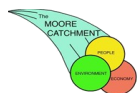




Love your soil



A helpful practical guide to healthy soils and sustainable gardening in the Moore catchment



Researched and designed by the Moore Catchment Council
Funded by State Natural Resource Management Program,
Western Australia



natural resource
management program





Welcome



Healthy soil = a healthy community and a healthy environment

Have you ever gazed longingly at a productive garden on social media or on the TV and wondered how they manage to produce an abundance of veggies and flowers? Well....

...it all comes down to the **SOIL** !

A healthy alive soil will support a sustainable food production system in your garden, block or farm wherever you are.

Page	Content
3	What is soil?
4	Healthy soil vs unhealthy soil
5	Soil texture
6	Soil pH & how it affects nutrient uptake
7	Healthy soil is alive !
8	Composting 101
9	What to compost
10	Making compost
11	Vermiculture (Worm farming)
12	Moisture magic
13	Mulch mulch mulch and more mulch
14	Improving soil fertility with plants
15	Love your soil the permaculture way
16	Need more dirt on soil?



In Western Australia we have some pretty average soils - nutrient poor, non-wetting, too sandy or too clay rich to mention a few issues. Coupled with poor rainfall, and hellish sun, heat and winds, it's a wonder how gardeners' manage !

Here in the Moore River Catchment and regional WA we do get the extremes but we can create productive gardens by building and maintaining healthy soil.

This booklet aims to get you excited about soil and encourage a more productive garden and sustainable healthy environment.

Get out there and get dirty !

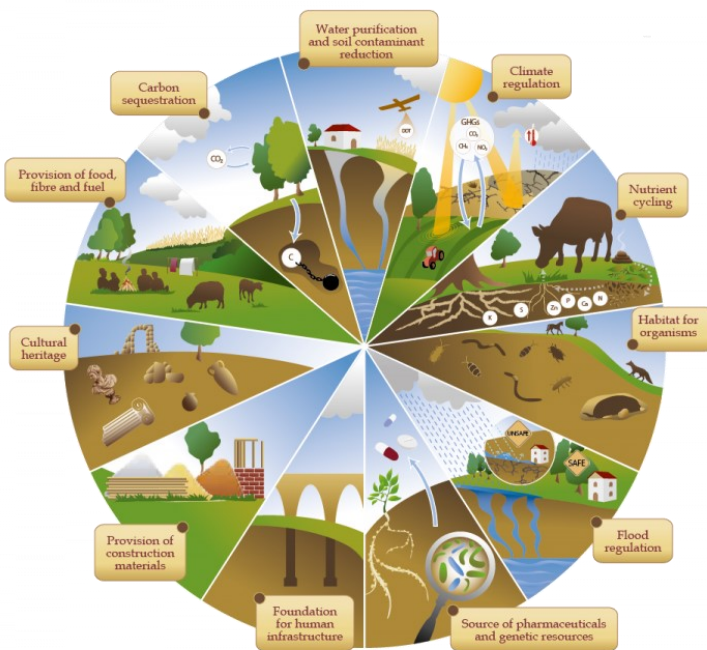


**Check out
Colin Carrot's
suggested soil and
gardening activities**





What is soil?



What is soil?

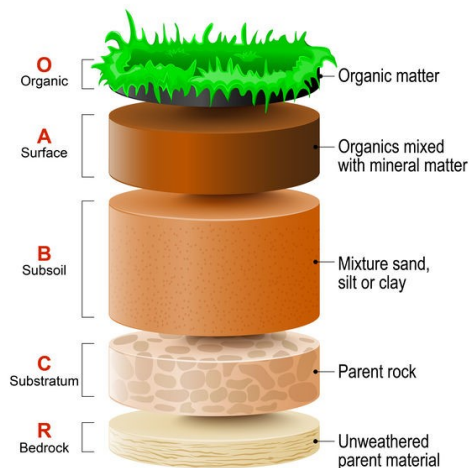
Soil is the thin layer of material covering the earth's surface and is formed from the weathering of rocks. It is made up mainly of mineral particles, organic materials, air, water and living organisms—all of which interact slowly yet constantly.

Most plants get their nutrients from the soil and they are the main source of food for humans, animals and birds. Therefore, **most living things on land depend on soil** for their existence.

Soil is a valuable resource that needs to be carefully managed as it is easily damaged, washed or blown away. If we understand soil and manage it properly, we will avoid destroying one of the essential building blocks of our environment and our food system.

<https://www.fao.org/global-soil-partnership/resources/news/presentations-gsb23/en/c/284443/>

SOIL LAYERS



Most soils exhibit 3 main horizons:

A horizon—humus-rich topsoil where nutrient, organic matter and biological activity are highest (i.e. most plant roots, earthworms, insects and micro-organisms are active). The A horizon is usually darker than other horizons because of the organic materials.

