South Gippsland Landcare Network
PO Box 419 Leongatha Vic 3953
Phone: (03) 5662 5759
Fax: (03) 5662 5569
Email: sgln@landcare.net
Web: www.sgln.org.au

Case Study: Improving soil and pasture health by using biological cultures; Hall property, Foster

The trial hypothesis

This demonstration seeks to see if soil and pasture can be improved by adding a culture of soil biology agents to a paddock using the Petrik biological farming system.

It is hoped that the addition of biological cultures will

- Speed up the formation of humic compounds in the soil, improve soil structure,
- Improve root penetration
- Improve pasture resilience.

By improving the soil

- The growth of desirable pasture species, such as rye grass and clover should be facilitated.
- The growth of species such as cocksfoot should be enhanced making it more palatable to stock.

Adding biological cultures as a spray avoids cultivation of the soil yet should improve soil structure. This could be applicable to steep areas where cultivation may not be possible. It also avoids the expense and soil carbon depleting effects of cultivation.

The soil still needs to be fertilised with the addition of nutrients according to soil test results. The soil biology cultures may make plant nutrient use more effective, but balanced nutrient levels still need to be provided.

For this trial the landholders identified an area that was less productive than they would like. It had compacted soil and grazing stock seemed to find some of the grasses unpalatable (cocksfoot) and tended to selectively graze the northern end of the paddock.

The landholders wished to find a method of soil improvement that avoided as much as possible the use of machinery as much of their farm is very steep.

The property

Location: Amey's Track Foster.
Elevation: 200.0 metres
Aspect: Ridge on Strzelecki ranges
Soil Type: Dermasol – grey brown clay over siltstone
Pasture Species: Rye Grass (Lolium sp), Clover (Trifolium sp), Bent Grass (Agrostis sp), Cocksfoot (Dactylis glomerata), Brome, and various pasture weed species.
Rainfall: 1008mm
Fertilizer history of the test site-
2012 (No applications due to wet conditions)
2011 (200kg 3 and 1 Super/Potash +70 kg Urea/ha)
2010 (2 tonne Calcimo 50/50 Lime/ha + 1tonne /ha of Pig Manure)
2009-1999 (An average of 300kg 3 and 1/ha +70kg Urea/ha)
2005 (Copper/Molybdenum)
2002 (2.5 tonne Darriman Lime/ha)

The property is a beef cattle property grazed rotationally, occasionally with a small number of animals for a long period.

David and Linda Hall farm several properties in South Gippsland. They have had success using biological cultures in the past, and are hoping that this property will benefit in the same way. To test if the added biology is the driver of the improvement, a trial has been devised on a small paddock, where the biological cultures have been added to only part of the area as the trial variable.

This case study is part of the South Gippsland Landcare Network's Healthy Soils Project which is funded through the West Gippsland CMA project "Healthy Soils Sustainable Farms: building carbon and managing pH in West Gippsland"

West Gippsland Catchment Management Authority

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Soil biology– an overview

Soil biology describes the life forms that live in the soil. These organisms are mostly very small and some, such a soil bacteria, can only be seen using a microscope. Soil organisms breakdown organic materials such as plant litter and animal manure and in the process release nutrients to plants and improve soil structure. The diagram below shows the relationships between some of the organisms. The relationship between plants and microorganisms in the soil is extremely complex, with plants providing exudates from their roots to support the soil microbiology in return for the nutrients that they need to grow.

In a gram of soil there can be billions of bacteria. There are over 50,000 different bacteria species, many of which are neither named nor described. Most live in the top 10cm of soil where organic matter, moisture and air are present.

