



Regenerative Food Growing Practices infosheets



Key practices for growing soils



Key practices for growing ecosystems



Key practices for growing polycultures

Citizen Science: Living Soils, Growing Food

Find out more:  growobservatory.org    @GROWobservatory



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 690199



Key practices for growing soils



© iStock.com/nixoncreative.

Well-functioning soils are important for supporting plant growth. The soil is where plants get their nutrients, water and air, where they form symbioses with other organisms and plants and where they receive supporting stability and the flexibility to grow. The following practices focus on growing soils by supporting soil biota (microorganisms, soil animals, fungi) and improving soil functions (water infiltration and holding capacity, nutrient cycling, and soil aeration).

Mulching

Mulch is a physical layer of material on top of the soil. This can help:

- Reduce weed germination by intercepting light and inhibiting weed growth
- Moderate temperature by dampening temperature fluctuations
- Reduce evaporation, so more water and moisture remain in the soil
- Protect soil from water and wind erosion, while still allowing rainfall to intercept the soil.

Organic mulches, as opposed to plastic ones, further improve the properties of soil. As they decompose, they add organic matter and nutrients to the soil. These additions



Organic mulches, as opposed to plastic ones, further improve the properties of soil. As they decompose, they add organic matter and nutrients to the soil. These additions can increase and improve the biota in the soil (all soil life), which, in turn, helps to improve soil structure. This reduces the need to water, weed, fertilise, and maintain the soil. Mulching is not the only factor, but due to the many benefits, it can help to increase your crop yield. Mulch can have significant effects on your soil, so you will need to understand its key aspects and also its limitations. Before deciding on your mulch material, depth, or maintenance procedures, consider your climate, soil type, season, and crop.

Climate

Mulches are excellent for conserving soil moisture in dry climates, and in drought conditions. They also reduce water erosion during heavy rainfall. Mulches may be detrimental in wet and humid climates if they are too thick, as they may exacerbate poor drainage and water logging conditions. Some mulches (for example, straw) applied thickly in a wet climate provide a perfect habitat for small rodents and slugs, both having the potential to damage crops.

Height and colour

The colour and thickness of your mulch will impact on its ability to moderate soil temperature. A lighter coloured mulch will be more effective at reflecting solar radiation, and protect your soil from heat extremes. The thicker the mulch, the more effective it will be. Conversely, mulches can keep your soil warmer for longer as you enter the cold season. The thicker the mulch is, the less heat will escape from your soil. Mulch applied during colder months may also prevent your soil from warming as the weather warms, which is less desirable. You may wish to have a thin mulch for this period.

Soils and plants

Different soil types and crops have their own considerations. Sandy soils will benefit more from a thicker mulch than a rich organic loam soil. Different mulches have different chemical compositions; some may change the pH and



© iStock.com/EduardSV.

nutrient composition of your soil. While a thicker mulch may give you extra protection against erosion, temperature extremes, and weeds, it may also be detrimental to your soil. Thicker mulches have been known to deplete soil nitrogen and soil oxygen. As a thicker mulch inhibits weed growth, it can also inhibit the growth of the plants you want to grow.

Maintenance

Mulch needs to be maintained as it breaks down. Some mulching materials will break down more quickly than others and need regular maintenance (for example, fresh garden waste, or grass clippings). In warm and wet climates, mulch will need to be re-applied regularly due to high levels of soil biota breaking down the mulch.

Source

If you are purchasing or acquiring mulch from elsewhere (for example, straw or hay), you will need to recognise the source. Mulches may harbour unwanted weed seeds and pests that will transfer to your soil.

How to choose a mulch

First, choose a suitable type of organic mulch. This will depend on all the factors above, including your growing site, what you plan to grow, and what you want the mulch to do for you. Let's take straw mulch as an example.

Straw mulch

Straw is great for reflecting solar radiation (keeping your soil cooler in the



summer) and preventing weed growth, but it can harbour pests such as slugs. If you are in a climate with a pronounced cold season, ensure your soil has warmed before applying your first mulch in the spring. Remove any weeds and ensure that your soil is moist – it may be a good idea to give it a soak first. Try applying the mulch to an approximate height of roughly 7.5cm and spread it in an even layer. It is difficult to state a “perfect” mulch height as it is highly dependent on your climate, soil, mulch type, and plants so that you will learn by experience. If you feel that the thickness is unfavourable to your soil and plants, apply less mulch next time. If you feel that it is not enough, and you are still experiencing high numbers of weeds, try adding to it through the growing season. If you already have plants established, place the mulch around them leaving a small gap at the plant stem. If you plant after mulching – recommended for larger areas – create a hole in the mulch for plants, seeds, or seedlings. Lightly work the remainders into the soil after you harvest and re-apply new mulch the next year.

