Is Soil the Key to Sustainable Farming?

Use this range of resources to investigate a number of factors affecting soil health, including worm counts, soil conductivity testing, and information about the importance of symbiotic relationships in ensuring good soil health.

- Soil Electrical Conductivity (EC Data Sheet)
- Earthworm Information and Identification Activity
- Nitrogen Cycle
- Nitrogen fixation by rhizobium information sheet
- What is soil electrical conductivity (EC)?

Soil Electrical Conductivity (EC) Data Sheet

In agriculture, measuring the conductivity of soil allows farmers and agronomists to determine optimum fertilizer usage and check the general “health" of soil.

INSTRUCTIONS:

Put a sample of the soil in a beaker with some distilled water and stir well for 3 minutes, then follow the instructions below and record your readings for each of the three soil samples.

- The optimal EC value for plant growth is between 0.8 - 1.8
  EC should not usually exceed 2.5

The following table is the adaptation range of EC value of some common crops for reference

CROP	Soil EC	CROP	Soil EC
African Violet	1.0 - 1.2	Lavender	1.0 - 1.4
Asparagus	1.4 - 1.8	Leek	1.6 - 2.0
Anthurium	2.0 - 2.5	Lettuce - Fancy	0.3 - 0.8
Balm	1.0 - 1.4	Lettuce - Head	0.6 - 1.4
Banana	1.8 - 2.2	Melons	1.0 - 2.2
Basil	1.0 - 1.4	Mint	1.0 - 1.4
Beans	1.8 - 2.5	Mustard / Cress	1.2 - 2.4
Beetroot	1.4 - 2.2	Onion	1.8 - 2.2
Blueberry	1.8 - 2.0	Parsley	0.8 - 1.8
Broccoli	1.4 - 2.4	Passion fruit	1.6 - 2.4
Bromeliad	0.8 – 1.0	Pea	1.4 - 1.8
Brussel Sprout	1.8 - 2.4	Pumpkin	1.4 - 2.4
Cabbage	1.4 - 2.4	Radish	1.2 - 2.2
Capsicum	2.0 - 2.7	Rhubarb	1.6 - 2.0
Carrot	1.4 - 2.2	Roses	1.8 - 2.6
Cauliflower	1.4 - 2.4	Sage	1.0 - 1.6
Celery	1.5 - 2.4	Spinach	1.8 - 3.5
Chives	1.2 - 2.2	Silver-beet	1.8 - 2.4
Cucumber	1.6 - 2.4	Squash	1.8 - 2.4
Roses	1.8 - 2.2	Strawberry	1.8 - 2.5
Eggplant	1.8 - 2.2	Thyme	1.2 - 1.6
Endive	0.8 - 1.5	Tomato	2.2 - 2.8
Fennel	1.0 - 1.4	Turnip, Parsnip	1.8 - 2.4
Garlic	1.4 – 1.8	Watercress	0.4 - 1.8

Soil EC values are affected by irrigation and fertiliser use. Excessive fertiliser use can cause increased soil salinity leading to reduced plant growth. Measuring soil EC can help farmers manage fertiliser and increase crop growth.

Earthworm Information and Identification Activity

Farmers can assess the biological health of soil by looking at the number of earthworms in a soil sample.