B horizon—clay-rich subsoil. This horizon is often less fertile than the topsoil but holds more moisture. It generally has a lighter colour and less biological activity than the A horizon. Texture may be heavier than the A horizon too.

C horizon—underlying weathered rock (from which the A and B horizons form).

Some soils also have an **O horizon** mainly consisting of plant litter which has accumulated on the soil surface.



Healthy soil vs unhealthy soil

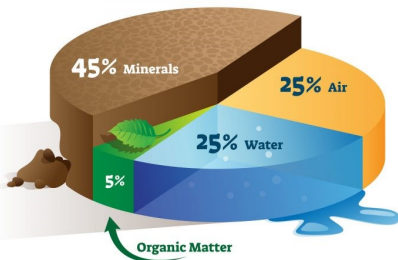


If you could buy a bag of healthy soil what would it look like?

Healthy soil has:

- ⇒ **Good texture:** You often hear gardeners talk about their soil's "crumb." This refers to the texture of the soil. **Good soil is crumbly**, like cookie crumbs scattered over the top of an ice cream sundae.
- ⇒ **Healthy pH:** Soil pH is the **measurement of the acidity of your soil**. This affects the minerals contained in garden soil and their availability to your plants. In general, the closer to neutral your soil is, the better your plants will be able to take up these minerals. Of course, some plants prefer a more acidic soil, but for most flowers, herbs, and vegetables, a more neutral pH is optimal.
- ⇒ **Plenty of organic matter:** Organic matter is just dead plant and animal tissue, which decomposes and enriches your soil as humus. Humus is wonderful because it helps improve your soil's texture by binding some of the smaller particles together, which increases your soil's aeration. It also **improves your soil's ability to both absorb and drain moisture**. Finally, organic matter helps provide nutrients to your plants. Microorganisms help break down the organic matter into its basic elements, which enables plants to absorb it and use it.

SOIL COMPOSITION

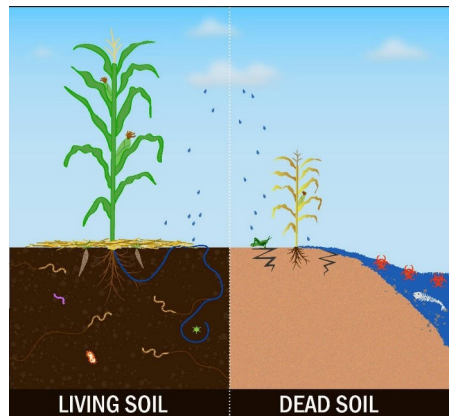


Healthy soil will have about:

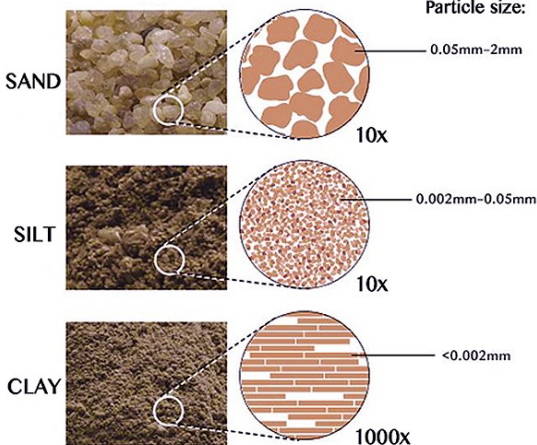
- ☺ 45% minerals
- ☺ 25% air
- ☺ 25% water
- ☺ 3-5% humus
- ☺ up to 1% living organisms

Unhealthy soil characteristics:

- ☹ Dry
- ☹ Water repellent
- ☹ Compacted
- ☹ No soil life
- ☹ No signs of organics
- ☹ No carbon sequestration
- ☹ Poor nutrient uptake
- ☹ Pests and diseases
- ☹ Poor growth of plants



Soil texture



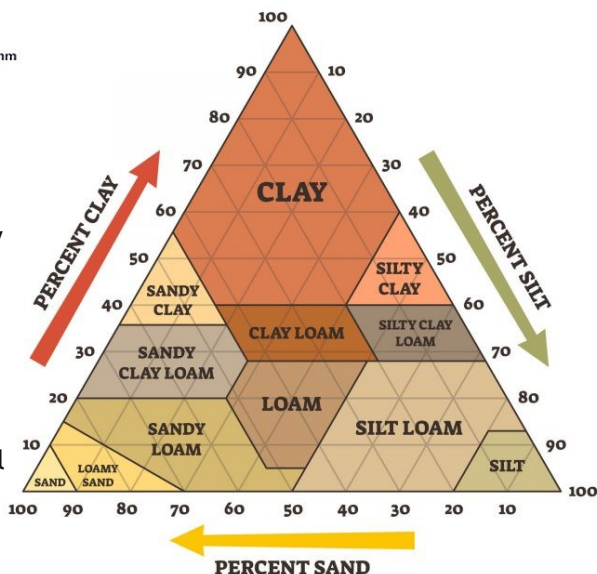
Soil types

A soil texture triangle is determined by the proportion of sand, silt and clay. Texture is important because it influences:

- ⇒ the amount of water the soil can hold
- ⇒ the rate of water movement through the soil
- ⇒ how workable and fertile the soil is.

