

WISE UP ON WORMS

Reuse your food scraps and
create great natural compost



Proudly promoted by the Marlborough District Council

Note: This programme has been adapted from the Westwise Organic Recycling Kit and we appreciate them allowing us to use their resources.



**MARLBOROUGH
DISTRICT COUNCIL**

15 Seymour Street
PO Box 443
Blenheim 7240
NEW ZEALAND

Ph: +64 3 520 7400
Fax: +64 3 520 7496
Email: mdc@marlborough.govt.nz
www.marlborough.govt.nz

The wonderful world of worms

Welcome to the Wonderful World of Worms, in particular how to successfully compost with worms. Here is a little background on worms.

Worms have been on Planet Earth for a very long time. Originally as marine worms, they adapted and became earthworms as the waters receded.

In ancient times the Pharaohs thought earthworms were pretty amazing and even organised a branch of the priesthood to study how worms affected the soil.

Today, particularly in the USA and Europe, earthworms are in serious demand by man, including as waste disposal experts! Worms help to break down refuse and their casings are sold as fertilisers.

Earthworms are also good indicators of soil quality and are now being introduced by agricultural and pastoral industries to replenish soil.

Recent studies carried out by American scientists show earthworm castings contain high proportions of trace elements including nitrogen, phosphorous, magnesium and calcium and potassium.

The benefits of earthworms

Earthworms do a power of good just by being there.

They aerate the soil by digging tunnels, which helps water and oxygen pass more easily.

They take care of plants, even though they live around roots of plants and deposit their castings - both plants and worms thrive.

Worms work; they convert the organic waste into rich compost for gardens.

Worms can prevent the spread of some fungal diseases by eating rotten material in orchard and vegetable gardens.

Having worms also cuts down the need to supply fertilisers.

The catch is worms like to live in good soil in order to make it richer. So you need to add a little organic waste when putting worms in, which gives them a base to work from.

Mulching also encourages earthworms to populate a good mulch or compost. A few worms can soon turn into a whole settlement.

Earthworms bring many rewards: healthier plants, fewer weeds and most importantly less need for sprays and chemical fertilisers.

Just start them off and you will have a happy relationship for a long time.

A little about worms

Worms are fascinating creatures. Although there are many different types of worms, there are many similarities.

A worm is made up of a muscular hollow tube with a mouth at one end and an anus at the other.

The worm has between 90 and 150 segments, with five hearts, a circulatory system, a mucus system and a brain and nervous system.

It also has lots of kidney type organs, which neutralise food.

It has a gizzard, which grinds food.

Earthworms are sensitive to temperature, light, vibration and moisture. Worms breathe through their skin.

And the old saying that "*the early bird catches the worm*" may indeed be an old wives tale. Worms have a system that allows them to dig themselves into the ground making it very hard for birds to pull them out.

The breeding system

Worms are ready to breed once they mature from 50 to 90 days.

Earthworms are hermaphrodites; they can be male or female (a great advantage!).

They can perform both male and female functions and mate every 7 to 10 days.

The mating process takes around 24 hours. Two mature worms lie next to each other head to tail and bring their sex organs into contact. The male cells on each worm then fertilise the female cells on the other by exchanging sperm.

When the worms break apart, each fertilised worm secretes a mucous substance, then helps the egg capsule form.

Worms hatch out of the capsule between 7 and 21 days. Between 2 and 20 worms can emerge from one capsule, but the average is around 6. These worms are white and tiny, but are completely self-sufficient.

Under normal conditions worm will make around 50 capsules a year, hatching around 200 earthworms, and these worms will become breeders within 3 - 4 months.

However worms will limit their breeding to available space and food. Pretty smart creatures aren't they!

Some worm types

There are thousands of earthworm varieties. the four here are the most common types.

The Red Worm

Red in colour, around 2 to 4 inches long, lives in gardens, lawns and moist rotting compost heaps and leaf mould, thrives where moist organic soil is covered with mulch, they breed fast and up to 5,000 can live in a cubic metre, in good conditions.

The Tiger Worm

Similar to the red worm but has small rings, hence the name. They love compost, manure and like sewage also. They breed fast and need to be in a moist area.

The Field Worm

About 4-6 inches long, these worms inhabit paddocks, lawns and gardens aerating and irrigating the soil.

The Night Crawler

This worm is slightly redder and usually remains below the surface. This worm doesn't like crowds. Normally there will only be around 10 worms in 1 metre of turf.

Worm (vermi) composting

Objective: To dispose of classroom and/or school's organic green waste in an environmentally friendly way.