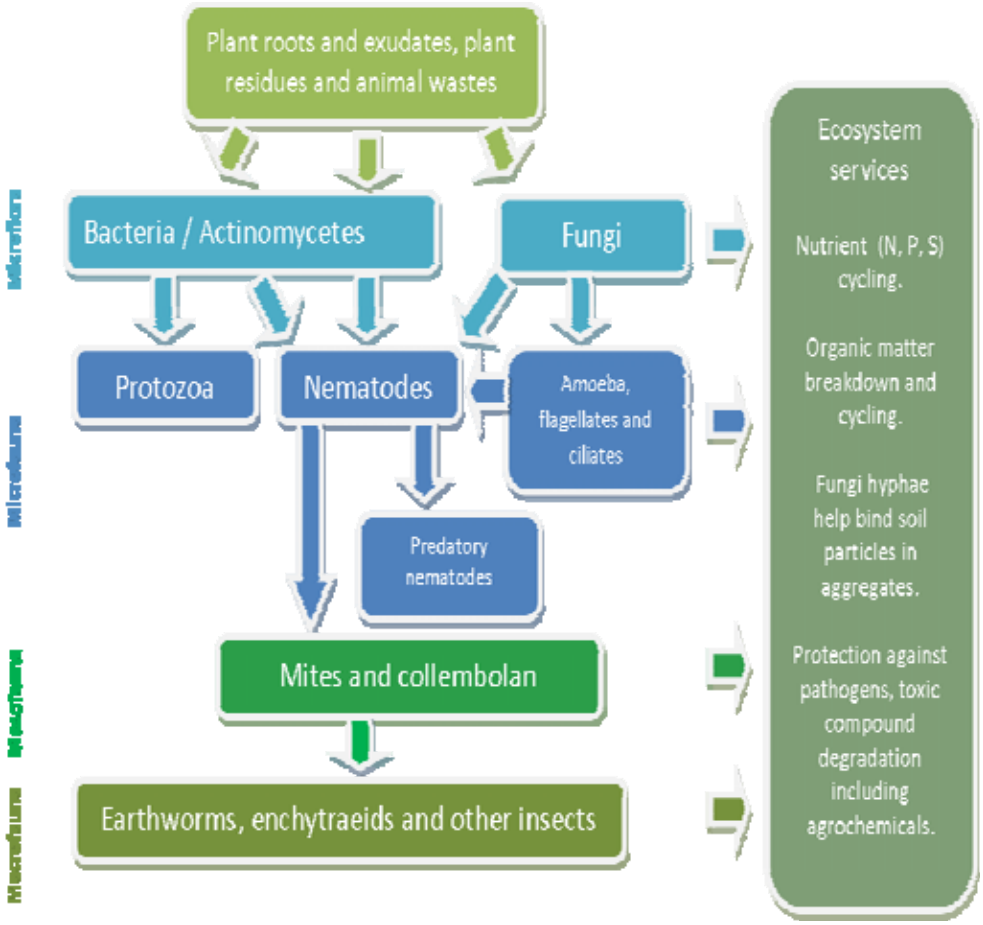
Soil fungi are microscopic plant like cells that grow in long fibre like structures (hyphae) that make a mass called mycelium.

Actinomycetes are types of bacteria, and many have a filamentous growth pattern (like hyphae) which makes a mycelium.

Actinomycetes are numerous and widely distributed in soil. They are sensitive to acidity (optimum pH range 6.5 to 8.0) and waterlogged soil conditions. This is because they need air to survive and waterlogged soil has none.

Some species, commonly present in compost and manures, are thermophilic (heat loving) growing at 55-65° C.

Bacteria and fungi are the primary decomposers in the soil. If they weren't present, dead plant and animal matter would never break down. The carbon and nutrients that make up all living matter is constantly recycled through the actions of the soil biology. Also, the microbes in the soil are responsible not only for the detoxification of harmful compounds such as many herbicides that are used in agriculture, but also for naturally produced toxins that would otherwise accumulate and inhibit growth.



Adding biological cultures to pasture

Any soil in South Gippsland growing some form of pasture plants must have all of the soil biology present. A soil that has been over cultivated, treated with fungicides, is extremely acid, very dry or extremely cold may have some species and genera missing, but by and large if soil smells like soil (a compound produced by actinomycetes called *geosmin* is responsible for the characteristic odour) has rotting dead plant material composting at ground level and is actively growing plants, it is fair to assume that microbiological activity is occurring.

When we want to improve the productivity of our farms, we can test the soil and add the nutrients that are lacking or unbalanced, we can improve the species of pasture that we grow and we can manipulate the grazing cycle to maximise pasture growth.

We can also make the system more effective by choosing actions that maintain the effectiveness of the soil microbiology. This might be reducing cultivation, aerating the soil, applying nutrients and increasing pH using lime. The C:N ratio must also be optimal for good microbiological growth.

If it makes sense to breed plants and animals for improved vigour and production, it is also possible for soil biology.

