Working with worms - Improving productivity using vermiculture in commercial vegetable growing

In addition to being a good indicator of soil health, earthworms can play a vital role in reducing the need for tillage, building soil carbon, and increasing plant-available nutrients. They can improve soil health and boost productivity by reducing costs, improving yields and building sustainable soils.

Introduction

Many vegetable growers already recognise the need improve soil health, and know that earthworms are a good indicator of a healthier soil. By working and fertilising soil, earthworms also provide 'free services' to vegetable growers wanting to improve soil quality.

Soil structure and health are boosted by practices that increase soil organic matter and reduce the negative impacts of tillage and compaction. Earthworms can further boost soil health, structure and fertility. Earthworms can reduce the need for heavy tillage, reducing bed preparation costs, producing deeper soils, and helping to build soil carbon.

To harness this free workforce, growers need to understand how to build and maintain earthworm numbers.

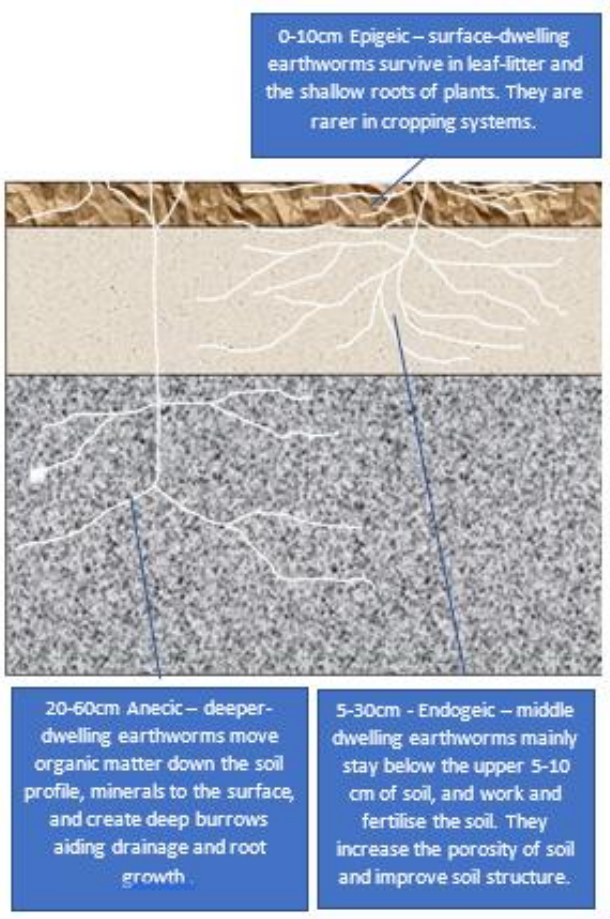
This factsheet outlines the potential benefits of using earthworms in growing systems, and provides guidance about how to get the most benefit from earthworms in commercial growing systems.

What are earthworms?

We all know an earthworm when we see one, but did you know there are literally hundreds of different types in Australia? Earthworms are a highly diverse group of different species filling different ecological roles in the soil? Some live only at the surface in pasture and leaf litter, rapidly converting organic materials into nutrient and carbon-rich droppings or 'casts'. These, 'Epigeic', worms include 'compost' worm species used in worm-farms. They can thrive in organic-rich environments, but are less vigorous and plentiful in the paddock. They generally do not survive under cropping systems, which means most worm-farm casts and worms will not re-populate vegetable growing soils. Other, 'Anaeic' earthworms inhabit the top 10-30cm, creating soil pores and delivering beneficial casts in the root zone. Others are deep-dwelling, living mainly more than 30-40cm below the ground surface, coming to the surface to feed on organic matter, creating deep channels of water infiltration and root growth, as well as moving organic material down the soil profile.

Although Australia has over 750 identified different species of native earthworms, only a small number of 'agronomic' worms are commonly found under agricultural systems. Many of these are introduced, and are species that can survive and, under the right conditions, thrive under cropping and modified pasture systems. In some areas native species that can thrive and contribute to soil health.

Different earthworms do work at different depths of the soil profile.



