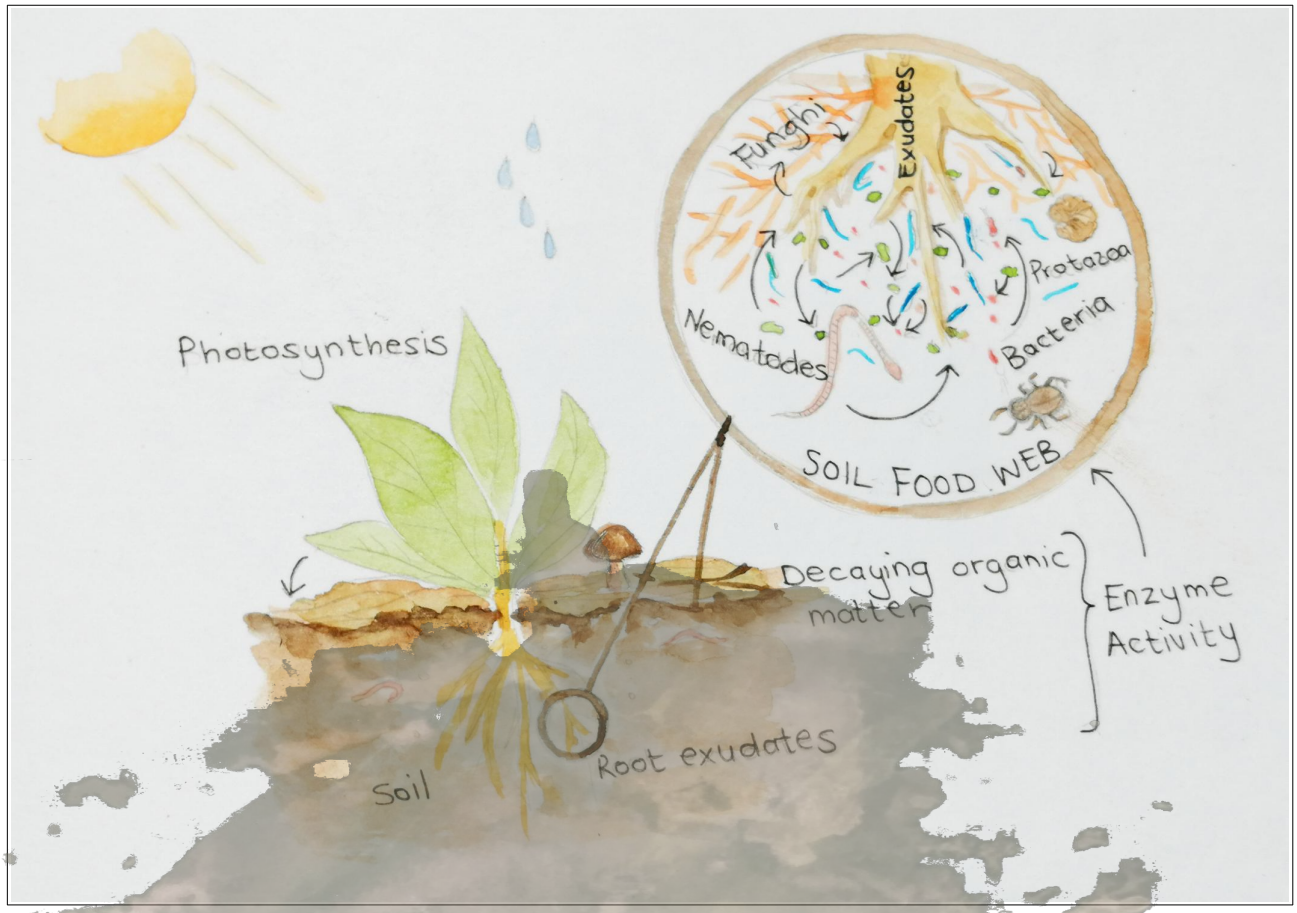
THE SOIL FOOD WEB



Soil is not a dead medium to grow plants in, soil is alive!

The Soil Food Web is a complex, living, web of relationships that takes place in the fragile topsoil of our earth. Scientists are still studying and discovering more about this relatively recent subject. It is essential to understand the role that plants and roots play: through photosynthesis, plants create types of sugars and carbohydrates, called root exudates, that are the food source of many bacteria. The area around the roots is called the rhizosphere and it is where the majority of life in the soil is found. Bacteria and fungi are attracted by the root exudates, and they in turn, attract nematodes and protozoa, such as amoebae, flagellates and ciliates, that come to eat them. These micro-organisms produce nutrients for plants when they die, as well as metabolize or excrete ammonium and nitrates. The fungal web also plays a key part in the food web: transferring and transforming nutrients, decaying matter and information between plants, the soil and even other plants. Other macro-organisms, like earthworms and termites, play another vital part, by transforming bacteria and organic matter into plant-available nutrients. Their movement also creates space for air and water in the soil, and they are used as "taxis" for other organisms who cannot move on their own. In a healthy soil, there is symbiotic relationship between multiple elements in the soil food web.

For more information and resources on the Soil Food web, visit https://www.soilfoodweb.com/ which explains the work of Dr Elaine Ingham PhD (soil scientist and microbiologist).



It is important to note, that each time we plow deeply or open the soil, we are damaging the delicate relationships of the soil food web and the delicate fungal network, these organisms depend on balanced quantities of air, water and protection from sunlight to survive and thrive.

Another vital part of the soil food web is the presence of plants! Soil can only be fully alive thanks to the photosynthesis functions of plants. The root exudates produced when plants photosynthesize and the decaying organic matter produced are essential to the soil biology, and vice versa.

Plants need ------ Living Soil ------- Living Soil needs------ Plants

SOIL DOs AND DON´Ts

MAXIMIZE coverage:
Keep soil covered using mulch or a living cover crop or plants, this will protect soil life (bacteria and fungi) from UV rays of the sun, it will also help to minimize evaporation and compaction and erosion;

MINIMIZE compaction:
Avoid walking on the soil, define clear walking pathways;
Avoid working the soil when it is wet, as this damages the soil structure and can take a long time to repair;
Avoid irrigating or watering with high pressure- this can compact the soil. Use gentle sprayers or hosepipe settings, a fine watering can, or drip irrigation
Avoid the use of heavy machinery;
Avoid deep ploughing;

MINIMIZE overworking the soil:
It should not be the consistency of fine powder. Instead, it should have a wide range of particle sizes and a fairly coarse feel;

MAXIMIZE the nutrient cycle
If you harvest or remove a plant through weeding, be sure to add compost or mulch to replace these nutrients;
Encourage earthworms and other beneficial organisms or add vermi-compost from your own worm bin;
Adding organic matter is an excellent way to maintain a good nutrient cycle;

MINIMIZE monoculture:
Rotate crops;
Plan to have a diversity of plants with different root depths, varieties, seasonalities and ecosystem functions;

MINIMIZE erosion:
Always keep soil covered (mulch, living plants, cover crops);
Avoid ploughing;
Plan planting patterns and paths along contours if you are on a slope
Plant or create windbreaks;

MAXIMIZE balance
Be aware of temperature, moisture, wind and compaction: use windbreaks or shade cloth or create microclimates for ideal conditions,
Adding organic matter will help to balance all these factors.