Adding compost

Compost is decomposed organic matter and provides nutrients for plant growth, similar to what artificial fertiliser does.



© iStock.com/Tom Acop.

Unlike artificial fertiliser, compost also helps to feed soil fauna, like earthworms and microorganisms (bacteria and fungi), which in turn, improve soil structure and fertility. With improved soil structure, roots can better penetrate the soil. This improves water drainage and infiltration as well as soil aeration. In sandy soils, compost

provides a substrate to enhance water and nutrient retention. In degraded soils, compost can help mitigate the problems of reduced organic matter and fertility, erosion, or compaction. Overall, compost helps to increase the quantity and

quality of plant yields while regenerating and protecting soils. Add your well-rotted compost before the start of your growing season(s). If your soil has little organic matter (light coloured), add 10-15 cm of compost to the soil surface, or add 3-7 cm of compost if your soil is rich in organic matter (dark brown or black). If your soil is loose, easy to dig and drains well, add the compost and dig to a depth of 15-30 cm in one step. If your soil is compacted and difficult to dig with poor drainage, loosen your soil to a depth of 30cm, then layer your compost on the surface and turn it under to a depth of 15-30 cm.

You can also use compost as a mulching layer on top of your soil. It is fantastic mulch for enriching your soil quickly, but it may not be very effective at smothering weeds. Compost mulch breaks down faster and will require re-applying more regularly. Re-apply halfway through the growing season, and again after harvest.

Planting cover crops

Cover crops have been used for thousands of years to increase soil productivity and provide ecosystem benefits. They can also help to sequester carbon in the soil. They are planted mainly to regenerate and protect soils during periods of low production. Planting cover crops is like giving soils a regenerating break. They can be planted as winter cover, or during the regular growing season to protect otherwise bare or “non-productive” soil from erosion and sediment runoff, while at the same time improving the soil’s overall water and nutrient-holding capacity. When used as green manure, cover crops can improve the available nutrients in soils leading to increased growth and yield of plants that are grown afterwards. Planting cover crops can also break pest and disease cycles, which occur naturally and often can’t be avoided completely. Leaving cut cover crops on the soil surface, or planting as “living mulch” with a tall main crop, can help reduce weeds. Although, careful plant selection and management are needed to ensure the cover crops do not themselves become competitors to the main plants.



The right choice of a suitable cover crop species (or mixes) and the timing of planting and removal depend on the aims and reasons for using them.



Phacelia tanacetifolia or purple tansy
© iStock.com/Sieglinde Bauknecht.

To protect soil from erosion and related nutrient loss

Any cover crop is better than bare soil. Species with fine-branched roots like rye (*Secale cereale*), oats (*Avena sativa*) and white mustard (*Sinapis alba*) can best improve water infiltration and hence reduce soil erosion due to water run-off.

To increase soil fertility and quality

When worked into the soil, cover crops improve the amount of organic matter in the soil. Legumes like vetch (*Vicia* species), clover (*Trifolium* species), beans (*Vicia faba*), peas (*Pisum sativum*) and alfalfa (*Medicago sativa*) can provide both soil nitrogen (for plants) and carbon (for soil organisms). Alfalfa is deep-rooted and can improve soil aeration and drainage. Non-legumes can also increase soil organic matter and, instead of providing nitrogen to soils, can take up surplus nitrogen.

To reduce weeds

Winter-grown cover crops can be cut and left on the soil surface to block weed germination before planting the food crop. Overall, this can make bed preparation easier. Living mulches, including perennials like white clover (*Trifolium repens*) or birdsfoot trefoil (*Lotus corniculatus*), may be grown alongside the main plant. The time spent hand weeding and the use of herbicides can be reduced. Also, if using perennials, there is no need to resow each year. Still, careful observation and management are needed to ensure that the germination and growth of the main plants are not affected.