This is the premise behind the soil cultures used in this trial. They have been selected from soil that has demonstrated vigorous plant growth in the absence of any other variable.

When sprayed on the paddock we would hope to see improvements in nutrient uptake by the pasture plants and improvements in soil structure due to the presence of fungal hyphae. The production of humic compounds by the microbes should lead to improved soil texture and moisture holding ability.

This demonstration aims to test this by adding soil biological cultures to pasture on a South Gippsland farm. By leaving an area untreated (a control area) we will be able to compare the soil and pasture and try and see if any improvement takes place.

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Pre trial soil test results

AREA	North test area	South test area
Laboratory	CSBP	
Date	30/8/2012 prior to trial	
pH Level (CaCl2) pH	4.9	5.1
pH Level (H2O) pH	5.7	5.8
Ammonium Nitrogen mg/Kg	7	12
Nitrate Nitrogen mg/Kg	6	7
Phosphorus Colwell mg/Kg	108	47
Potassium Colwell mg/Kg	336	205
Sulphur mg/Kg	6.7	4.4
Organic Carbon %	4.05	3.30
Exc. Calcium meq/L	1.13	1.05
Exc. Magnesium meq/L	0.43	0.34
Calcium Magnesium ratio	5.1	6.8

Soil test samples showed significant differences in nutrients, particularly P & K which were much higher in the northern area of the test paddock. This is probably due to a stock camp/ fertility transfer scenario.

Setting up the trial

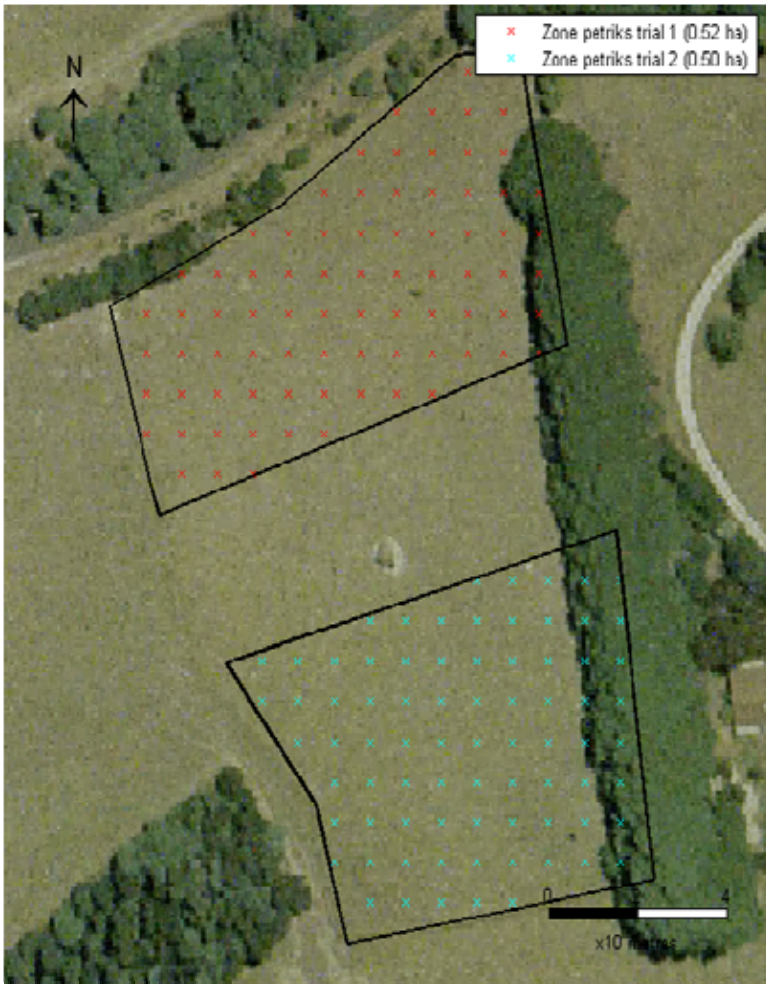
The soil tests are the baseline measurement and also inform the paddock treatment. The recommendation was to apply to the whole paddock 1 tonne/Ha good quality dolomite or Mag-lime when conditions were suitable for spreading.
For the trial it a buffer strip between north & south of at least 50 metres was left and both the north and south areas were treated with Petrik biology and trace elements which were;
Petriks Evergreen @ 2 litres/Ha and Green manure @ 1 litre/Ha and added to spray tank Debenhams trace elements copper @ 1 Litre/Ha and cobalt & selenium @ 1litre/Ha.

