

## Growing food at home series

# Microorganisms - building good soils

### Pack C Notes 5

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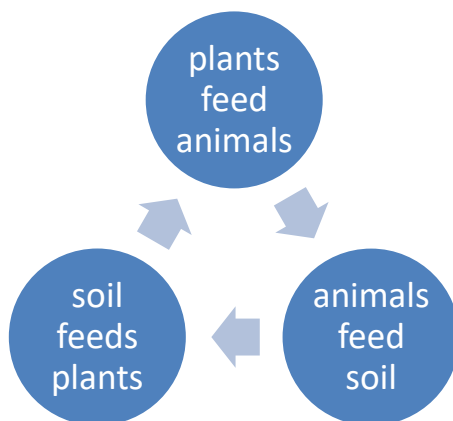
Plants survive and thrive interacting with the environment around them. They have an active relationship with the many and varied creatures that live on and in the soil. These include animals either living there permanently or temporary visitors, bacteria and fungi; and together they are part of the ecology. In our own gardens we can influence the health of our soil and local ecology through our garden design features, plants, and our gardening practices. Working with natural systems to encourage their activities we gain many benefits from them including reduced need to apply chemical pest control, better soil health and thus more nutritious edible plants our garden, and the enjoyment of wildlife in close to home. This ecology can be referred to as the soil food web.

**The Soil Food Web** - Microbes = Bacteria and Fungi plus very small soil animals = **Soil Flora**.

A variety of animals, some are more obvious, are helping the plants and soils. In nature plants provide most

### Healthy soil is full of life

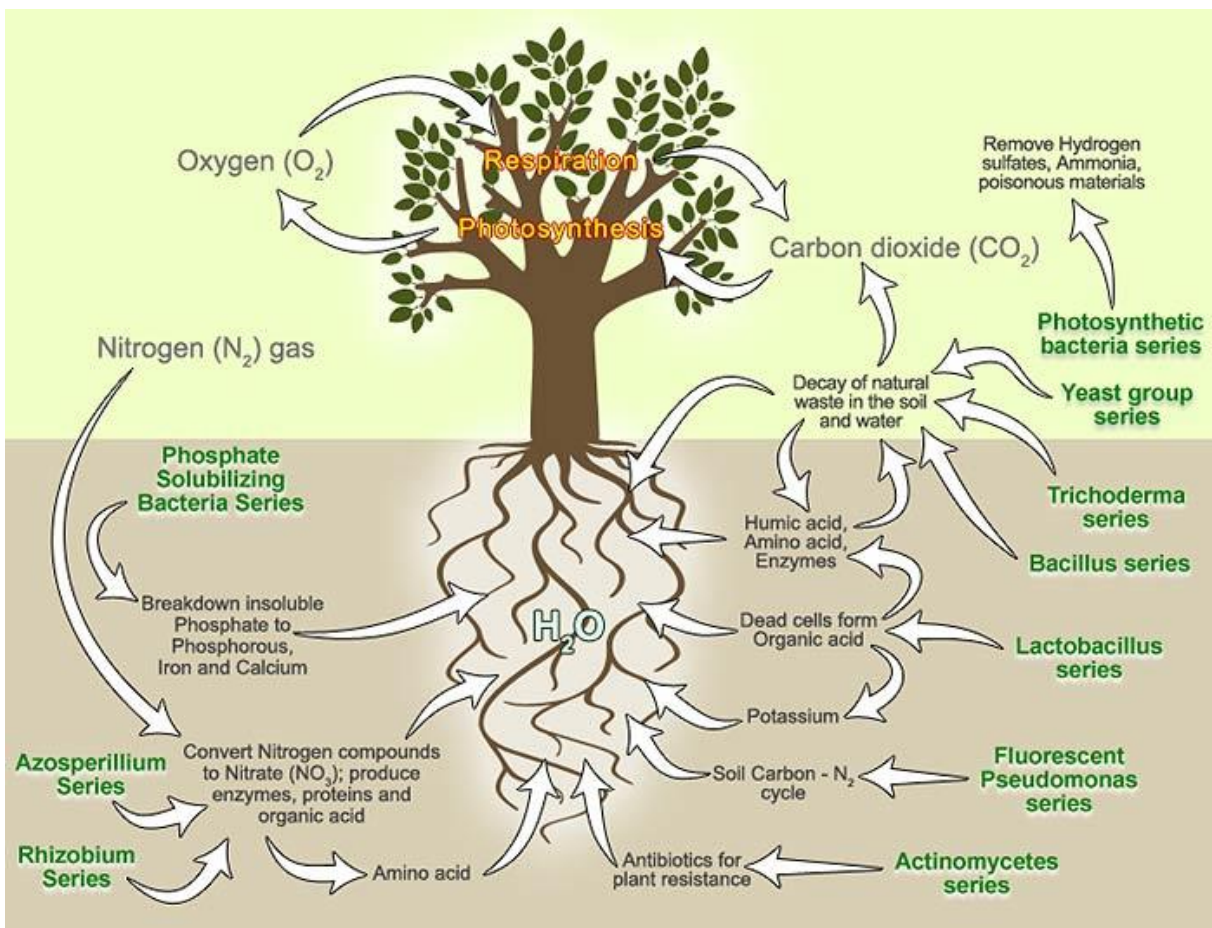
of the food for animals. Animals eat the leaves, stems, roots, seeds or fruits, or other animals that eat plants. In turn animal droppings provide fertiliser for soil continuously in small amounts, they are feeding the soil.