Soil is made up of different-sized particles. **Soil texture refers to the size of the particles** that make up the soil and depends on the proportion of sand, silt and clay-sized particles and organic matter in the soil.

Sandy soils feel gritty when rubbed between your fingers. Silts feel smooth - a little like flour. Most clays are sticky and mouldable.



Find out what your soil type is by doing the jar soil test?



Full online instructions [here](https://www.soilquality.org.au/factsheets/measuring-soil-texture-in-the-laboratory-new-south-wales)

To test soil texture using a jam jar, start by filling the jar 1/2 of the way full of well-sifted soil. Add water to almost the top of the jar and a splash of dish soap. Then shake the mixture up.

As the soil/water mixture settles over 48-72 hours the sand, silt, and clay will separate forming horizons (sand at the bottom).

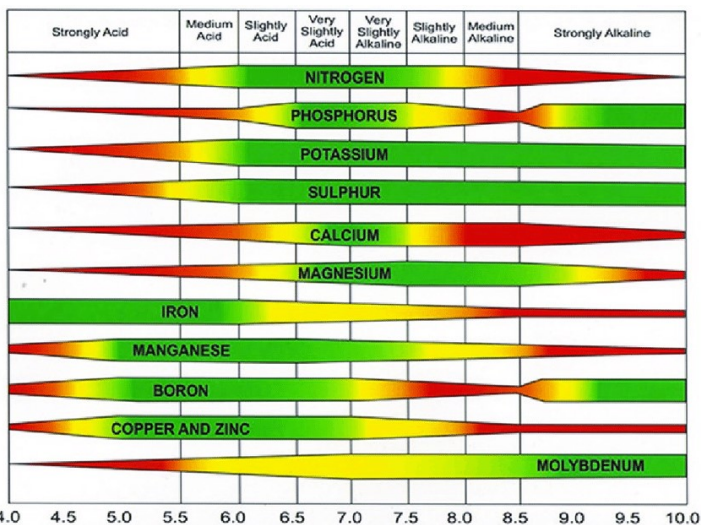
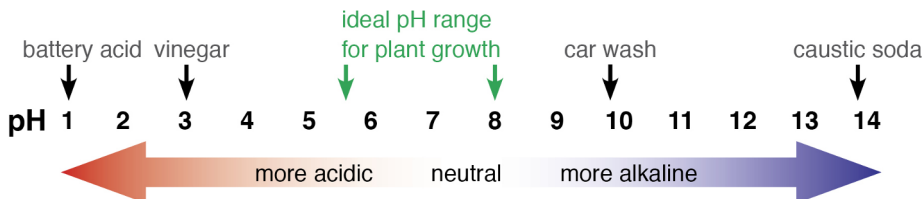
Mark on the jar each horizon and work out what percentage of each there is to determine your soil type on the triangle.



Soil pH & how it affects nutrient uptake



In chemistry, the **pH scale** is used as a measure of how acidic or alkaline a substance is, which in this case is soil. The pH scale ranges from 0 to 14, where a pH of 7 is neutral. The lower the pH value, the more acidic a substance is, while the higher the pH value is on the scale, the more alkaline (basic) it is. By comparison, pure water has a neutral pH of 7, and sits right in the middle of the pH scale.



The green bar indicates the pH level each nutrient is most available at. Red least available.

When the soil pH is above or below this optimum range, it changes the soil chemistry and affects the soil microbiology, which adversely impacts plant processes to reduce growth and yields.

All plants are affected by extremes of pH. but they vary widely in their tolerance of acidity and alkalinity. Some plants can grow well over a fairly wide pH range, while others have very specific soil requirements and may be very sensitive to small variations in acidity or alkalinity.

Different nutrients will be available or less at different pH levels so it pays to know what your soil pH is so you can make adjustments if needed.

Find out what your soil pH is?



Buy a soil pH kit (approx.\$30) and follow easy instructions to determine pH. They do hundreds of tests.

You only need a small amount of soil on the provided tray, moisten with pH dye indicator then puff some white barium sulphate powder on and compare colour to provided pH colour chart.