SOIL RESTORATION

Severely degraded, compacted soil.

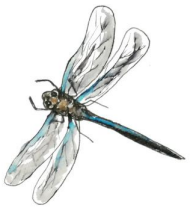
After light tilling, adding organic matter, cover crop seeds are germinating.

Note the root matter, improved porosity and water holding capacity.

Soil has improved remarkably. Note the improved structure, porosity, organic matter content, living material. A combination of nitrogen fixing legumes and grasses is present.

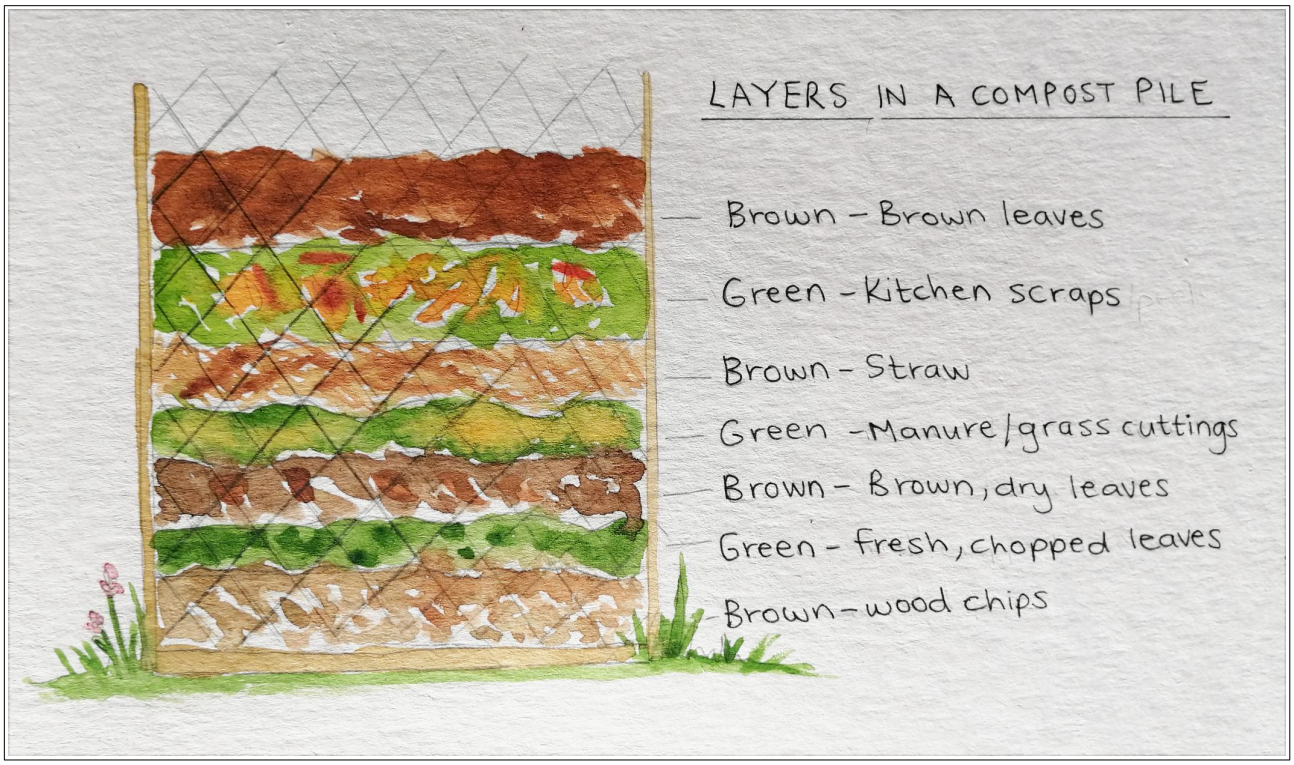
TECHNIQUES TO MAINTAIN SOIL HEALTH

There are many ways to maintain and improve the health of soils, from simple, small backyard composting systems to large-scale rotation of grazing animals.



1- Compost
2- Natural fertilizers
3- Biochar
4- Mulch
5- Cover crops
6- Crop Rotation, Mixed cropping & Support Species
7- Working with Contour Levels
8- Correct Animal management
9- Regenerative Agriculture

1- COMPOST



- Create a simple compost pile by layering:

  Organic material high in Carbon or "Brown layer":
  straw, dry leaves & grasses, woodchips, shredded cardboard, etc)

  Organic material high in Nitrogen or "Green layer":
  chopped leaves, fresh grass clippings, cow/horse manure, fresh kitchen vegetable scraps (uncooked, like vegetable and fruit peelings)

- Build the pile with Nitrogen layer: 1 part to Carbon layer: 2 parts.

- 1 parts "Green" to 2 parts "Brown" is a good general rule to follow to balance the Carbon and Nitrogen ratio. You can adapt this as you observe the pile decomposing, too much nitrogen will produce a rotting, unpleasant smell and possibly attract pests; while too much carbon will cause decomposition process to slow and cool down, and eventually stop. Compost should not smell when you have the correct N to C balance.

- You can either create 1 large pile, all at once (1 cubic meter is recommended for best results) or you can layer the compost at the same rate that you produce kitchen scraps, building the pile slowly. You will need to wait for it to become compost after you have added the final layer- the bottom layer will most likely already be further decomposed, by turning it, you can help to balance the material.

- It needs to stay moist, aerated, and at an even temperature. This means you may need to cover it to protect it from direct sun or too much rain (brown cardboard works well as a cover)

- You can add catalysts like urine, cow milk, molasses, etc. to accelerate the composting process

- Turning the compost every 2-3 days can accelerate the decomposition process (research Berkley´s 18 day hot compost)

- Use the compost to improve degraded soil, as top dressing in garden beds, in pot plants or to replace nutrients after harvest.

- If you build minimum 1 cubic meter, and have plenty of fresh nitrogen rich organic matter, the composting process and all that microbial activity, can generate quite a lot of heat. Some people harness this heat for hot-compost showers by burying a coil of black water pipe in the compost pile and connecting it to a shower.

EARTHWORM OR VERMI-COMPOST

Another useful and good way to create compost from organic waste, animal manure and/or kitchen scraps is by vermi-composting. You can create a "worm farm" in many different sizes and contexts. There are a lot of DIY ideas online from small urban setups to larger bathtub systems. It is recommended to research and find one that suits you and your situation.

Worm castings (the compost produced) are a great fertilizer. The liquid run-off often called worm "tea" or "juice" can be used diluted to improve soil. They are both full of useful bacteria and nutrients for the soil.

Note:
It is not recommended to add large amounts of citrus to a vermi-compost system, as they it may lead to too much acidity and affect useful bacterias populations. It is also advisable to avoid adding too much onion or garlic as this can also have an anti-bacterial effect on the compost and slow down the decomposition process.