Animals eat plants or other animals that eat plants

These animals can be divided into two groups- vertebrates and invertebrates.

- Vertebrate (have a backbone) and are the larger animals, such as grazing animals like goats, sheep, cattle, kangaroos, wallabies and wombats, birds, bats, rats, mice, possums, lizards, frogs, cats, dogs, and people
- Invertebrate (don't have a backbone) and are smaller animals
  - Insects including beetles, moths, butterflies, flies, wasps, bees, grasshoppers, scale, aphids, earwigs and thrips
  - Non-insect invertebrates including slugs, snails, spiders, centipedes, millipedes, slaters, mites, springtails, nematodes and worms
- Above ground you will find both vertebrates and invertebrates
- Below ground mostly will be invertebrates



### Animals living in soil

You will see lots of animals if you dig through undisturbed soil and examine it carefully. Many animals make tunnels or burrows. Ants, spiders and burrowing rodents remove the soil and pack the sides hard. They may line the sides with silk or hair. Weevils, curl grubs and other animals that feed on dead or living roots burrow through the soil, turning it over, fertilising as they go.

Earthworms eat soil. They grind and pass soil through their gut to digest food in it. So earthworm poo is digested soil. They line their burrows with mucus, which holds soil together. Nematodes, molluscs, mites, springtails and many other animals live in the soil. Most of them are too small to see. As they are burrowing, breathing, eating and pooing they helping to open up the soil. They also use mucus to glue soil particles together to build their “homes”, which helps build soil structure.

Underground, the plants are feeding most of these animals and they are feeding the soil, which feeds the plants.

### How soils feed plants

Soil fertility is the combined effect of three things in soil.

- **Soil texture and structure**
- **Soil chemistry**
- **Soil biology**

Each of these affects the others. Soils texture and structure are covered in [Pack C Notes 3](#). Soil chemistry is beyond the scope of these notes. Here we will concentrate on soil biology.

**The soil flora** - bacteria, fungi and very small soil animals break down (or eat) organic matter and fertilisers. Most bacteria and fungi are good for plants. Fertile soil has what we call a healthy soil flora. It is in balance. Feed the flora gradually and they are happy. Overfeed the flora and you upset the balance, just like your own gut system and its microorganisms.

A little bit of fertiliser does feed your plants directly. Most of it feeds bacteria and fungi that in turn feed the plants. If we build up the numbers of good bacteria and fungi gradually, we build up our soil fertility. Fungi may be large enough for us to see as grey-white filaments in the soil, or their fruit as toadstools and mushrooms. However, most fungi and all bacteria are microscopic, with billions of them living in a teaspoon of soil. They live, multiply and die at a fast rate. Bacteria may only live for a few hours. By this time they could have multiplied 10 or 20 times.



#### **Bacteria**

Most bacteria are good for plants. They have a symbiotic relationship with each other: bacteria are food for plants and keep the soil just right for plant roots; plant roots keep the soil just right for the good bacteria. Bacteria need stable soil, air, moisture, plants and animals to survive.