Key Words: Organic, Vermicomposting.

Activity: To set in place a vermicomposting bin to deal with the classroom and/or school organic wastes and use for further projects.

Discussion Ideas:

- Q. What is VERMICOMPOSTING?
- Q. What is ORGANIC green waste?
- Q. Are there other types of composting?
- Q. Who has a compost bin at home?
- Q. Does it have worms in it?
- Q. What compounds make up anything ORGANIC?



Some Facts

- The earthworm used in vermicomposting is the Tiger worm, *Eisenia fetida*, also known as the composting worm. This is the worm commonly found in the home compost bin and the common earthworm commercially farmed.
- Tiger worms will only eat organic food scraps – not greenwaste.
- If you want to set up a school worm farm, we can come and help you with the process.
- You will need to calculate the volume of organic waste your class and/or school creates on a weekly basis (ie; your organic lunch scraps). Do this by collecting your organic foodscraps for a week, weigh them and then average a daily amount.
- You will then need to calculate how many worms you will need to put into your worm bin. (1 kg [approx 4000 worms] will eat 5 kg of food a week). Worms actually eat their own body weight of food each day!
- You could start with a smaller number of worms and increase their food as they multiply in numbers. But it is best to get the right volume of worms to the food they will need to eat.

Worms

Objective: To learn more about worms.

Key Words: Bacteria, Clitellum, Cocoon, Gizzard, Hermaphrodite, Mucus, Nervous, Setae.

Activities: To investigate how worms move, breathe, eat and re-produce.

Discussion Ideas:

- Q. How do worms move? Do they have legs?
- Q. Do they have teeth? How do they digest their food?
- Q. How do they hear? Smell? Breathe?
- Q. How do they have babies?



The Facts on Worms

Movement

- Earthworms have a segmented, cylindrical body.
- To move either forward or backwards the worm uses its muscles. It uses its 'round' muscles squeezed together to make it long and thin. By squeezing together its 'long' muscles it is able to contract, making it short and fat.
- SETA, the tiny bristles from each segment of the worm, dig into the surrounding matter to keep the worm from slipping; a good tool when it doesn't want to be pulled out by a bird!
- Earthworms have no bones and can bend their bodies in any direction, wriggle and even curl up into a ball.
- They excrete MUCUS which helps them slide along.

Breathe, Smell and Hear

- Earthworms have no eyes, ears or lungs.
- They breathe through their skin. The air which is present between soil and food particles is diffused through their moist skin into a complex network of blood vessels.
- The MUCUS they excrete helps keep their skin moist.
- They have a complex NERVOUS system which enables them to sense light, food, acid conditions, vibrations and heat etc.



Eating:

- An earthworm has no teeth so cannot chew.
- Its food needs to be soft and moist.



- BACTERIA and FUNGI play an important part by breaking down large particles of food first.
- The worm has a small pad of flesh that sticks out above its mouth. When the worm is eating the pad stretches out and scoops the food up, pushing it into the worm's mouth.
- Muscles then pass the food down through its GIZZARD where tiny hard pieces of grit rub together and grind the food into smaller particles.
- The food leaves the GIZZARD and passes into the worm's digestive tract. The digestive tract has BACTERIA and strong juices in it which break down the food into even smaller particles.
- These nutritious particles are absorbed into the worm's bloodstream, which is pumped around the worm's body by up to five pairs of hearts.
- The remaining particles are passed out of the worm. This is called vermicast.

Reproduction:

- Earthworms are HERMAPHRODITE, which means they are both male and female, but it still takes two worms to reproduce.
- In the act of mating the worms lie next to each other nose to tail almost looking like they are tied in a knot, and exchange sperm.
- The worms then part and each worm secretes a thick MUCUS ring around its CLITELLUM. This ring contains the worm's female eggs and exchanged male sperm.
- As the MUCUS ring is passed over the worm's upper body and head it hardens and forms a COCOON.
- Each COCOON will contain between one and six worms.
- Inside the COCOON the baby worms grow and are ready to hatch in approximately three weeks. The COCOON in this time has changed from yellow to dark brown in colour.
- The worms when first hatched are very pale in colour, and about the thickness of a strand of cotton, but soon start eating and change to a reddish brown colour.
- The new worm will continue to grow and in about two to three months will develop a CLITELLUM. It is now an adult and able to mate.
- The composting Tiger Worm can mate and lay an egg every 7-10 days. Many other species of earthworms only mate once or twice a year.