2- NATURAL FERTILIZERS

There are many ways to naturally (and affordably) nourish and fertilize the soil.

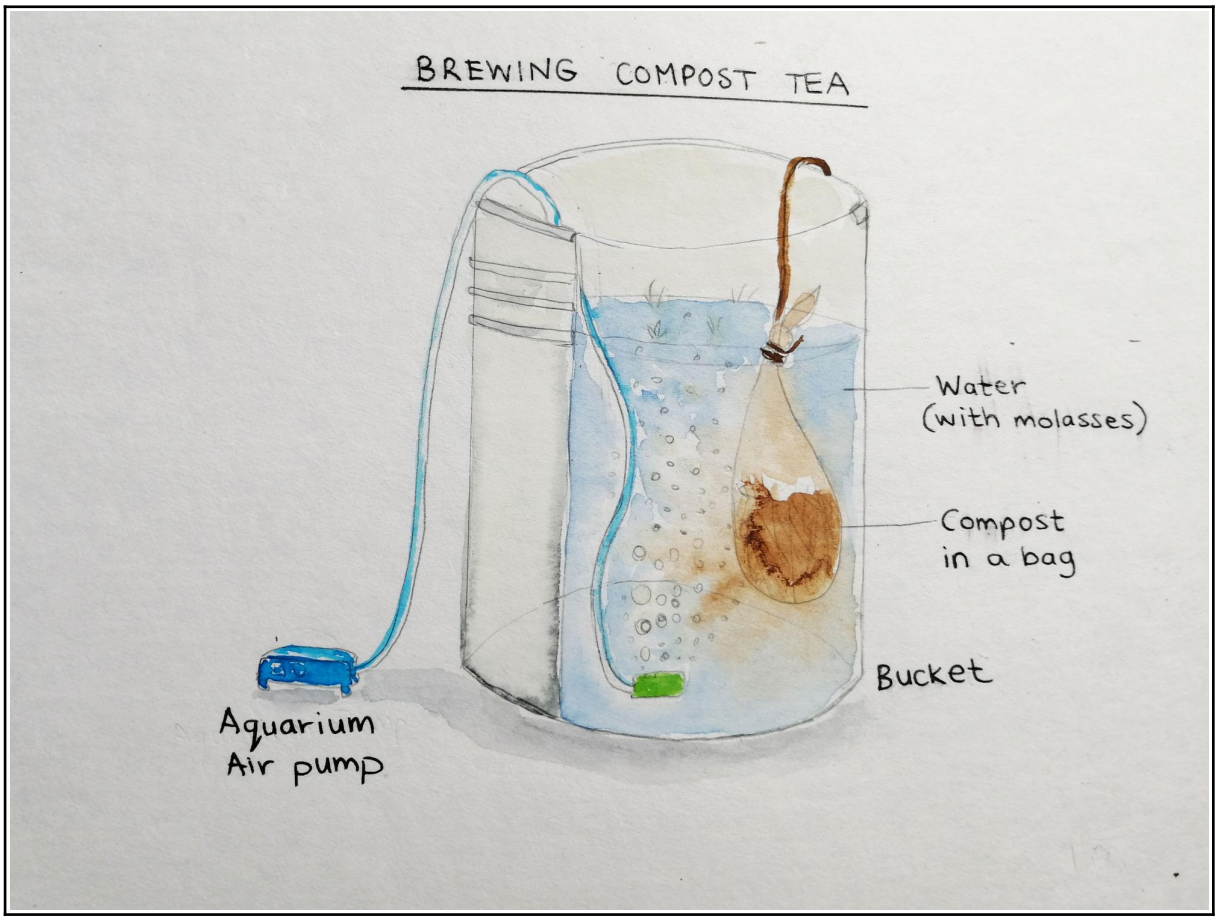
Manure:

Simply introducing horse or cow manure on top of soil (and covering with mulch) will boost soil fertility. Horse and cow manure are excellent fertilizers that can be made into liquid slurry by simply adding it to water. An optional small amount of molasses (or raw milk) can be added to provide sugars to the bacteria, this can be left overnight and stirred well (to introduce oxygen) and then applied directly to soil or compost piles.

Be careful when using such a rich fertilizer close to plants- the high nitrogen content can burn leaves and roots. Don´t allow manures to be in direct contact with leaves or branches. Apply directly to soil or mulch only.

Chicken and other fowl, goat, sheep or rabbit manure is best composted first, as it can be too Nitrogen rich and cause imbalance. Stable bedding is also a good addition to soils or compost piles.

Compost Tea:



To brew compost tea you will need:

- 1x 20 liter bucket
- about half a small bucket of fresh compost or verm-icompost,
- a bag or old cotton tea-shirt to use as the “teabag“
- simple aquarium pump
- a quarter cup of raw molasses

Leave the “tea” brewing for 3 days in the shade, at an even temperature. This procedure enables the multiplication of the good bacteria and funghi in the compost. The aquarium pump ensures that there is oxygen for aerobic bacteria and the molasses provides the sugars for them to metabolize.

Apply diluted as foliage spray to plants or direct to the root zone or onto the soil.

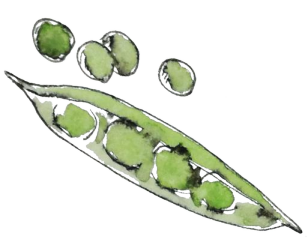
Simple Plant Ferments:

Use Cumfrey, Nettle, Horsetail, Dandelion. Yarrow and other mineral rich plants.
Shred the leaves into small pieces until 1/3 of large bucket is full, fill bucket with water, then add small amount of molasses to feed bacteria. Stir 3 or 4 times daily to aerate, or use an aquarium pump if available.
It will start to smell like “earth” and perhaps you will see bubbles and foam when stirring. Depending on the outside temperature, it will be ready to apply diluted in 3-5 days. It is recommended to research your local areas available plants and experiment to find what will work best in your specific climate zone.

Rockdust, Woodash, Eggshells, etc.

Adding rockdust (a bi-product of stone mining) to remineralize soils has been claimed to improve soil conditions and plant-available nutrients.
Wood ash (from wood burning fire places) is a good fertilizer to add to soil or compost, as it contains large amounts of calcium, lesser amounts of potash, potassium and phosphate, and may contain traces of iron, manganese, zinc and copper. Be careful when applying ash as large doses can alkalize the soil and harm bacteria and plants.

You can also dry and crush eggshells, bones, etc. to a fine powder and apply this to the soil for added minerals.