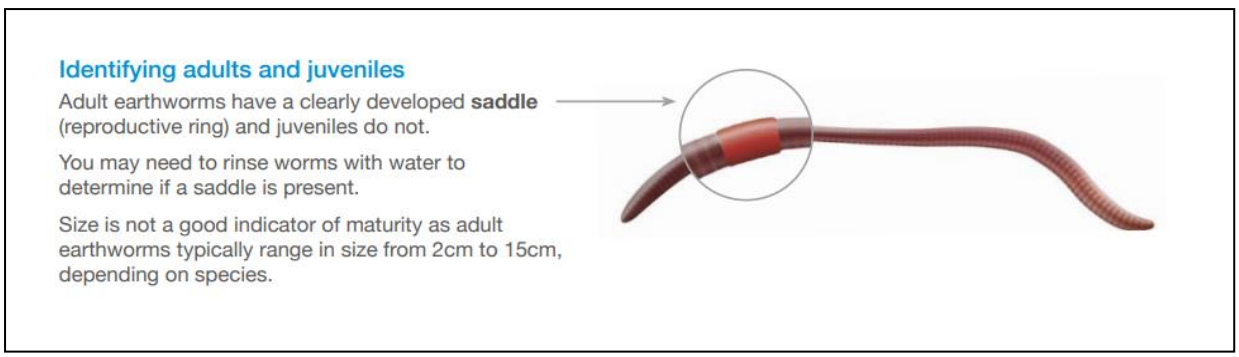
Why are worms a good indicator of the biological health of the soil?
Earthworms create tunnels by burrowing. This helps **'engineer' soil structure**, which in turn helps **aerate the soil and drain water**.
A **wormery** can be used to view earthworm activity.
Worms feed on the remains of dead plants and animals and then fertilize the soil with their faeces (poo!). This can be seen in the field in the form of **'worm casts'** which contain recycled nutrients from the plant remains and soil organic matter that the worms have eaten.

Earthworms **improve plant productivity** and are an important **food source for native birds** such as the song thrush.
There are up to 10 common earthworm species in agricultural soils, and these can be grouped into **three ecological types: epigeic (litter dwelling), endogeic (topsoil) and anecic (deep burrowing) earthworms** – each group having a unique and important function.
Earthworms are an indicator of soil health, earthworm numbers are affected by soil pH, waterlogging, compaction, tillage, crop rotation and soil organic matter management.

Working with the soil samples provided find the earthworms, carefully remove them into a container and then sort the adult worms into the three types (**epigeic, endogeic and anecic)**. Use the Guidance sheet to help you. Record your results in the table.

Identifying Earthworm types

1. Only adult worms can be classified into types.



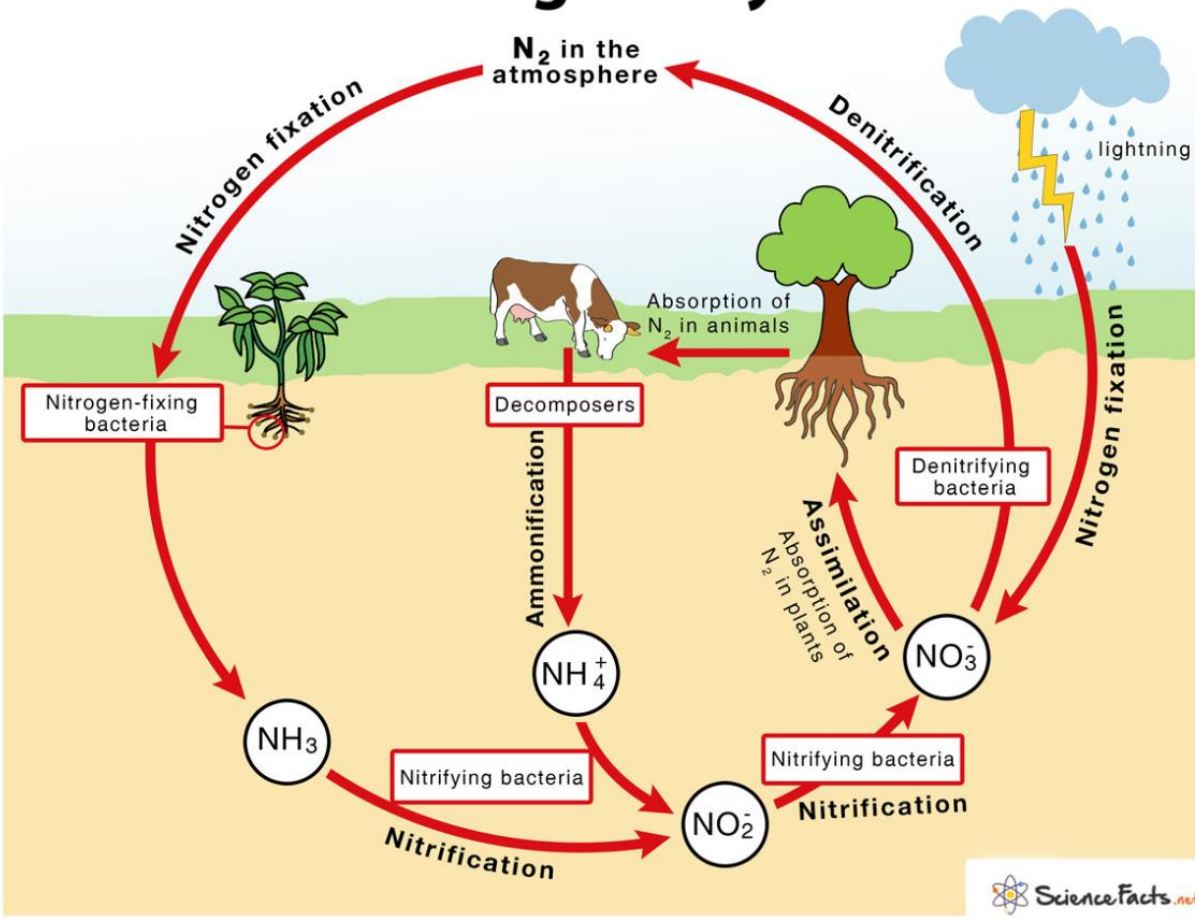
2. Sort the adult worms into the three types using the containers provided.