Other benefits

Many cover crops have additional benefits. E.g. Phaeceila (*Phacelia tanacetifolia*) is effective green manure and, if left to flower, attractive to bees and other pollinators.

Planting legumes – a special case



Trifolium pratense or red clover
© iStock.com/tamer.

A legume is a plant from the family Fabaceae, also known as the pea, or bean family often used in intercropping, crop rotations, and as mentioned above, as cover crops. Their speciality lies at their roots. Most legumes have root nodules containing a bacterium called Rhizobium. Rhizobia fix atmospheric nitrogen and turn it into soil nitrogen, which can be readily available to plants.

It is estimated that legumes contribute approximately half of the yearly biologically fixed nitrogen to the world's soils. The potential increase in soil nitrogen caused by legumes can increase the protein levels of other plants alongside, or after the legumes. Legumes can help regenerate nitrogen deficient soils as well as help substitute nitrogen fertilisers. Nitrogen fertilisers, if applied broadly, intensively and not buffered properly, often harm fresh water sources by runoff. Legumes include edible crops (for example, beans, lentils, and peas), or forage crops (for example, alfalfa and clover).





Key practices for growing ecosystems



© iStock.com/T.W. van Urk.

Previously, we focused on the impacts of growing practices on the soil as a specifically relevant ecosystem and their direct benefits for growing food. Now, we will take a step back and look at relevant factors above ground and across landscapes.

Implementing regenerative practices for growing ecosystems not only helps to mitigate the negative effects of conventional, monoculture-based food production, but also of extensive soil sealing due to urbanisation and industrialisation. These negative effects can include the loss of biodiversity, the loss of natural areas (for example, forests, marshes, shrub and grasslands), and increased pollution due to extensive fertiliser and pesticide use or industrial and household waste. These are undesirable outcomes on their own, but they can also lead to the decline and loss of essential ecosystem services, such as water infiltration and purification, pollution buffering, carbon storage, natural pollination and pest control, and genetic diversification. They also push our systems closer to so-called tipping points. Once a tipping point is crossed, it is impossible to buffer back. Some ecosystems might take ages to restore,



and others may not be able to recover at all. Using practices to grow ecosystems not only avoids mistakes and negative “side-effects”, but it is also a smart way to make the best of nature’s services for growing good, healthy foods, while supporting long-term land stewardship and green urban development.

Two core ideas lie at the root of practices for growing ecosystems above ground: to restore natural land and diversify landscapes in general, even on a small scale; and to create wildlife areas, which can provide local and regional habitats and resources for animals, and ensure the movement of animals across landscapes.

Most often, these go hand in hand, and in practice, and cannot be separated. So, as a grower, what can you do?

Flowers



© iStock.com/kodachrome25.

Flower strips or fields are a great way to improve the abundance and diversity of pollinators around your growing area, such as wild bees, bumblebees, butterflies and hoverflies. Wild bees including bumblebees are the heroes of pollination, and more efficient than honey bees.

To determine what kind of flower strip fits your context best, you can consider a few things. Does your growing area, or the landscape around it support pollinators with nesting sites and continuous foraging resources? What kind of crops or edible plants are you growing and does that effect which pollinators you’ll need?

Depending on your conditions, you will want to use flowering areas mostly to: attract the right kind of pollinators; support pollinators in periods of resource shortage (often at the beginning and end of the growing season, but also due to surrounding monocultural landscapes); build and sustain diverse pollinator communities and colonies around your growing area long-term.

You could have flower strips and flowering plants in the form of: adjacent strips or field margins; as part of a crop rotation (planting different plants after one another on the same piece of land); as part of a multi-cropping design (planting different plants in a mixed design at the same time); or as temporary or longer-term fallows.

Sown flower strips

Sown flower strips can create additional, diverse habitats using annual and perennial flowers. These attract pollinators and natural enemies of pests by providing nectar and pollen throughout their active foraging period, especially during resource-limited times.

You can include:

- Suitable host plants for butterflies
- ‘Bridging’ plants, which flower during otherwise resource-poor periods
- Mass-flowering plants, which help to build bee colony size ‘Framework’ plants, which provide considerable nectar and pollen to numerous pollinator species, and may sustain a more diverse pollinator community overall.