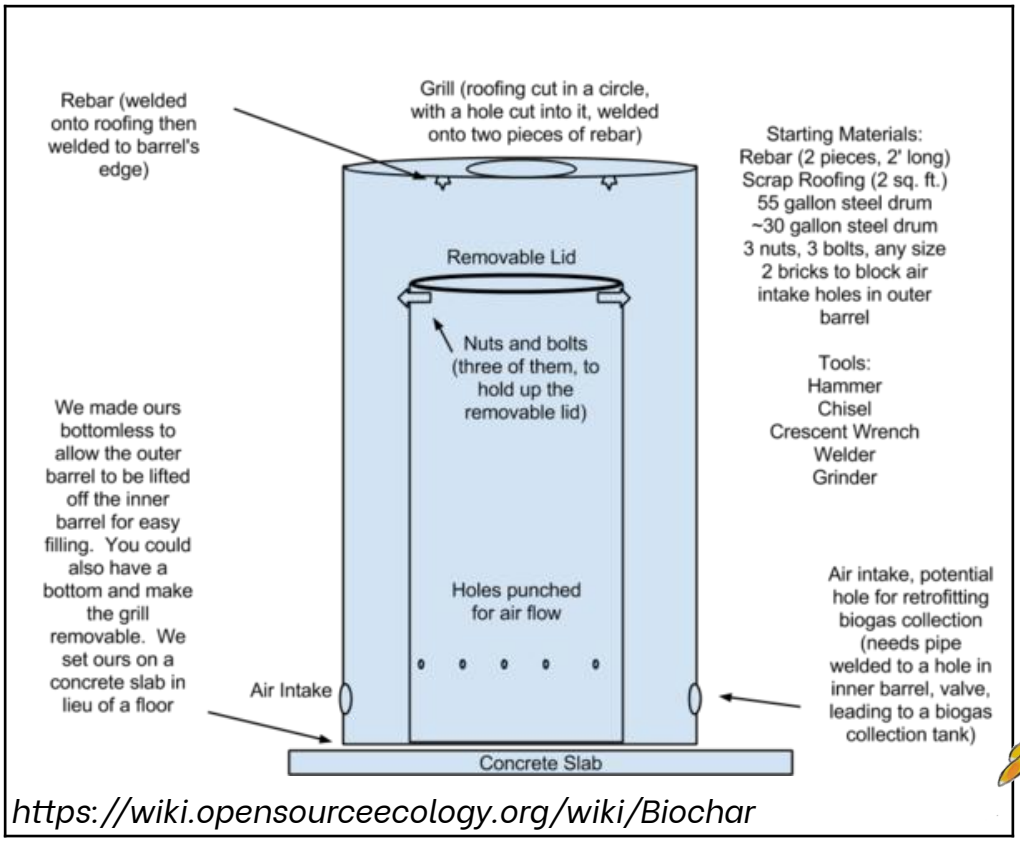
3-BIOCHAR

Biochar is charcoal used as a soil amendment for both carbon sequestration and soil health benefits. Biochar is a stable solid, rich in carbon, and can endure in soil for thousands of years. Like most charcoal, biochar is made from biomass via pyrolysis (Wikipedia).

The immense surface area of biochar creates an increase in areas for microorganisms and bacteria to inhabit. It is recommended to "charge" or activate biochar, by adding it to compost or soaking it in compost teas or urine, before adding it to the soil. This activated charcoal will provide long-lasting, slow-release nuggets of nutrients to the soil. Due to its ability to retain soil nutrients for long periods of time, **biochar** reduces the need for chemical fertilizers.

Please note: It is only recommended to use biochar in areas where there is an excess of organic matter to burn (pruned tree branches, coconut shells, almond shells, wood filings, etc).

There are many low tech, open source designs for biochar kilns available online. Start small and observe how it impacts your soil health!



https://wiki.opensourceecology.org/wiki/Biochar

4- MULCH

"Though the problems of the world are increasingly complex, the solutions remain embarrassingly simple."

Bill Mollison, co-founder of the Permaculture movement.

If we observe nature, we can learn so much about how to take care of natural systems. It is extremely rare to find uncovered soil in a natural setting; as soon as a part of soil is opened, either a so-called weed will start to grow there, or leaf litter or decaying organic matter will cover it.

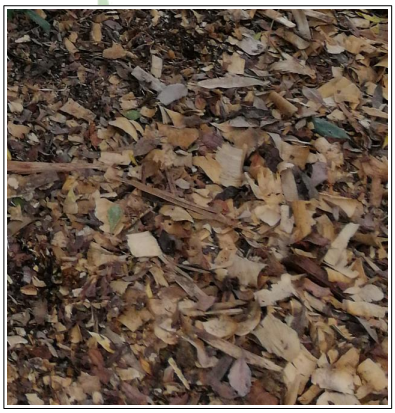
Mulch is material (such as decaying leaves, bark, wood chip or straw, etc) spread over the surface and around plants to enrich or insulate the soil. Is is a general protector and improver of soil.

Mulching is one of the basic and most essential things to do to take care of soil health. Try to always keep soil covered.

What are the benefits of mulch?

- Prevents dehydration through evaporation, maintaining moisture levels.
- Prevents erosion from wind.
- Prevents soil compaction from heavy rain, watering or frost damage.
- Feeds the soil food web, earthworms and fungal networks with decaying organic matter.
- Suppresses weeds.
- Protect the soil from harsh UV sunlight that sterilizes and damages microorganisms.
- Improves the water holding capacity of soil by adding organic matter.
- Is a great insulator for regulating soil temperature. Keeps roots consistently cool in summer and warm in winter, this reduces plant stress.
- Improves soil drainage and structure as it decomposes.
- Improves soil conditions. Helps to bind sandy soils and open up clay soils.





5- COVER CROPS

A cover crop is a crop you grow for the soil, instead of to obtain a harvest. The practice of growing specific crops just for fertilizing and building the soil dates back to the Roman Empire. Cover crops add organic matter to the soil, and add nitrogen in a slow-release way. Cover crops can also act as mulches if managed correctly, improve soil physical properties in just one growing season, and attract beneficial insects and pollinators to your garden. Cover crops are also often called Green Manure.

Below is a list of common cover crops for gardeners, their season, and their benefits in the garden:

Crop	Season	Seeding Rate (lbs)/1000sq. ft.	Type	Main Benefits
Buckwheat	Summer	1.75	Grain	-Attracts pollinators -suppresses weeds - scavenges phosphorus -good in poor soil
Crimson Clover	Winter	0.3	Legume	-Biomass provider -nitrogen fixer and scavenger -attracts beneficial insects -suppresses weeds
Annual Rye	Winter	1.75	Grain	-Nitrogen scavenger -biomass provider -suppresses weeds -discourages overwintering of pests
Cowpea	Summer	2	Legume	-Biomass provider -drought-tolerant -attracts beneficial insects -fixes nitrogen -peas can be harvested and benefits to soil remain
Sorghum-Sudangrass	Summer	0.5+	Grain	-Deters nematodes -suppresses weeds -aerates soil -provides biomass -good in poor soil
Hairy Vetch	Winter	0.75-1.25	Legume	-Fixes nitrogen -scavenges phosphorus -suppresses weeds -drought tolerant -combines well with a grain crop
Austrian Peas	Either	1.5-2	Legume	-Multi-season -drought-tolerant -fast-growing -fixes nitrogen -provides biomass
Wheat	Either	1.75	Grain	-Scavenges nitrogen -provides biomass -suppresses weeds

https://organicgrowersschool.org/gardeners/library/basics-of-cover-cropping/

Cover crops are tools to keep the soil in place, improve water quality and reduce pollution from agricultural activities.
They include:

- Cereals, brassicas, legumes and other broadleaf species
- Annuals, biennials, perennials

Cover crops are adaptable to various cropping systems.