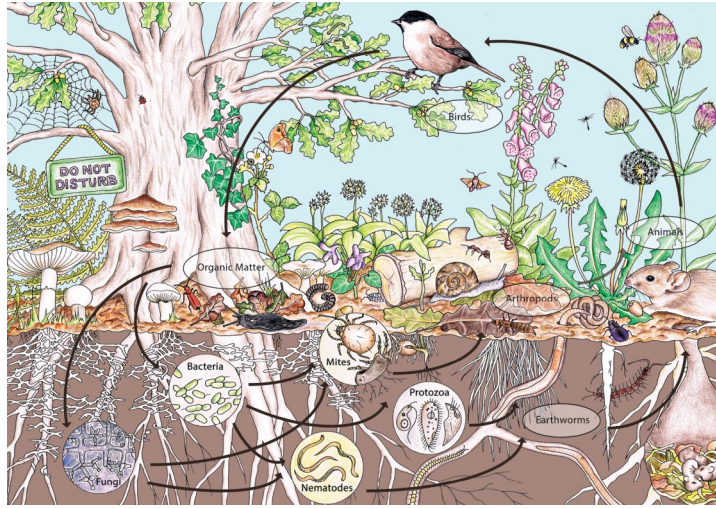
Instructional video [here](https://www.youtube.com/watch?v=...)

Healthy soil is alive !

There is a whole world in the dirt that we can't see with the naked eye, upon which all life on Earth depends in so many ways.

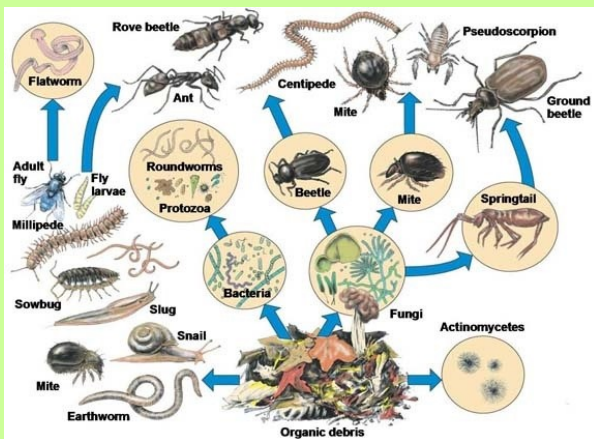
Healthy soil, much like a healthy human body, contains a whole ecosystem of flora and fauna. There are more than **50 million genera of bacteria** in the soil, and more than **50 million genera of fungi**.

Soil organisms, which range in size from microscopic cells that digest decaying organic material to small mammals that live primarily on other soil organisms, play an **important role in maintaining fertility, structure, drainage, and aeration of soil**. They also break down plant and animal tissues, releasing stored nutrients and converting them into forms usable by plants. Since most of the functions of soil organisms are beneficial, soil with large numbers of organisms in it tends to be fertile.



Some soil organisms are pests. Among the soil organisms that are pests of crops are (some) nematodes, slugs and snails, symphylids, beetle larvae, fly larvae, caterpillars, and root aphids. Some soil organisms cause rots, some release substances that inhibit plant growth, and others are hosts for organisms that cause animal diseases.

One square metre of rich soil can harbour as many as 1,000,000,000 organisms.



How alive is your soil ?

Dig up some soil - include organic layer - and examine it with a microscope or hand lens. Smartphones work well to magnify small animals.

Do you see any of the bugs and critters opposite?



Composting 101

To have lovely healthy plants, you need healthy soil... and to have healthy soil you need the following important ingredients:

Compost

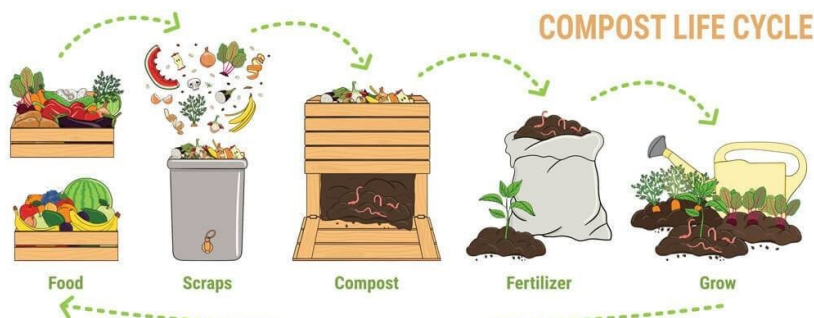
Moisture

Mulch

Good drainage

Compost

- ☺ Composting recycles essential nutrients back into the soil,
- ☺ Composting reduces the need for pesticides and synthetic fertilisers,
- ☺ Composting reduces waste, makes us less dependent on landfills, and decreases greenhouse gas emissions,
- ☺ Adding compost to soil improves its structure and texture, making it more ideal for plant growth by adding organic matter.