Plants with large inflorescences, or which flower in dense patches (for example, ox-eye daisy) increase flower visitors overall. Others can attract pollinators with special skills or tools (for example, leguminous plants attract long-tongued bumblebees). Different pollinator groups have their own ‘favourite’ plants (for example, hoverflies love oregano, garlic chives, sweet alyssum, buckwheat and cornflower).



The presence of attractive plant species may result in more flower visits, but it may not automatically increase the diversity of pollinator species. It may increase competition with less abundant or attractive crops and native flowering plants. The positive effects of flower strips on wild pollinators may also take time to manifest. Whatever population size you experience at the moment reflects more on the resource availability of previous years. Test regionally important forage plants for pollinators and look for abundant plant species native to your local region. They can indicate which pollinators and natural enemies of pests are likely to be around already. Consider possible positive and negative interactions between the sown flowering plants, wild plants, and your own food plants to select a mix that improves overall resource availability for pollinators, while avoiding competition over their pollinating services.

Flowering cover crops in orchards

Often, orchards are scarce in nectar and pollen available to bees after trees bloom. In this case, flowering cover crops can provide additional resources for pollinators. Fortunately, ground plants in orchards do not compete for pollinators but strongly enhance bee abundance. Apple-dominated landscapes have drastically reduced the richness of wild bee species, even though wild bees are important and efficient orchard pollinators. Flower mixes can increase the availability of early-flowering plants in orchards. *Daucus carota* (highly attractive to insects generally), *Trifolium repens* and *Lotus corniculatus* (for long-tongued pollinator species) can support key groups of pollinators such as wild bees and bumblebees.

Legumes

Legume-rich borders or fallow fields will attract mostly long-tongued bee species, which

specifically benefit leguminous food crops like field beans. Many pollinator-friendly leguminous cover crops also fix atmospheric nitrogen, with positive effects on soil fertility. If grasses are inter-planted with leguminous plants, they absorb a portion of nitrogen, storing it for later release when the grass is cut.

Grassland with forb flowers



Hedgerow between fields © iStock.com/northlightimages.

Grasslands with a long-lived cover of legume and non-legume forb flowers can increase the long-term persistence of floral resources for pollinators, especially if they are minimally managed. Summer resting periods (no cutting during summer) lead to longer total flowering periods throughout the year and provide a more persistent resource for pollinators to feed on. Such meadows provide forage resources as well as suitable nesting sites for the most

abundant non-*Apis* species (for example, *Lasioglossum morio* and *Andrena dorsata*).

Hedgerows

Compared with flower strips, hedgerows provide longer-term sheltered habitats for some native woodland and woodland-edge pollinator and wildlife species. Hedgerows, like other non-cropped habitats, support greater numbers of beneficial insects, birds and mammals than simple landscapes. However, hedges may also pose considerable barriers for pollinators to move between more open landscapes and fields.



Hedgerows help to limit soil erosion and absorb excess soil nitrogen. It is best to select hedgerow plants that support the maximum amount of locally important pollinators (framework plants) while also providing other ecological services.

Wild areas



File of logs on top of fallen leaves
© iStock.com/welcomeinside.

Only the preservation and restoration of (semi-) wild habitats, including wildflower strips, forests, shrubs and grassland will maintain the overall diversity of native pollinator and wildlife communities. The restoration of habitats provides more forage and nesting possibilities, and facilitates the movement of pollinators. It is recommended that at least 7.5 - 10% of wildlife habitats are restored and protected within a region. This can double the abundance of pollinators and birds. Wild

areas are characterised by limited human activities to allow natural succession, or help its acceleration (for example, selectively logging monocultural forests and supporting the regeneration of natural vegetation).

Try and see for yourself on your growing site or in your garden – do you leave or establish wild areas?

Depending on their size, shape and distance from each other, flower strips, hedgerows and other wild or densely vegetated areas can become so-called stepping stones, bio-corridors or permanent habitats for wildlife and pollinators. Bio-corridors allow animals and living organisms to securely move across landscapes by providing appropriate habitats, for example, shelter material, foraging resources, protection and physical

support. Stepping stones are less connected and diverse habitats, but they still provide necessary support for animals and other organisms to move and even colonise from one place to another (single trees can be stepping stones). Islands of flowering plants, trees and shrubs can facilitate the colonisation of new habitats by highly mobile species. Less mobile species rely on connected bio-corridors.