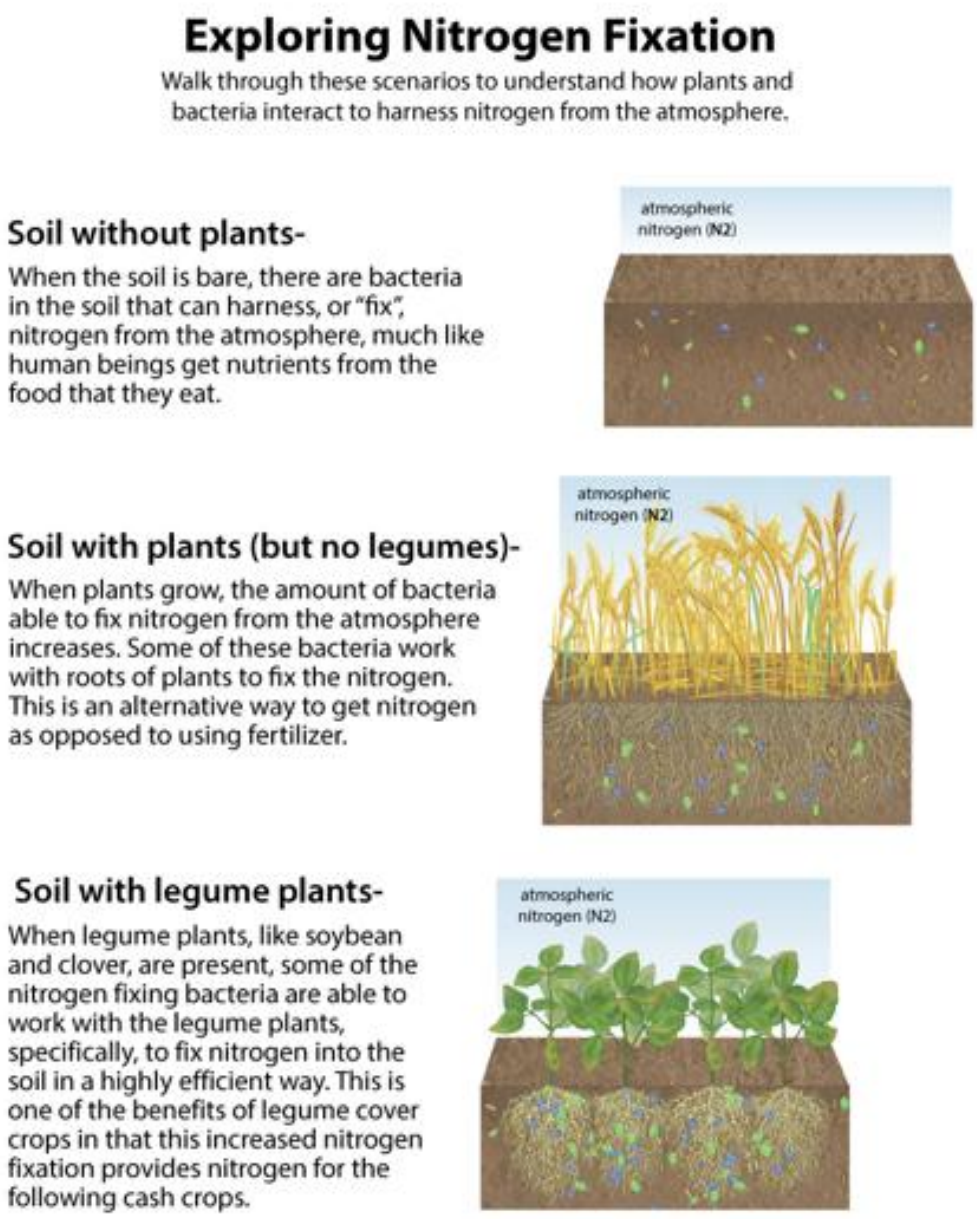
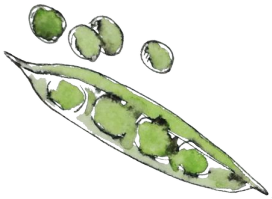


Illustration design by Carlyn Iverson; concept from Michael Lehman.



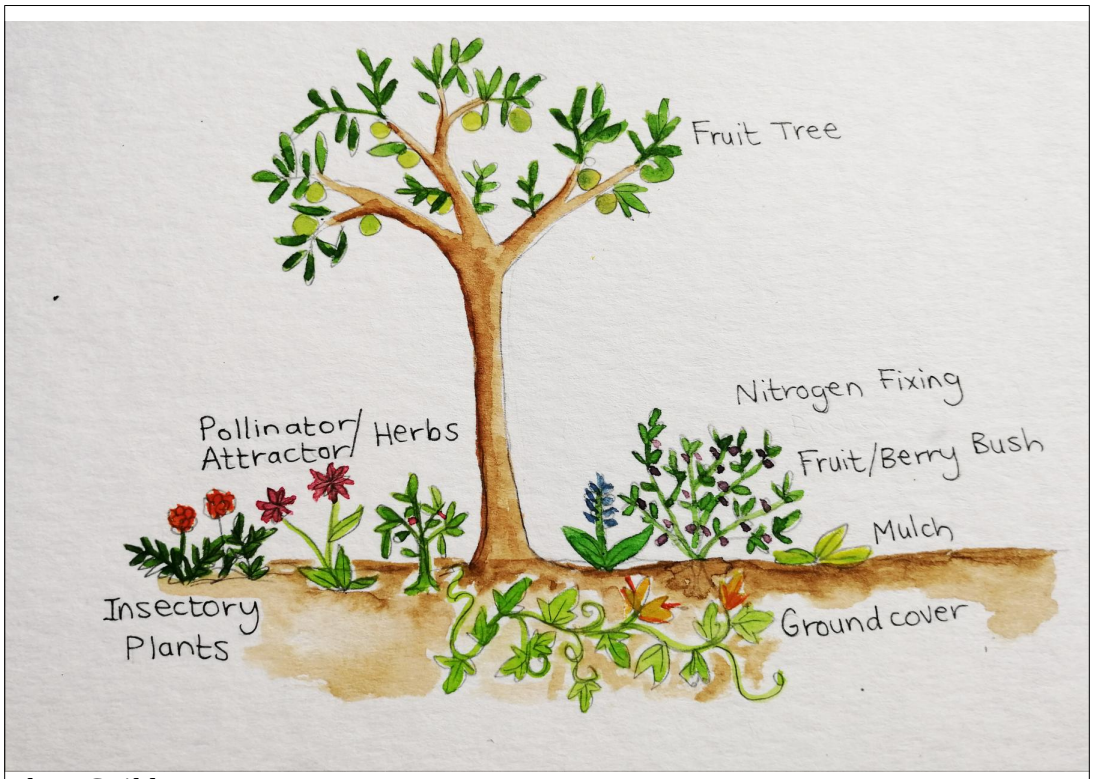
6- CROP ROTATION & MIXED CROPPING & SUPPORT SPECIES

Another way to ensure an active, healthy nutrient cycle and that soil remains alive is by applying the principle of **diversity**. Different plants have different properties: from root depth and structure, nitrogen fixing capacities, biomass (Organic matter) production, mineral accumulation, lifespan to seasonality, etc. Ensuring a diverse range of inputs, ensures a range of minerals, nutrients, habitat, etc.
Rather than planting in monoculture, which, on a large scale, always requires the use of harmful pesticides, intercrop and rotate crops for balanced nutrient input-output.