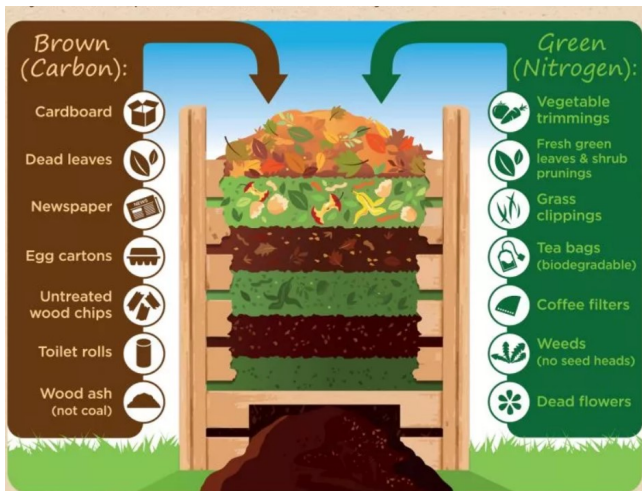


Different composting methods

- **Compost piles** - open pile in the garden, turning and aerating occasionally.
- **Composting bins** - bought or home made structures made of plastic, wood, tin etc. Can be multi-bay for different aged compost.
- **Tumblers** - cylindrical in nature, a tumbler has hand-held insets or a handle that allows it to be “turned” or tumbled easily.
- **Bokashi** - more fermentation than composting. You can compost things like meat scraps and dairy products.
- **Vermicomposting** - composting using worms. Farms can vary in size from balcony to large scale. Products are leachate and worm castings.
- **Trench composting** - direct in-garden composting in a trench or hole.



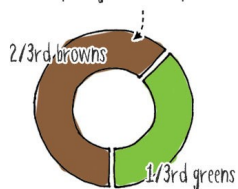
What to compost



What should I compost?

Good compost is a balance of different ingredients, but essentially it comes down to the ratio of Green and Brown ingredients.

ratio : 1 part greens to 2 parts brown



Greens to browns by volume 1:2 (1/3 greens to 2/3 browns).

Carbon/nitrogen ratio

So, what's it all about? Well, let's call carbon "**Brown**", and nitrogen "**Green**". We need a good balance of brown to green, generally **30 brown to 1 green**. Sounds complicated? but it's not.

Brown materials include things like cardboard and paper (the shredded newspaper minus the glossy magazine bit is perfect), sawdust (from untreated timber only), dried leaves, toilet rolls and oaten hay.

Green materials are things high in nitrogen, including garden and lawn clippings, fresh manures (cow, sheep and chook only!), vegetable scraps and urine.

The best way to get this right is to add **one bucket of "Browns" for every bucket of "Greens"**. So, when adding a bucket of silverbeet add in a bucket of shredded newspaper. Because of the different make up of these products, it gets the C/N ratio just right!

What Not to Compost

- ⊗ Animal byproducts – dairy products, bones, and meat
- ⊗ Foods rich in fat and oil (i.e. mayonnaise, peanut butter, salad dressing, or vegetable oils)
- ⊗ Animal (or human) waste
- ⊗ Garden waste treated with pesticides
- ⊗ Garden waste from sick plants
- ⊗ Feral weeds (make tea instead)
- ⊗ Plastics (even biodegradable ones)
- ⊗ Large sticks or branches
- ⊗ Pressure-treated wood





Making compost



Make a compost heap

Watch how to make a compost heap with Costa [here](#)



Solving common compost problems

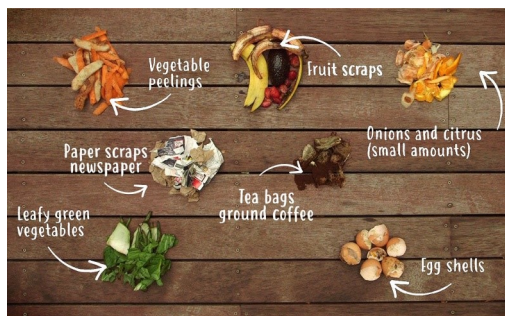
- **Left with half-decomposed big lumps?** Adding smaller pieces to the bin should ensure that it all decomposes evenly. Chop up woody items.
- **Smelly like rotten eggs?** Shortage of air and too wet. Aerate more often and work in some good, dry brown material, like sawdust, straw or leaves.
- **Crawling with ants and slaters?** Too dry, moisten up.
- **Plagued with rats, mice, blowflies or maggots?** Use a blanket to cover the contents of your bin, such as hessian sacking, carpet felt underlay or thick newspaper. Don't add meat scraps or fish bones. Chook mesh surround can help deter rodents.
- **Compost taking too long !** The carbon/nitrogen ratio needs to be altered. Remember: too wet, add dry matter, such as newspaper. Too dry, add water along with some high in nitrogen compost activator, such as blood & bone, pelleted organic fertiliser or chook poo.