Worm cast (poo) and compost are full of good bacteria. It is hard to add too much worm poo or compost to the soil surface. However, if we add too much animal manure or fertiliser, we can upset this balance between the bacteria, the fungi and the plant roots. This is particularly so if we dig animal manure, green manure or fertiliser into the soil. It may take 3-6 weeks for the soil to “settle” and come back into a healthy balance. It is better for the soil flora to apply smaller amounts of these fertilisers to the soil surface, and to protect them with mulch.

### **Mycorrhizal Fungi**

Fungi can break down woody material to use as food. They in turn get eaten by animals or decay by bacteria to feed other soil microbes. Fungi can dissolve minerals in the soil that plants cannot, and can store water and survive in drier soil than plant roots.

Mycorrhizal fungi feed plants directly by attaching to the plant's roots. Through their roots plants feed the mycorrhizal fungi sugar and the fungi feeds the plant minerals; they trade. As for bacteria there is a symbiotic relationship occurring between them. Fungi can also provide moisture to the plant as soil dries out. Mycorrhizal fungi can be increased by adding compost to the soil surface and mulching to prevent it from drying out. The humates in compost, seen as dark brown or black crumbly material, store water and minerals as well as providing a home for mycorrhizal fungi.

### **Building a living soil**

The further away we move from gardening in accordance with natural cycles the greater the need that we become active in nature's roles. In our home gardens we remove the animals that eat our plants, both large and small. Resulting in reduced biodiversity: no insects, spiders, slugs, snails, grubs or grasshoppers which leads to less birds, lizards and frogs that eat them. If the soil in food gardens is not getting fertilised by their droppings then we need to add fertiliser to the soil.

The further away from nature that your garden is, the greater the need that you become nature.

The best fertilisers for healthy soil life are the organic ones as they feed the soil animals as well. These include: compost, worm casts and the higher nitrogen composted pellets from chicken, horse and cow manure. Note: all fresh manures are best composted. Dried manures can still boost the soil by adding carbon but have lost most of their nitrogen fertility. Seaweed solutions and pellets add minerals and root stimulants.

### **Feeding your plants is feeding the soil flora or microbes, the bacteria and fungi.**

Building a healthy soil also involves building soil structure or soil that holds together in clods rather than breaking apart. Soil structure can only be established by living organisms; plant roots in association microbes and animals. It is the mucus from earthworms and other larger animals as well as the bacterial and fungal "slime" and clay that holds the soil together. Good structure allows the soil to "breathe" letting oxygen and water in and allowing waste gasses such as carbon dioxide to escape.

Every time you dig the soil you help to destroy soil structure. Add compost, worm casts and other living mulches to the soil surface. Always cover with protective mulch. A healthy balanced soil flora may take a number of years to develop.

**The aerobic zone is where the soil is most fertile.** This is the top 10-20 cm (topsoil, and over 80% of a plant's nutrition comes from roots in the top 10-20 cm. As soil structure becomes established this aerobic zone becomes deeper. Plant roots, worms, insect larvae and a host of other organisms do this. For further information on building soil fertility refer to [Pack C Notes 4](#).



### Habitat building

#### Adding above ground animals

The food plants you want are also habitat (food and home) for pests. Especially blocks of single type of plants (monocultures) provide few barriers for pests; with pests able to go from one tasty plant to the next. Plant diversity makes pests work harder to find suitable plants. It also provides hiding spots and food for predators of these pests. If we have good diversity of healthy plants, we are likely to have a balance between pests and predators, which results in less need for toxic pest control sprays or dust. Reducing chemical sprays will assist beneficial microorganisms live in your soils.



To provide a diverse habitat, plant non-food plants in the garden as well as around it. These can be flowers, grasses, herbs and bushes; you want a



variety of plants with a range of ages, sizes, flowering types and times. Planted to replicate a “balanced” natural system; layered with a three to five story habitat from ground covers up to trees, with a mix of levels in garden.

Add animals to your garden to **build habitat and biodiversity.**

**This will create a garden that works for you, not you work for it!**

Smaller bushes provide protection for smaller birds (insect eaters). Perches and water also bring birds in. Provide water for insects and shelter for lizards such as logs and rocks.

You are looking to have food and shelter to support a diverse range of creatures which will either live in or visit your garden and will eat pests. These can include: birds/insectivores, lizards such as geckoes, skinks and blue tongues, frogs with multiple ponds, bats, spiders, wasps, bees, damsel and dragon flies, flies, lacewings, mantids, ladybirds, mites, nematodes and fungi. This mix will help keep some sort of “balance” in your garden and reduce the pest control you need to do. The idea is to provide stable homes for them so they are not disrupted in their life cycles - minimal intervention with maximum benefit.