Type	Picture	Notes
Epigeic litter-dwelling earthworms		**Dark red-headed worms.** **Small (<8cm)** Similar size to a matchstick. Often **fast moving**. Role: Carbon cycling and prey for native birds
Endogeic topsoil earthworms		**Pale coloured or green worms** (not red) **Small to medium size**. Often **curl up when handled**. Role: Soil Structure and providing nutrients for plant growth.
Anecic deep burrowing earthworms		**Dark or black-headed worms.** **Large (> 8cm)** Similar size to a pencil. **Common in grassland** but often absent from ploughed fields. Role: Deep burrows- up to 2m – improve aeration, drainage and root development.

3. Record your findings in the table below:

Worm Type	Number found in the soil sample
Epigeic	
Endogeic	
Anecic	
Total number of adult worms	

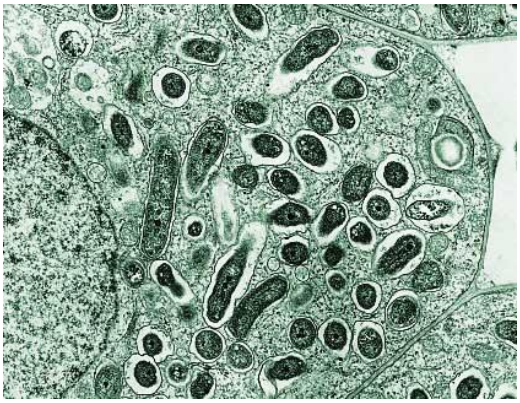
Nitrogen Cycle

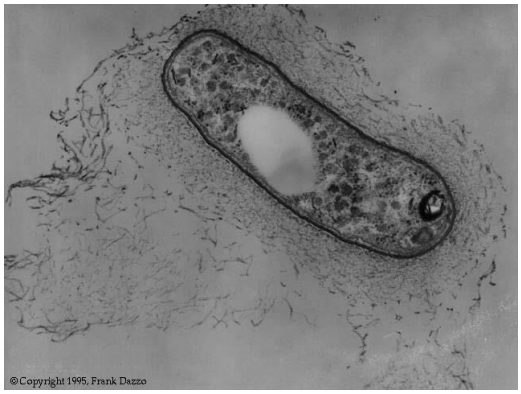


How do farmers make best use of the Nitrogen Cycle?
Think about crops that can be grown and crop rotation, the role of animals and their manure.