Earthworms differ from pathogenic 'worms' or nematodes. They will not target living root or other plant tissue, living on dead and degrading organic matter and the bacteria and fungi living on this matter. Earthworms will not damage roots or plant growth and will usually improve root growth. They will even eat nematodes, and high earthworm numbers can keep pathogenic nematodes in check.

Most earthworms are not prolific breeders, and even under good conditions some key species can take over a year to re-establish populations after events that reduce their numbers. Heavy tillage, low moisture, severe heat and some chemical applications can greatly reduce worm numbers. Growers hoping to get earthworms to work for them need to manage factors that can reduce their numbers.

What can earthworms do for your soil?

In simple terms, earthworms make soil richer and deeper. They create pores in soil and convert organic matter and microbial biomass into nutrient-rich soil conditioner. Greater soil porosity improves drainage and aeration of soils, and allows healthier root growth. Earthworm casts are rich in plant available nutrients, and also contain more stable forms of soil carbon (including calcium carbonate) and chemicals known to stimulate beneficial soil microbes and plant root growth. Earthworms move organic matter and nutrients down the soil profile.

A significant benefit of increasing earthworm numbers is the reduced need for deeper or heavier tillage. A challenge for growers wanting to improve soil structure and health through reduced tillage is that many soils, and particularly those with a history of heavy tillage, can lack the structure and porosity needed for seedling establishment and deeper root growth.

Earthworms can provide a free tillage service, and a healthy earthworm population of more than 50-100 earthworms per square metre can consume and excrete over 5-10 tonnes of materials per hectare per day at active times of the year. On irrigated soils, earthworms can be expected to be active for at least 6-8 months of the year, and a healthy earthworm population can therefore be expected to work (and rework) and fertilise over 10,000-20,000 tonnes of material in the top 30-40cm of soil per hectare per year. That's the equivalent of tilling the soil several times! In addition to reducing costs, reducing mechanical tillage helps to build better soil structure, soil carbon and healthy soil biology.

What do earthworms need to thrive?

The main factors earthworms need to thrive and do useful work for growers are:

- Food. Earthworms feed on rotting organic matter and the fungi, bacteria and other microorganisms that feed on organic matter and nutrients in the soil. Organic matter and biological activity can be boosted using retention of crop residues, cover crop and pasture phases, and/or addition of composts in vegetable cropping rotations. Application of nutrients such as nitrates, molasses or vermicast liquid extracts may also stimulate soil biology and earthworms.

Earthworms need organic matter in soil and are often found in dead plant matter.

- Moisture. Earthworms will migrate to where conditions are favourable. As soil dries they will move down the soil profile and go into a form of hibernation known as 'aestivation'. They also lay eggs, usually in the upper 0-20cm of soil that

survive dry periods so long as they are not disturbed by tillage.

- Less and well-timed tillage. A health population of earthworms can reduce the need to work soil at depth. Once earthworm numbers have been built up, it might be possible to reduce tillage, eliminating rotary hoeing and either avoiding tillage or only preparing the upper 5-10cm of soil as seed or seedling bed.
- Reduced compaction. Earthworms move more freely through uncompacted soils, and as they improve soil structure they can move more freely. However, vehicle compaction will undo their work and reduce their activity. Reduced and controlled traffic using permanent or semi-permanent beds will minimise compaction in growing areas.
- Less and more judicial chemical use. Most fungicides (including 'organic' treatments containing copper), many insecticides and some herbicides damage earthworm numbers. Some herbicides can have an indirect benefit to earthworms by providing dead organic matter to the soil. It is recommended growers wanting to build earthworm numbers consider the chemicals used and measures that can protect earthworms from them, including use of mulches and spraying at times when worms are likely to be deeper in the soil due to reduced surface soil moisture and higher or lower ambient temperature. If earthworm numbers are high and the conditions in the soil are good, chemicals are less likely cause long term damage to earthworm numbers.

What are the first steps?

The following steps are recommended:

1. Work out if it's worth trying

Growers need to consider likely productivity gains from increased earthworm activity, and the net costs of the practices that will build and maintain earthworm numbers under cropped areas.

Consideration needs to be given to the different costs of different management options such as: conventional tillage vs no or reduced tillage; use of cover crops; use of compost or other organic additives; and the yield response and costs of different rates of fertiliser and water conversion to yield.