Example of a Four-Bed Rotation Plan:

- Area 1: Enrich area with compost and plant potatoes and tomatoes (Solanaceae). When crop has finished sow onions or leeks (Allium) for an overwinter crop.
- Area 2: Sow parsnips, carrot, parsley (Umbelliferae). Fill gaps with lettuce and follow with a soil-enriching green manure during winter.
- Area 3: Grow cabbage, kale, rocket (Brassicas) during the summer and follow with winter varieties of cabbage and Brussels sprouts.
- Area 4: If this is your second or subsequent year, harvest the onions or leeks previously growing here over winter. Then sow peas and beans (legumes). When harvest has finished, lime the soil for brassicas which will move from area three to occupy the space next.

In a smaller garden, you can combine crops in the same bed, as in the image below: Corn, bush beans and lettuce growing together happily!



Plant Guild

Apply the same principle of diversity to perennial crops and fruit trees.
Planting support species (like leguminous, nitrogen fixing trees and biomass production species) in between your main fruit production species, along with returning pruned branches and leaves to the ground as mulch, will ensure that nutrients are cycled back into the soil. Permaculturalists often refer to this technique as **“chop and drop”** it´s a great way to **grow soil** while still obtaining a yield. See image below

7- WORKING WITH CONTOUR LEVELS

"As the quality of water changes with the nature of the soil;
So will a man's reason vary with the quality of his friends."
Thiruvalluvar, Tamil poet and philosopher

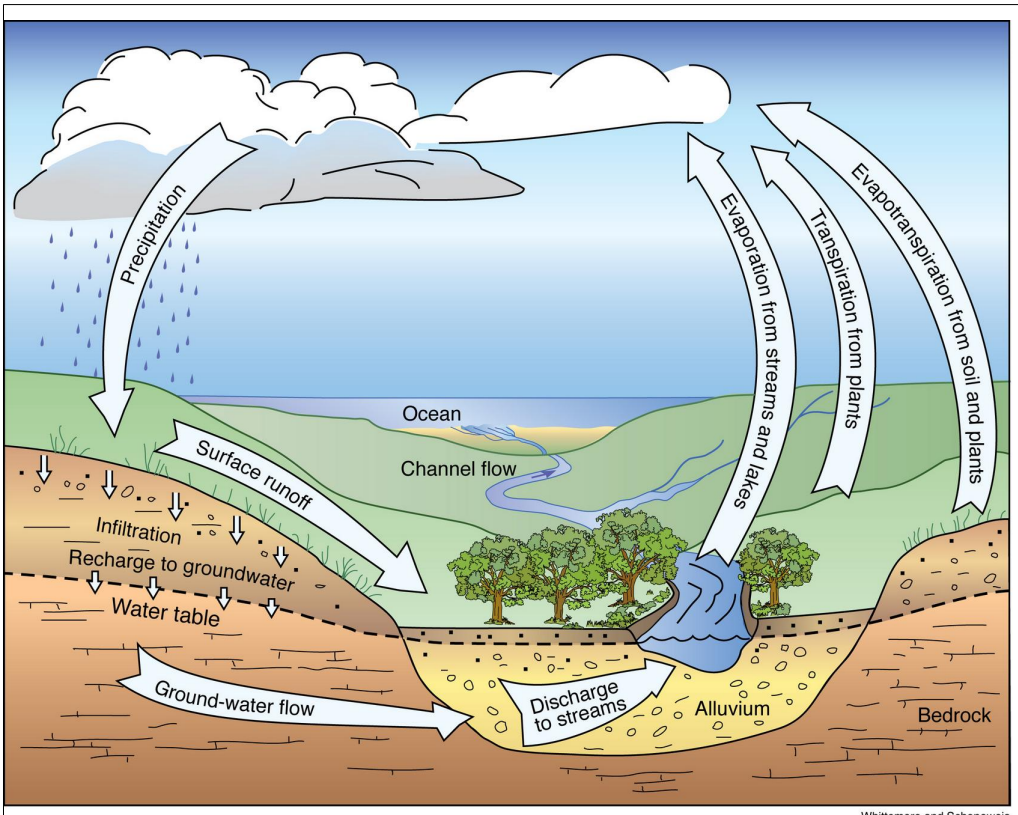
Water, plants and soil are intrinsically linked. Water runoff is one of the main causes of erosion. Often large erosion events, like landslides, happen because of deforestation or removal of vegetation. This is accelerated rapidly on slopes. It is particularly important to protect the soil along riparian zones, waterways and river edges) through conservation, regeneration and protection of these fragile and vital biomes. Trees and grasses in riparian areas stabilize stream banks and reduce floodwater velocity, resulting in reduced downstream flood peaks. Erosion control and improved water infiltration can be created by working with contour lines.

Contour Farming along elevation lines

- Can reduce soil erosion by as much as 50% from up and down hill farming;
- By reducing sediment and runoff, and increasing water infiltration, contouring promotes better water quality;
- Should be combined with covercropping and other sustainable practices;
- The practice is effective only on slopes with between 2% and 10% gradient.