Mutualistic nitrogen fixing bacteria (*Rhizobium*)

- Rhizobium bacteria live in root nodules (swellings) on plants belonging to the Legume family e.g., Peas and Beans
- Nitrogen**ase** (an enzyme) inside the bacterial cells **converts nitrogen gas into Ammonium ions (NH_4^+) which are used by the plant and increase the nutrient level in the soil.**
- Nitrogenase is inhibited by oxygen; anaerobic conditions are maintained by a special pigment called **leghaemoglobin**. This pigment gives the nodules a red colour!
- Mutualistic means both the plant and the bacteria benefit from living closely together.
- The legume plant uses the ammonium ions to make amino acids needed for growth.
- The bacteria obtain carbohydrates from the plant which provide them with energy.





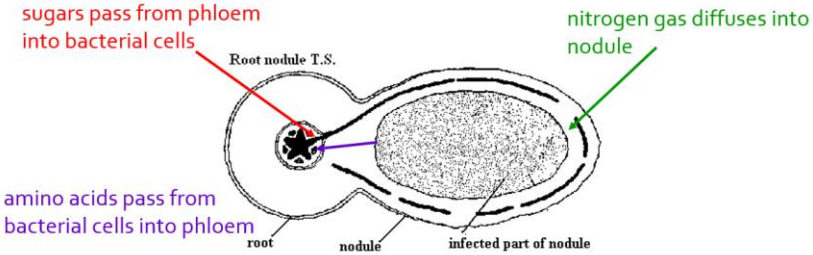
Why do farmers include Legumes in crop rotations? (Think about how these crops benefit the soil)

Root nodules on the roots of a Legume plant

The root nodules have a red colour due to the presence of a pigment called **leghaemoglobin.**

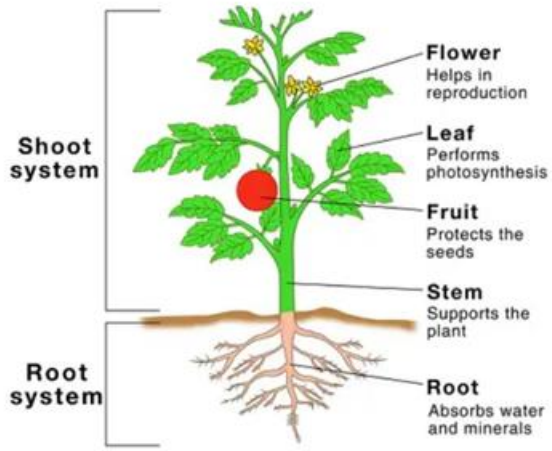
Mutualism (symbiosis)

A Win-Win Relationship!



What is soil electrical conductivity (EC)?

Soil electrical conductivity is a measure of soil water soluble salts and is an important indicator of mineral nutrients in the topsoil. Plants need a range of soluble nutrients for growth the most important being nitrate (NO_3^-) Phosphate (PO_4^{3-}) and Potassium (K^+).



Potassium is for flowers

Nitrogen is essential for healthy for leaves

Phosphorous is for healthy roots

Measuring soil electrical conductivity can be used to determine if the soil needs more nutrients for plant growth. This helps farmers plan fertiliser applications and avoid unnecessary application which could cause pollution.

Plant roots absorb water from the soil by osmosis. If soil EC is too high 'reverse osmosis' can occur and roots will become brown and dry. If soil EC is too low, it indicates the soil does not have enough nutrients for plant growth.

Record your results in the table below. Which soil has the highest level of available nutrients?

Soil Sample Name	Soil Conductivity