Vermiculture (Worm farming)

Worms are amazing creatures. These living fertiliser tubes are full of countless beneficial bacteria and enzymes that help sustain the life and fertility of our horticultural and agricultural systems. Worms dig and aerate the soil, allowing more water to soak in.

When living in your worm farm, **worms will eat up to 3-4kg of your kitchen waste every week**, then turn it into worm castings (rich plant food) and worm tea (liquid fertiliser) that can be used to improve the health of your garden. Keeping a worm farm is fun for the whole family and a great way to get everyone involved in nurturing the environment and making your home more sustainable.



Compost worms aren't garden earthworms. They are surface feeders and don't burrow deep into the soil like garden earthworms do. The various breeds of compost worms, such as Tigers, Reds and Blues, are capable of eating their own body weight in food each day, so a kilogram of worms will consume that much food daily!

Worm farm design

You can buy or build a worm farm, and they come in all shapes and sizes to suit all tastes and requirements.

Most worm farms consist of a set of stacked trays with legs, and don't take up much room at all. They are ideal in size for a small household.

If you're after a larger capacity worm farming system, one that can process large amounts of food waste, you can make one out of a recycled old bathtub or buy one of the commercial wheelie bin worm farms



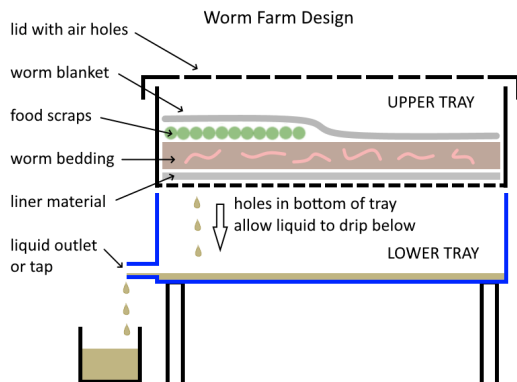
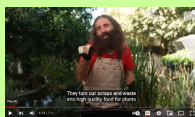
Make a worm farm



Buy a kit from a garden centre or create one yourself in an old bath tub or similar structure. Follow the principles on the right. Composting worms can

be sourced from stockists such as The Worm Shed.

Watch how to make a worm farm with Costa here

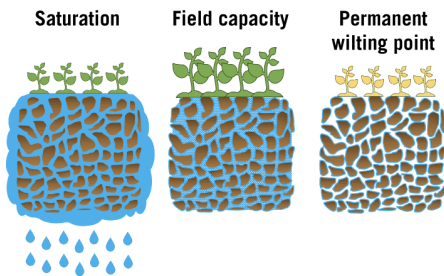




Moisture magic



The best place to store moisture is in the soil. Unfortunately WA has some 'difficult' soil types which either let water straight through (sand) or hold water and become water logged (clay) which isn't great for a productive soil. The 'goldilocks' soil type for growing most garden produce is a loam (see page 5). Also dealing with ad hoc weather events - too much rain which just washes off soil or too infrequent rain events which lets soil go dry. So many problems but improving your soil with organic material will help tremendously!



Adding organic matter such as compost and manure into the soil helps with moisture retention and builds 'humus' (the substance that is left over after plants and animals have undergone a long process of thorough decomposition done by earthworms, bacteria, fungi, and other micro-organisms).

Humus is crucial for soil health.

- ☺ Humus contains important nutrients needed for plant growth, including nitrogen, plus provides it in a form that is highly usable for plants.
- ☺ Humus also gives soil the necessary structure and a crumbly and loose texture so oxygen can get in and reach the plant roots.
- ☺ Humus lets water move through, which is the key characteristic of well-drained soil, and at the same time absorbs and holds water.

Remember, add organic material for a healthy water retaining soil!!

A couple of permanent soil amendments which can be used includes Zeolite and Biochar. Both help with water retention.



Find out how much water your soil holds

Do this simple experiment to compare soil moisture retention around your garden.

Get old water bottles and cut top 1/3 off and invert. Line each with kitchen paper. Get different soils ie sandy, clayey and compost rich and measure 50g of each. Label each bottle and add corresponding soil type into paper lined inverted top. To each bottle add 100ml of water on to soil and time 2 minutes (do each bottle individually or get more helping hands!). After 2 minutes measure how much liquid is in the bottom. What have you found?



Typically a sandy soil will let a lot more water through than a clay rich soil.

Instructional video [here](https://www.thespruce.com/understanding-humus-in-soil-5209565)



Mulch mulch mulch and more mulch



Mulch is used to

- ☺ retain moisture in the soil,
 - ☺ greatly reduce evaporation loss,
 - ☺ suppress or block weeds,
 - ☺ keep the soil and plant roots cool,
 - ☺ prevent frost heaving in winter,
 - ☺ make the garden bed look more attractive.
- Applying a generous amount of mulch can help you save up to 20% of water in the garden.