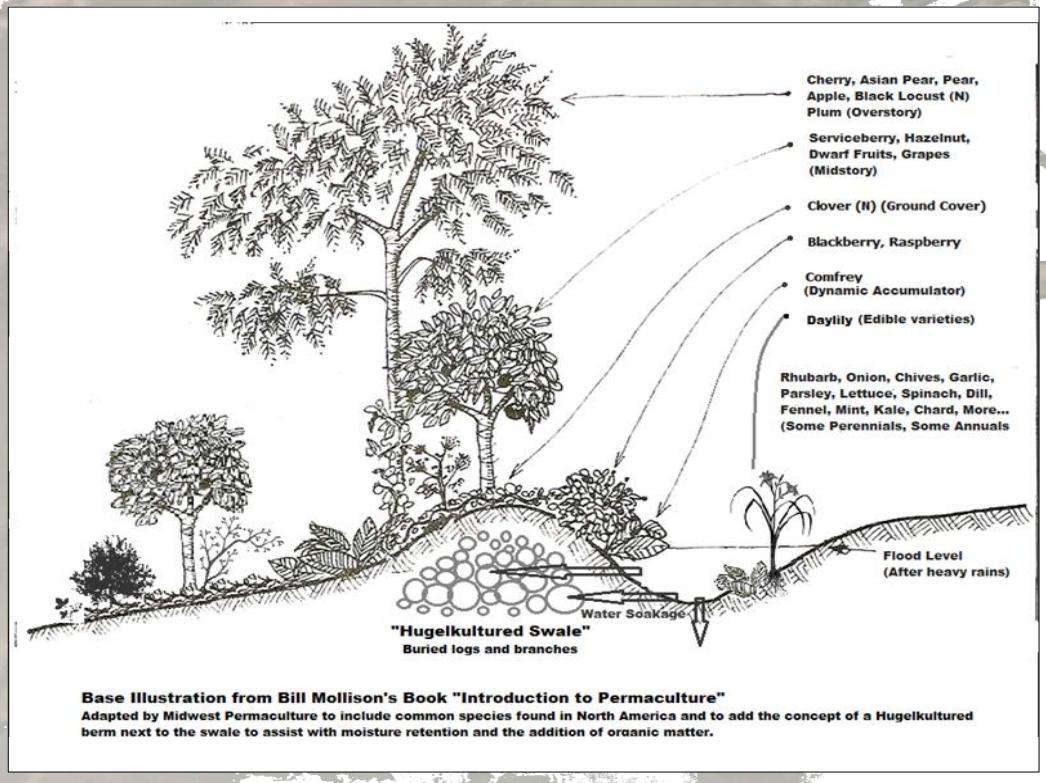
A similar practice is **contour bunding** where stones are placed around the contours of slopes to prevent erosion and increase water infiltration.

Keyline (https://en.wikipedia.org/wiki/Contour_plowing)
P.A Yeoman´s Keyline Design system is critical of traditional contour plowing techniques, and improves the system through observing normal land form and topography At one end of a contour the slope of the land will always be steeper than at the other. Thus when plowing parallel runs paralleling any contour the plow furrows soon deviate from a true contour. Rain water in these furrows will thus flow sideways along the falling "contour" line. This can often concentrate water in a ways that exacerbates erosion instead of reducing it. Yeomans was the first to appreciate the significance of this phenomenon. Keyline cultivation utilizes this "off contour" drift in cultivating furrows to control the movement of rain water for the benefit of the land. See Chapter 7 in Priority 1 History of Twentieth Century Soil Conservation and Keyline.



THE HYDROLOGIC CYCLE

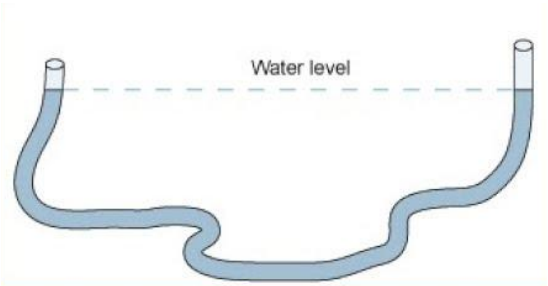
https://geokansas.ku.edu/hydrologic-water-cycle



ACTIVITY 2

MAKE A SIMPLE, LOW-TECH LEVEL TOOL TO FIND CONTOUR

To build this simple **A-frame** tool you will need:
•2 x 1.5 meter sticks
•1 x 45 cm stick
•1 x 60 cm of twine or string
•1x stone/rock to use as a weight
•Marker to mark level
•3x nails or enough twine to join wooden pieces firmly into A shape
The A shape should have 1m distance between the 2 “feet”.
Calibrate using 2 horizontal points and marking on the cross bar where the string lies when the A-Frame is level.



Another way to find contour is using a **Water level or Bunyip**
You will need:
•Clear plastic tubing
•Wood or measuring stick
•Marker
•Tape or wire
Each end of the tubing should be bound to a solid measuring stick, mark every 3 cm, starting from the top and going down. To tell if you are level or not, one person should remain stationary while the other person walks around. Place the measuring sticks solidly on the ground, then compare numbers. If the numbers are the same for both ends, you are on level ground.

8- CORRECT ANIMAL MANAGEMENT

"The nation that destroys its soil, destroys itself."
Franklin D. Roosevelt, 32nd President of The U.S.A

Animals are an integral part of a balanced, healthy ecosystem. Many herbivores and grazers are living "compost makers" and their manure is a valuable input to the soil food web. Predators have the natural function of controlling and influencing the grazing patterns and habits of herbivores and this too has an effect on the soil.

Incorrect management of animals is not only harmful and unethical to animals, it is also harmful to the soil.

Factory farm waste from concentrated animal feeding operations (CAFOs), also known as factory farms, spread on agricultural fields can contain harmful microbes and antibiotic and other pharmaceutical residues, which can lead to antibiotic resistant bacteria in soils. Antibiotics can stay in soil from a few days to hundreds of days. Some studies show that certain classes of antibiotics, such as tetracyclines, can be taken up by crops. Application of animal waste from industrial animal facilities can also be a cause of heavy metal contamination (stemming from metals used in feed), including copper, zinc and lead.

Correct management of animals should:

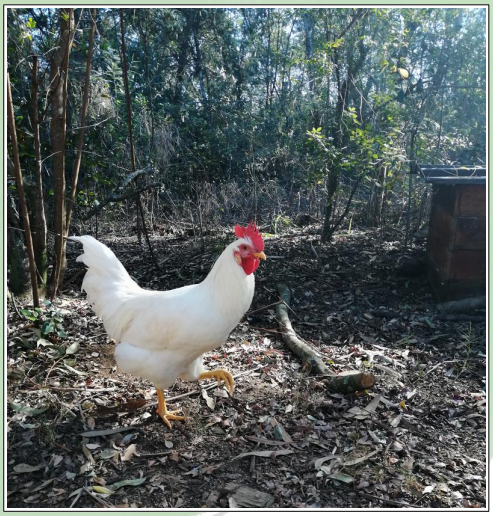
- take into consideration the impact of the animals on the soil, water and total biodiversity of the area
- not cause compaction to soil
- not lead to overgrazing
- not cause contamination of soils nor water bodies
- be in balance with the food production /growth rate of the plants and season
- benefit the ecosystem (win-win) ie. manure and urine from grazing animals replaces fodder or grasses that have been grazed
- include rotational grazing and movement of animals across the landscape
- be part of an integrated system, where animals and ecosystem thrive together

There are many traditional techniques for integrating animals into cropping systems that have been shown to be sustainable over decades.
One example is *montado-dehesa (Portuguese- Spanish)* where free-range pigs graze acorns from a variety of oaks, which are also used for cork and other harvests.

Some examples to further investigate are:

- **Silvopasture**- is the practice of integrating trees, forage, and the grazing of domesticated animals in a mutually beneficial way
- **Holistic Management-** uses herds of grazers to restore grasslands (Alan Savory, Savory Institute)
- **Chicken "tractoring"**- involves moving chickens across the landscape in moveable coops, so that chickens prepare and fertilize the soil by scratching and manuring, the farmer can then plant behind the tractor as it moves.
- **Rotational grazing**- Rotational grazing is a system where a large pasture is divided into smaller paddocks allowing livestock to be moved from one paddock to the other easily. Giving grasses a chance to recover and regrow between grazing cycles.
- **Aquaponics** is a system of aquaculture in which the waste produced by farmed fish or other aquatic creatures supplies the nutrients for plants grown hydroponically, which in turn purify the water. These systems can sometimes be high-tech and therefore costly, but there are traditional low-tech methods too.
- **Aquaculture**: Integrated rice and fish farming in paddies

When well managed, animal manure which is organic and chemical-free is a beneficial addition to soil and compost, and can improve fertility and provide nutrients and minerals that plants alone cannot.