These practices help to grow ecosystems. Not only do they improve biodiversity to help pollinate your plants, but they also enhance ecosystem services in general. Most of them help to avoid runoff and erosion by improving water infiltration and by providing wind barriers. They buffer changes and extremes in temperature, and they absorb pollution and help purify and clean air, water and soils. Long-term plantings (trees and permanent forests) and areas left wild help to capture and store carbon.

Many of them directly improve the well-being of people, too. Who doesn't enjoy the sight of a flowering meadow, a morning full of birdsong, or tree shade on a hot summer's day?





Key practices for growing polycultures



© Permaculture Association

Polycultures are two or more useful plants grown on the same plot, usually at the same time. From an ecological perspective, they try to mimic natural cycles. Like natural systems, they offer benefits including reduced pest damage, soil conservation, and can even increase crop yields per area compared to monocultures.

Polycultures are the traditional way of growing food and are still widely used in the tropics, temperate market gardens, home gardens and allotments. Growing several crops together offers growers a diverse nutritional range, greater security of production and income, and efficient use of space. Although specialisation of machinery and economies of scale have led to widespread use of monocultures (large fields of a single crop). Polycultures offer significant advantages, for example, they can enhance:

- biodiversity
- nutrient cycling
- soil and water conservation
- carbon sequestration.

They can also offer improved regulation of pests and diseases and can be more productive per land area than growing each crop alone.



Methods of growing polycultures

There are several ways to grow polycultures. The crop plants can be mixed (mixed cropping) or grown in single or multiple rows of each crop (row, or strip intercropping). A second crop can also be planted amongst a first just before it is harvested (relay intercropping).

In **mixed cropping**, seeds can be combined then scattered over an area together, or crops planted around each other. In the classic Latin American “three sisters” combination, beans are planted around corn (maize), with squash planted around the outside.

Row intercropping is popular in smaller gardens where many crop types are grown. At a farm scale, there are usually just two alternating crops.



© P199

Alley cropping, a type of agroforestry, is a form of polyculture where an annual crop is planted between rows of perennials like trees.

Forest gardens are perhaps the most diverse form of polyculture, where extensive use is made of vertical as well as horizontal growing space.

Growing a polyculture is relatively easy for new growers and experienced growers alike, but choosing good combinations for your site can take some practice and experimentation.

Choosing a combination

Consider:

- the height that different crops will be (pick ones that use complementary spaces)
- how much space each crop needs to spread (decide how many to plant and how close together)
- the light requirements and shade tolerances of each crop (grow smaller shade-tolerant crops between larger light-demanders)

A quick polyculture mix

Lettuce, spinach, rocket, and other salad leaves often grow well together. Mix seeds together, add a little compost to help spread them and scatter over your ground. Water them in well. Pick frequently for tasty baby leaf salads.

Hand mixing seeds for polyculture planting



© N.K. van der Velden

A classic polyculture mix

4 Sweetcorn, 16 climbing beans and four squash are grown on a low mound 1.2 m across and 20 cm high. After frost risk, plant sweetcorn 25 cm apart in the middle of the mound. When the corn seedlings are about 20 cm high, plant





four bean seeds evenly spaced around each corn 15 cm away and 3 cm deep.
1-2 weeks later plant the squash around the outside, leaving space on the shady (north) side so you can get in to harvest the beans and corn.

The corn provides a pole for the beans to climb. The leguminous beans fix nitrogen to the soil, and their vines help to stabilise the corn plants. The squash vines become a living mulch, shading weeds and preventing loss of soil moisture through evaporation.

Where and how to grow polycultures



© Manfred Sause

Polycultures are most widely grown in the tropics where light levels are high and relatively consistent through the year. There is high native plant diversity, and considerable food production is at the household level.

Polycultures tend to require

higher labour levels than traditional mechanised cropping, particularly when planting and harvesting. The grower also needs to be able to identify all crop plants at the seedling stage (if weeding), and to understand how they grow and what their requirements for growth are.

The benefits (for example, yield increase and pest protection) depend on crops chosen, relative densities, and other environmental factors. Outcomes may be unfavourable as well as advantageous.

Most scientific research focuses on row intercropping of two crops at the farm scale. As of yet, there is little scientific research on temperate crop systems with more than two crops, and further investigation into suitable crop combinations of three or more crops is needed before suitable mixes can be recommended.

You can find a detailed set of instructions to set up your own polyculture vs monoculture experiment [here](#)