Never leave the soil bare !



Organic mulch: This is a natural mulch and not made of anything synthetic. It's best for adding beneficial nutrients to your garden, and it can suppress weeds, but it will not always fully block weeds.

- ⇒ Bark, shredded or chipped
- ⇒ Lupin straw
- ⇒ Grass clippings
- ⇒ Newspaper and cardboard
- ⇒ Shredded leaves



Organic mulch will decompose and have to be replaced. But in the process of decomposing, **organic mulches also help improve the soil's structure**, drainage, nutrient-holding capacity, and boost organic content. The dryer and woodier the mulch, the slower it will decompose and the fewer nutrients it will give to the soil.

Inorganic mulch: This is a 'synthetic' mulch and made of materials such as stone or gravel. It's best for fully blocking weeds, retaining water, and keeping longer than organic, but it doesn't add value to the soil.

Using Cover Crops

Cover crops, "green manures," or "living mulches" can be useful to suppress weeds and add nutrients and carbon to soil.

Cover crops should be chosen based on your location. Cool season choices include legumes such as hairy vetch, clover, beans and peas; annual ryegrass, oats, rapeseed, winter wheat and winter rye; and buckwheat. Warm season choices include legumes like cowpeas, and soybeans, buckwheat, and sorghum.

Mow down before seeding occurs and incorporate into soil or cover with compost and mulch.





Improving soil fertility with plants



Soil fertility is the ability of a soil to sustain plant growth by providing essential plant nutrients and favourable chemical, physical, and biological characteristics as a habitat for plant growth. Plant nutrients include the macronutrients nitrogen, phosphorus and potassium, sulphur, calcium and magnesium.

Rather than spend mega \$\$\$\$ on synthetic fertilisers, why not get plants working for you instead?

Plants are nature's greatest fertiliser. When plants die, they decompose and add organic matter to the soil. This organic matter is filled with nutrients that can then be used by other plants. All parts of the plants contain nutrients; the roots, stems, and leaves will all be turned into natural fertilizer. The **best plants for increasing soil fertility are those that are nitrogen-fixing** and/or generate large amounts of biomass that can be worked into the soil. Plants such as comfrey, peas, beans, alfalfa, clover, and oats are examples of plants that are regularly used to increase soil fertility.

Dynamic Accumulators

Dynamic accumulators are plants that actively accumulate appreciable amounts of useful nutrients. Popular recommendations of **dynamic accumulators** include comfrey, amaranth, chickweed, dandelion, chicory, lamb's quarters, and nettles. For example comfrey pulls its nutrients from way down in the subsoil with its long tap root, where most other plants can't reach. **Comfrey is high in just about every nutrient a plant needs**, including the big three, nitrogen, phosphorus and potassium, and many trace elements.



Weeds

When is a plant a weed? Lots of plants around the garden are regarded as weeds (a plant in the wrong place). Why not make use of them and convert them into weed tea?



Make some garden plant tea fertiliser to feed your soil

Get a 20l bucket (or better still a bin) and fill it with cuttings from garden plants (including dynamic accumulators if you can) and weeds (grasses, capeweed etc).

Add enough water to submerge the material and give it a good stir.

Cover and leave for 4-6 weeks out of the sun.

Strain the tea through a sieve or equivalent - it will probably pong a bit ! Use it on your plants diluted with water 1:10 or colour of weak tea.



Instructional video [here](#)