9- REGENERATIVE AGRICULTURE

"To forget how to dig the earth and to tend the soil is to forget ourselves."

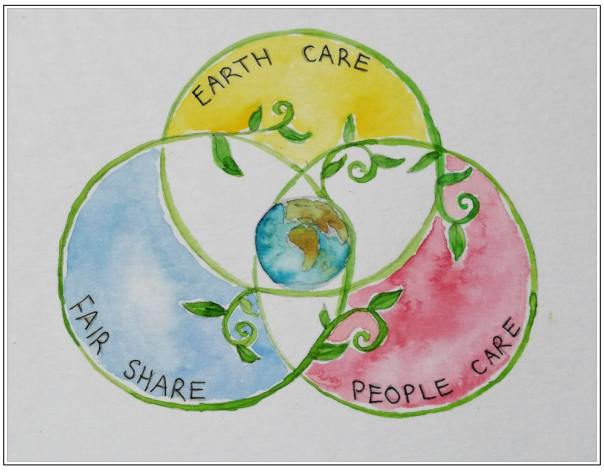
Mahatma Gandhi, Indian activist

Regenerative agriculture is a conservation and rehabilitation approach to food and farming systems. It focuses on **topsoil regeneration**, increasing biodiversity, improving the water cycle, enhancing ecosystem services, supporting biosequestration, increasing resilience to climate change, and strengthening the health and vitality of farm soil. Practices include recycling as much farm waste as possible and adding composted material from sources outside the farm.

On a regenerative farm, yield should increase over time. As the topsoil deepens, production may increase and fewer external compost inputs are required. Compost inputs can also be grown onsite and included in the outputs of production. Actual output is dependent on the nutritional value of the composting materials and the structure and content of the soil.

On a small scale regenerative farming can apply principles from movements such as Permaculture, Agroecology, Agroforestry, Restoration Ecology and others. Larger scale farmers will often simply apply "no-till" or "minimum till" and call it regenerative, as they aim to build topsoil.

When we realise and acknowledge that everything is connected, we will start to recognize that caring for the soil includes caring for the water, the air, the plants, the animals, the people and all life on Earth.



VOLUNTARY GUIDELINES ON SUSTAINABLE SOIL MANAGEMENT

The Voluntary Guidelines for Sustainable Soil Management (VGSSM) were developed through an inclusive process within the framework of the Global Soil Partnership (GSP). The guidelines provide technical recommendations on how sustainable soil management can be achieved. The VGSSM are of voluntary nature and are not legally binding. They elaborate the principles outlined in the revised World Soil Charter, taking into account the evidence provided in the Status of the World's Soil Resources (SWSR) report.

The technical principles recommended by VGSSM are the following:

(1) to minimize soil erosion
(2) to enhance soil organic matter content
(3) to foster soil nutrient balance and cycles
(4) to prevent, minimize and mitigate soil salinization and alkalinization
(5) to prevent and minimize soil contamination
(6) to prevent and minimize soil acidification
(7) to preserve and enhance soil biodiversity
(8) to minimize soil sealing
(9) to prevent and mitigate soil compaction
(10) to improve soil water management

While these soil management principles are technically straightforward, they pose major challenges for global implementation and require an enabling environment to be achieved through the following government and international core actions:

(1) establishing or strengthening inclusive SSM-supportive agricultural/environmental policies
(2) increasing responsible investment and positive incentives aimed at promoting Sustainable Soil Management
(3) promoting secure land tenure rights according to the Voluntary Guidelines on the Responsible Governance of Tenure
(4) fostering and strengthening targeted soil research
(5) preventing or minimizing soil degradation and restoring/rehabilitating degraded soils
(6) promoting effective education programmes
(7) ensuring adequate inclusion of SSM in extension services
(8) promotion of SSM principles and practices by agricultural extension services
(9) establishing/strengthening soil information systems
(10) fostering international cooperation/collaboration on soils
(11) promoting communication on SSM practices

ACTIVITY 3

BECOME A SOIL AMBASSADOR!

Take action for soil in your local area or with your local organization!

Here are some ideas:

• Start an awareness campaign to stop soil sealing or contamination in your neighbourhood, school University or city;
• Green a local abandoned area, pavement or your own balcony;
• Start a community or school composting system and grow veggies in the compost you make;
• Start practicing regenerative agriculture in your vegetable garden;
• Mulch your paths, walkways, gardens and record the positive impact;
• Sow cover crop seeds, or indigenous wild flowers where you see bare soil;
• Start a conservation campaign to protect undamaged soils;
• Turn concrete slabs, parking areas, pavements into areas for raised plant boxes

Write about your story and send it with some photos to CCIVS secretariat@ccivs.org Your Soil Story will be published on the blog www.soil4life.blogspot.com.

Have your say on Soil!

"We as part of the ecosystem, see ourselves as guardians of the soil..."
Contribute to the Soil4Life Manifesto here. We will deliver it to UNESCO in 2022.

"When one tugs at a single thing in nature, he finds it attached to the rest of the world."
John Muir

RESOURCES AND REFERENCES

- The Soil Food Web For more information and resources visit www.soilfoodweb.com which explains the work of Dr Elaine Ingham PhD, Soil scientist and microbiologist.
- Berkleys 18 day Compost Method, developed by the University of California, Berkley. Article: https://deepgreenpermaculture.com/diy-instructions/hot-compost-composting-in-18-days/
- VGSSM: http://www.fao.org/land-water/land/land-governance/land-resources-planning-toolbox/category/details/en/c/1043063/
- FAO World Soil Day: Useful Educational and campaign resources and information: http://www.fao.org/world-soil-day/about-wsd/en/
- Permaculture: https://permacultureprinciples.com/
- Permaculture: A Designer´s Manual by Bill Mollison (Book)
- Holistic Management: https://savory.global/holistic-management/

Special thanks to all the participants of the Soil4Life Soil Management Training of 2019, and deep gratitude to all my previous teachers and inspirations: Rico Zook (Itinerant Permaculture), Govinda Sharma (Hasera Organics, Nepal), Doug Crouch (Treeyo Permaculture) Larry Korn (The One Straw Revolutionary), Ernst Goetsch (Syntropic Agriculture), Roman Eisenkoebl (Soil Sun Soul), Bernat and Deepika at Pebble Garden (Auroville, India), Ben Murray (for teaching me the Soil Food Web game) and all the other friends and fellow soil-lovers who strive to build, restore and respect the soil that feeds us all!

"The soil is the great connector of our lives, the source and destination of us all."
Wendell Berry