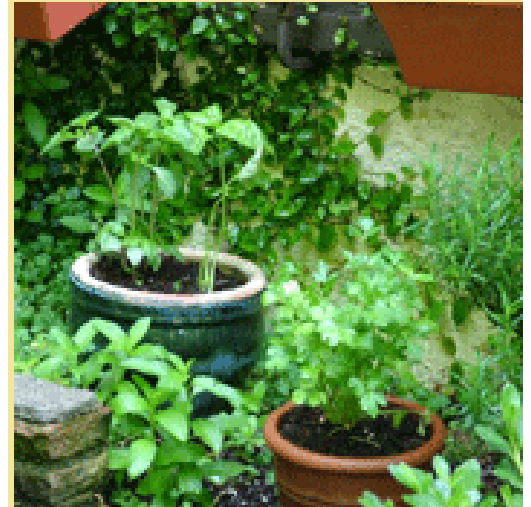


The End Product - Vermicast:

- After the food has passed through the worm it will have broken down into small particles. This is ideal plant food.
- Because each particle is so small the plants are able to use it straight away.
- This end product is known as vermicast and contains nutrients and minerals, all important for healthy plant growth.
- Vermicast could be used as a school fundraiser by being bagged and sold to parents for their plants at home as well as being used to enrich your own school gardens.

Harvesting the Vermicast:

- Feed only one side of your worm bin for two weeks prior to harvesting your vermicast. The worms will move to this side for the food.
- Dig out the vermicast from the unfed side and place in little piles on plastic sheeting in the sunlight. The worms will move away from the light and will burrow to the bottom of the pile.
- Gently brush the vermicast from the top and sides of the pile and you should find any worms in a mass at the bottom of the pile.
- Gently place the worms back into the worm bin and bag the remaining vermicast for sale or place around your school gardens or lawns. Because it is a rich plant food it only needs to be sprinkled around plants on the top of the soil, not dug in.



Activities:

- Examine a worm under a magnifying glass; can you see the setae, clitellum, segments etc?
- Find out about The Lifecycle of a Worm.
- Carry out experiments to see how worms move. Observe them on different textures, eg; dry paper, wet paper, sandpaper, etc.
- Set up your own experiments using plants and castings to find out what percentage of castings you need for best growth, how castings compare with normal fertilisers, etc.
- Share with the rest of the school what you have learnt.

An Experiment in Worm Reproduction:

You will need:

- Six x two-litre ice cream containers with several holes in the bottom.
- Worms.
- Good bedding material for the worms (vermicompost from your worm bin).
- Water.
- Hessian bags or small pieces of underfelt.



Step 1

Set up each of the six ice cream containers as mini worm farms by placing equal amounts of bedding in each, wetting them to the same degree, and then placing food scraps on top. Cover each container with a piece of hessian or underfelt.

Step 2

Add different numbers of worms to each container eg;

1 worm
50 worms

2 worms
100 worms

10 worms
500 worms

(MARK HOW MANY ON THE CONTAINER)

Step 3

Treat each container in exactly the same way, keeping moist and feeding every week with scraps. Add some dolomite every two to three weeks to keep each container 'sweet'.

Step 4

After a period of time - allow at least one month - empty each container and count the number of worms in each.

Step 5

What conclusions can you make concerning the reproductive rate and numbers of worms?

Worm Eggs

- See if you can find any worm eggs or capsules.
- They are about the same size and shape as a match head. They are yellow-golden or orange-brown in colour.
- Gather about four or five and place them between two layers of wet hessian and place in an ice cream container.
- Look at them at the same time every day and record your findings. (You can draw what you see).
- After about two weeks, the eggs should have hatched. Can you see any baby earthworms?
- Average out how many came from each egg.



Class Worm Farm

1. Container

Worms will live in most containers. Be inventive and see what you can come up with, as long as it is not too high and can be moved around.

Even an old drawer with holes drilled in works well as worms like shallow areas.

Punch or drill 8-12 holes about 10 mm in diameter in the bottom of the container for aeration and drainage.

You also need a plastic tray underneath to capture excess liquid (this makes a great plant fertiliser - dilute at rate of one part liquid to 10 parts water).

Cover the bin to conserve moisture and provide a dark place for worms.



Place hessian or a sheet of black shade cloth on top to keep worms in and scavengers out.

2. Where to put your worm bin

You can keep worm bins inside in a cool, dark place.

Outside place them in sheds, garages or in the garden. They like some sun, but need to be sheltered.

3. Worm bedding

Worms require a moist bedding in which to live and breed. You can use shredded and moistened black and white newspaper, peat, straw and some compost.