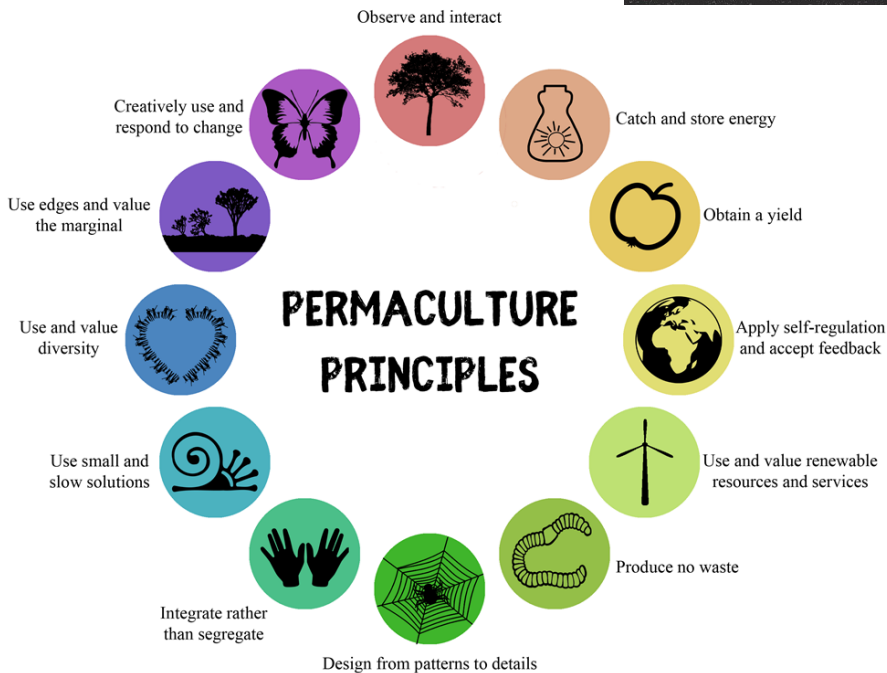
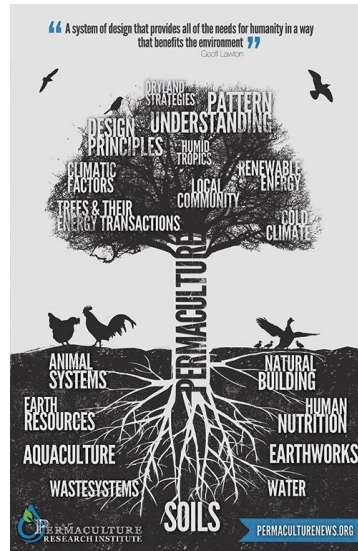


Love your soil the permaculture way

Permaculture integrates land, resources, people and the environment through mutually beneficial synergies - imitating the no waste, closed loop systems seen in diverse natural systems. The philosophy behind permaculture is one of working with, rather than against, nature.

Recycling of nutrients and energy in nature is a function of many species. In our gardens, it is our own responsibility to return wastes (via compost or mulch) to the soil and plants. We actively create soil in our gardens, whereas in nature many other species carry out that function.

The permaculture design system was coined by two Aussies Bill Mollison and David Holmgren. Central to permaculture are the three ethics earth care, people care and fair share, and the 12 principles (below).



Lots of gardeners and farmers already include elements of the permaculture framework in their everyday lives to improve the soils eg cover crops, no-till farming, composting, mulching, but there is much more room to expand activities so that soils and the natural environment are worked alongside rather than against.

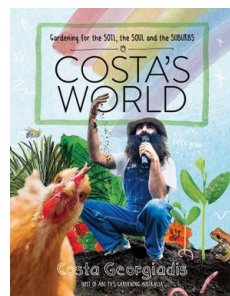
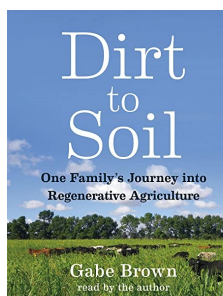
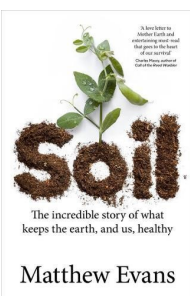
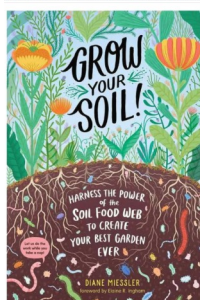
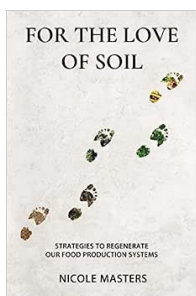


Need more dirt on soil?



- <http://www.soilhealth.com/index.htm> - complete **soil health reference** for farmers, consultants and researchers
- <https://www.uwa.edu.au/news/Article/2022/May/New-app-provides-fertile-ground-for-soil-health-knowledge> **SOILHEALTH app** developed by UWA Professor Lyn Abbotte, features soil EBook, podcasts and more
- <https://www.agric.wa.gov.au/climate-land-water/soils> - Department of Primary Industries and Regional Development WA (**DPIRD**) **soil info**
- <https://www.soilquality.org.au/au/wa> **WA soil quality** info
- <https://www.sgaonline.org.au/> Sustainable Gardening Australia website, empowering communities to garden sustainably
- <https://www.farmingsecrets.com/mentor/dr-christine-jones/> **Dr Christine Jones** soil guru extraordinaire website - soil carbon, regenerative farming
- <https://www.soilfoodweb.com/> **Dr. Elaine Ingham** Soil Food Web
- <https://permaculturewest.org.au/> **Permaculture West** learning portal
- <https://www.milkwood.net/> teaching and sharing **permaculture** skills

Books - weblinks to Booktopia on each



Please contact Moore Catchment Council on 9653 1355 or moorecc@bigpond.com for more information

www.moorecatchment.org.au

Download a copy of this booklet here:



SCAN ME