#### Minimise habitat for pests and diseases

A thick mulch will harbor millipedes, slaters, earwigs so use only as much as you need. Rockeries, hollow cement blocks, wood may host slugs and snails. Plants such as milk thistle, wild lettuce, even alliums (onions, garlic, shallots, spring onion) near stone fruit may host black peach and other aphids. Tubular shaped flowers attract butterflies which you want but will also attract the cabbage white butterfly which you don't want!

### Observe then act

#### Observe what occurs in your slice of nature

Activities in your garden will vary between day and night, from season to season, after rain, when in flower and fruit. Go out regularly at night with a torch to watch for tell-tale signs of pest. The presence of chewing insects may be obvious but those of sucking ones are harder to detect. Assess the damage before you intervene. Often the plant is fine, and there needs to be regular food to keep the beneficial animals in, so we need to tolerate a certain amount of damage.

In your garden you are the major herbivore; harvesting food plants, pruning branches and shrubs etc., taking more vegetation than all the creatures including: birds, possums, rats, mice, lizards, snails, slugs, caterpillars, beetles, grasshoppers and other invertebrates through to nematodes and cockchafer in the soil. You need to weigh up the losses against the benefits as not all of them are the enemy, nor the amount of damage they do severe. Always assess the damage that a pest is causing with the possible solutions. Grasshoppers may bring in insectivorous birds that also eat aphids. Is there protective cover such as a bush or two nearby for these birds? Some birds are a problem with seedlings, scratching them up, yet eat lots of bugs. Are blackbirds trawling through your mulch a pest or a pest removal service?

To protect seedlings you can provide temporary physical barriers such as collars, netting and sticky barriers over newly sown sections. Or raise suitable seedlings in pots and transplant out when bigger. You may need to protect them for a while.

### Beneficial invertebrates

There are many creatures that can assist in natural pest control widespread in urban areas. Their habitats include low bushes, shrubs and flowering plants, and they will appear with the right conditions, especially if you use no sprays at all. These helpful creatures include:

- Spiders eat lots of insects and other pests
- Damselfly/Dragon Fly eat flying insects including mosquitoes
- Lacewing/Hover Fly larvae/Ladybirds eat aphids, mealy bugs, scale, thrips, white fly
- Ladybirds and many “predatory” mites eat russet and spider mites
- Wasps may be parasitic to aphids, caterpillars, scale, white fly or predatory to these and more
- Praying Mantis is a general predator
- Beetles may be general assassin/ground beetles or specific.





### Safe chemical and alternatives

Some chemicals are less harmful and a few are listed below with their uses and cautions.

#### FUNGICIDES

- **Copper** is a metal and as such may build up in the soil. It is toxic to a wide range of soil organisms. Cupric hydroxide (Kocide) is acceptable for organic practice. Use for curly leaf in peaches
- **Sulphur** available as liquid or dust will break down in soil. It is toxic to insects, mites and fungi so can be used for all e.g. lime sulphur on tomatoes. Use with care re bees and other beneficial creatures
- **Skim Milk** can be diluted 10 to 1 for powdery mildew
- **Seaweed/worm juice/compost teas** research to show that their application to the surface of plants may protect against diseases particularly fungal and bacterial

#### INSECTICIDES

- **Pyrethrum** is short lived but a strong insecticide. Is useful for black peach/cherry aphid
- **Dipel** (BT) is caterpillar specific. Use for cabbage white/corn earworm/tomato hornworm/ any caterpillars
- **Spinosad** organically derived and approved general insecticide. Will kill good with bad so use with care
- **Citrus cleaning agents** may be useful to target ants. Will keep cats and dogs off
- **Potassium soaps** general insecticide and miticide- aphids, thrips, white fly
- **Pest Oil/Eco Oil** non-specific, smother everything. Useful for aphids, leafminer, scale, thrips, white fly
- **Multigard** snail killer. Use sparingly, very small targeted patches. Place Inside a pipe or in container with access doors to keep away from animals and children. It breaks down

*Adapted from Harry Harrison's notes form the Grow your Own Food workshop series, 2015*

Compiled by Shannan Davis, September 2020

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