Don't use sawdust as it often contains resins.

Also add a few handfuls of coarse sand or topsoil. The worms need this to grind their food.

Fill the worm bin to three-quarters high with the bedding and make sure it's moistened - damp, not soggy.

4. The worms

Place about 500 grams of tiger worms in your bin. That's about a thousand worms. This is the fun part as the students either love or hate them!

5. Worm food

Worms are omnivores so will eat both plants and meat tissue, although it's best to use only plants as food in a class situation.

They eat most kitchen/vegetable/fruit scraps and peelings, teabags, crushed egg shells, bread scraps, leftover cereal, cottage cheese, even ice cream.

You can put meat scraps in, but only small amounts and it's best to do it only occasionally.



Worms don't like

Too much citrus, onions, garlic, fats and oils, hot spicy food.

How much and how often to feed them?

Around 100 grams of waste per day per 500 worms; 200 grams if you use over 500 grams of worms for a classroom-size bin).

At home or in your school bin much more can be disposed of if the bin is bigger.

Some helpful hints

- Add food regularly rather than in large quantities.
- Breaking up food into smaller pieces speeds up the composting process.
- Add egg shells for calcium also; dolomite or garden lime keeps acid levels down.
- Keep the worm farm moist. If odours are produced that means you are overfeeding the worms; the bin is too moist and not enough air flow gets in. Slowing down the amount of food for a few days usually corrects this.
- Make sure you bury the food so the worms can get to it more quickly.

- You might also find some seeds growing, as worms don't generate heat so some seeds might germinate.

Worm Farms – A quick reference guide

The Worms:

The earthworms you will need are 'Tiger Worms'. These are the composting worms you will find in your home compost bins. You can purchase worms from a worm farmer or bring in from your home compost bins.

You will need to work out how many worms you will need for you school.

Remember 1 kg = 4000 worms = 5 kg food eaten a week.

Feeding the Worms:

There are two ways you can go about feeding your worms. The first is by feeding them every day, or every second day, in a different area of the bin. The second way is by storing the food in a pre-composting bin first then feeding it to the worms once a week.

The food is broken down and digested quicker if it is broken up into small pieces and is moist.

Maintaining the Worm Bin:

The key to taking care of your worms is to leave them alone as much as possible. But that does not mean you can ignore them!

A black plastic cover on top of the food will help it break down by keeping it dark and moist.

Old carpet or underfelt on top of the plastic will help it stay moist and temperature controlled.

Your worm bin should not smell. If it does, you may need to add a little lime or dolomite to 'sweeten' it, or you may be overfeeding and need to stop feeding for a few days.

There may be a few very small vinegar flies around the decomposing food but the plastic, carpet and lid will deter any other pests from your bin.

Keep an eye on (and a good written record) how much food the worms are consuming and how quickly. Adjust the volumes accordingly.

The moisture level is important so you will need to do a 'squeeze test' every now and then.

As long as their home is well maintained the worms will happily turn your wastes into a valuable plant food called vermicast.

Harvesting

Harvest your bin after around two to three months. You will know when it's time because the soil changes to a dark brown.

Tip the bin onto a plastic sheet and spread out. Worms dislike light so will burrow into the compost.

You can also use horse manure as a way to separate the worms out from the vermicast. Place a small handful of horse manure into the corner of your worm farm. Wait for 24 hours and you will find a waiting mass of worms. Lift the manure and worms into another bin and use the vermicast. Then put the manure and worms back into your worm farm to start the process again.



Some fascinating facts

- Earthworms are larger than their ancestors.
- The earthworm keeps growing after it reaches its mature stage for as much as 6 months.
- Red worms make great bait worms and will remain live and active in the water for long periods.
- Earthworms stay at home under normal conditions and do not migrate.
- Red worms have a life span of several years; in some cases they can live 10 to 15 years.
- An earthworm will swallow its own weight in soil or compost each 24 hours, and will deposit a like weight in castings.
- If you cut a worm in half both ends do not grow. In fact it will depend on where the cut is made as to whether it will survive at all. It can grow a new tail depending on where the cut is.
- Worms are not great citrus eaters.
- Never feed worms any material that has been sprayed.
- You can eat earthworms, they are very high in protein but you need to first wash them and place them in a container of bran for a few days. They will eat the bran and clean themselves out. Separate them from the bran and wash them again. They taste a little like whitebait!



Vermi-composting Data Collection Sheet

Date	Amount fed	Type of Food	Watered/Lime	Notes