See map right.

What will we be measuring?

- Pasture production will be measured using a rising plate meter.
- The landholder will take Brix test measurements at regular intervals.
- Biological activity will be measured using the Solvita Soil Life test which measures soil biological respiration.
- Soil testing will be performed at intervals by a recognised laboratory.
- Plant tissue testing would be a useful measurement every 12 months. If the program continues this measurement should be taken.
- Plant root structure will be monitored using visual assessment. The method of assessment found at ftp://ftp.fao.org/agl/agll/lada/vsfast_methodology.pdf will be used as a guide. A photographic record will be kept.
- Pasture species by percentage will be determined by identifying the species in a one metre by one metre frame randomly placed every 5 paces (5 metres) on a transect across each of the test and control areas.
- Visual assessment of the pasture will be made to identify any trends in growth or animal grazing patterns. This will be recorded photographically.

The results of these tests and assessments will be recorded in the Trial document found on the West Gippsland Catchment Management Authorities web page www.wgcma.vic.gov.au. The link to the Soil Trial Directory is
http://www.wgcma.vic.gov.au/index.php/component/content/article/45-publications/284-the-gippsland-soil-trial-directory.html
And the link to the Trial document is
http://www.wgcma.vic.gov.au/images/stories/PDF/Publications/Regional/Soil_Health_Directory/david_hall_soil_demonstration_trial_2012.pdf



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Some initial results

SOLVITA #1 Blue-Gray	SOLVITA #2 Gray-Green	SOLVITA #3 Green	SOLVITA #4 Green-Yellow	SOLVITA #5 Yellow
VERY LOW SOIL ACTIVITY Associated with dry sandy soils, and little or no organic matter.	MODERATELY LOW SOIL ACTIVITY Soil is marginal in terms of biological activity and organic matter	MEDIUM SOIL ACTIVITY Soil is in a moderately balanced condition and has been receiving organic matter additions.	IDEAL SOIL ACTIVITY Soil is well supplied with organic matter and has an active population of micro-organisms	UNUSUALLY HIGH SOIL ACTIVITY High / excessive organic matter additions

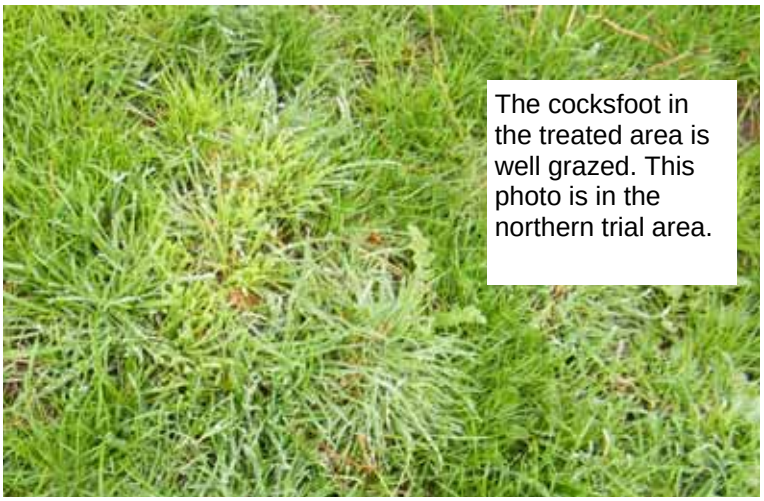
Soil-Quality Curve

The Solvita test as pictured above measures the amount of CO_2 respired by soil micro-organisms. The CO_2 is absorbed by a gel on the plastic paddles and the gel changes colour when CO_2 is absorbed. The two trial areas that had biology applied to them as part of the trial are showing increased biological activity.

Root structure before trial began

Root structure from the northern area 7 months into the trial

The cocksfoot in the control area is ungrazed.



The cocksfoot in the treated area is well grazed. This photo is in the northern trial area.

Early indications of results from this case study

- The soil shows more biological activity in the treated areas.
- One of the treated areas showed increased production
- The grass roots seem to be improving in the trial areas
- The cocksfoot is being better utilised by stock in the treated area.