Note that some soils and climates will struggle to maintain earthworm populations. Highly sandy soils, heavy soils with very poor structure, soils with pH outside a 5.5-8 5 range, soils with high levels of copper, soils with low organic matter, and areas with extended dry (soils receiving less than 450mm of rainfall or irrigation per year for one or more years) and hot periods may struggle to support earthworm populations.

Soils can be improved and moisture managed to better support earthworm numbers, but growers on loams, well-structured clays, neutral to alkaline soils, and in higher rainfall and more temperate climates have more opportunity to use earthworms to boost productivity.

2. Check earthworm numbers and soil health

Most farms will have a surviving population of earthworms that can recolonise areas if the conditions are right. Introduced and some native 'agronomic' worms are present in most agricultural soils, even if in very small numbers. However, earthworms need a healthy soil biota (mainly bacteria and fungi, as well as other microorganisms) and organic matter to feed on. There is no point in trying to make use of earthworm activity unless work is being done to build soil health.

In some instances, earthworm numbers might be so low that there is need to build numbers by bringing worms from neighbouring worm-rich areas and 'seeding' paddocks with worms. This can be done by taking sods of soil containing worms and worm eggs from worm-rich areas and putting them into same sized holes at intervals of 10-20 metres across the paddock where higher worm numbers are needed. This should only be considered if the low-worm soil has organic matter, soil biota and moisture that can support the introduced worms. Worm-rich areas can often be found in undisturbed areas, near water channels, or at points where animal effluents have been discharged to paddocks. Growers could create worm-rich areas for seeding other areas of the farm by applying organic matter, such as a composted manure or stable waste, as a mulch over an undisturbed and moist area.

The levels of earthworm can be checked by:

a. During early autumn or spring, when soil is moist, dig for earthworms in cropped areas. This involves quick extraction of at least 'a spadeful' of 15cm wide x 15cm long X 20-30cm deep, and sorting through the soil to count earthworms. Samples should be taken at multiple sites across the sample area. In a healthy soil, at least 2-4 worms should be found in nearly every sample taken (equivalent to 100-200 worms per square metre, which is a minimum level to be considered 'healthy' -).
b. Checking under any plastic mulches when soil is moist and ambient temperatures are cool. A large number of earthworms near the surface under the mulch indicates a healthy earthworm population.
c. Placing wet heavy carboard, carpet squares or a wet straw layer on the soil when it is moist. Return after three to five days to check on the number of earthworms that have migrated to the surface under the cover. These should be visible without digging, but rapidly extracting a dug sample from under the cover will help to confirm whether earthworm numbers are healthy.

3. Have soils tested for levels of biological activity

A healthy biota is needed to support earthworm numbers. If levels of biological activity are low, then the soil cannot support a healthy earthworm population. There are several laboratories that can test bacterial and fungal activity levels in soil, as well as field testing kits that measure respiration of soil as an indicator of levels of microbial activity. Earthworms numbers will not always be high where there are high levels of biological activity, but an active biota is a good indicator that earthworm numbers could be increased through changes in management, such as reduced tillage and more sensitive chemical use.

4. Try changing practices

If you'd like to see how earthworms can work for you, try it on a smaller area first where it can be compared with a similar area next to it. If the soil isn't already rich in organic matter, consider how you are going to build soil organic matter and soil biology in the area. This can be by retaining crop residues, cover crops, less intensive tillage and potentially organic additives such as compost. Nutrients to boost soil bacterial activity could also be considered.

Reduced tillage is important to allow earthworm numbers to build. If soil structure is poor, ripping rather than rotary hoeing is preferable. On lighter soils with good structure down the soil profile, lighter cultivation in the upper 5-10cm can be used to prepare the seedbed, or direct sowing of seed or seedlings as plugs without cultivation can be used. Increased earthworm activity should allow lighter cultivation over time.

Monitor earthworm activity and benefits

Periodically undertake earthworm counts and monitor soil health as described in points 2 and 3 above. Note how soil structure changes. If earthworms are working, the top 30-40cm of soils should be more porous and have better more granular 'ped' formation down the profile. Worm casts might be more visible at the surface after heavier rain or irrigation, and may also be visible along with tunnels down the soil profile with soil containing rounded casts.

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