

Final Report: Healthy soils, healthy future – bridging the gaps in soil health for sustainable agriculture

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1.0 Summary

This report completes a three year project with the main objective to improve soil health and sustainable land use in the Fitzroy Basin and Northern Gulf through capacity building activities based on the findings from on-farm participatory action research. The project timeframe of three years commenced in July 2008 and concluded in June 2011.

The project focused on two key components; Education and capacity building activities to increase the knowledge and skills of landholders and advisors and Establishing on-farm research trials and demonstration sites to address critical gaps in soil health knowledge examining the benefits of a number of alternative or new soil management practices.

The education and capacity building activities included training workshops on soil fertility, soil carbon and biological inoculums with field days showing the adopted learnings through on-farm research trial and demonstration sites. One research trial site and eleven demonstration sites were established on nine properties within the local vicinity of the townships of Biloela, Baralaba, Calliope, Kingaroy and Mareeba.

The research trial site was centred on one property to review innovative practices such as pasture cropping and biodynamics. Property owners through collaboration with project staff designed individual trials conducted on demonstration sites to investigate the benefits of biological inoculums (compost teas and biodynamics) within a grazing landscape.

Increases in both soil and plant health were not apparent from compost tea or biodynamic applications on grazing lands within Central or Northern Queensland. While changes in organic matter, soil biological and nutrient levels were recorded in the Northern Gulf trial, the confidence in the results is limited due in part to the soil sampling strategy and changes in management by reducing potential harmful products within the treated paddocks.

The on-farm production of compost tea and biodynamics were of a high standard that should have benefited multiple aspects of soil or plant health. There was no benefit to soil biological biomass or activity from compost teas

or biodynamics even with the addition of specific food sources to assist survival and growth of biology. Food sources did not enhance activity levels in endemic soil organisms within or above the desired ranges to achieve a healthy soil ecosystem.

Visual changes to pasture species and topsoil health were more often associated with the treated paddocks. The removal of harmful products which is most often the cause of the soil and plant fertility issues is most likely why any response albeit visually, is likely to have occurred in the short to medium term.

For Central and Northern Queensland farmers at the large property level, applying compost teas or biodynamics cannot be justified in relation to increasing soil or plant health. Future activities should be undertaken to create an environment where soil moisture is optimised. Changes will be required to present day management and may involve establishing new plants. The adoption of targeted 'enhancement' products such as compost teas and biodynamics may then provide additional benefits in a healthier and functioning landscape.

2.0 Objectives

The overall objective of the project was to improve soil health and sustainable land use in the Fitzroy Basin and Northern Gulf through capacity building activities based on the findings from on-farm participatory action research. Specific objectives were to:

- Increase the capacity (skills and knowledge) of landholders to implement sustainable land management practices.
- Undertake investigation, using on-farm trials and demonstration sites, to identify appropriate techniques to address NRM issues of fertility decline, soil organic carbon loss, water quality detriment and erosion.
- Improve effectiveness and efficiency of information sharing and knowledge broking through the engagement of regional bodies (Fitzroy Basin Association (FBA) and Northern Gulf Resource Management Group (NGRMG)), government agencies (DPI&F CQSFS) and landholder groups

(Baralaba, Taroom and Callide Landcare groups).

- Implement best management practices with engaged landholders in three years.

To achieve these outcomes, the project focused on two key components:

- 1) Education and capacity building activities to increase the knowledge and skills of landholders and advisors, with the anticipation of future changes to current management of improved soil health and long term sustainability of their farm, while improving farm productivity.
- 2) Establishing on-farm research trials and demonstration sites to address critical gaps in soil health knowledge examining the benefits of a number of alternative or new soil management practices. The findings from the trial and demonstration sites would 'complete the feedback cycle' into the education and capacity building activities throughout the project timeframe.

3.0 Education and Capacity Building Activities

A series of training workshops were developed with the inclusion of field visits to the on-farm research trial and demonstration sites. Specific workshops were aimed at addressing the objectives of the project and the requirements of project partners to increase their knowledge and skills. These workshops included:

- Soil fertility and soil health (workshops)
 - Soil organic carbon (workshop)
 - Use of soil treatments and how to make them work in your farming system (workshop)
 - Pasture cropping (workshop and field days)
 - Making your own biological products (workshop and field day)
- Trial and demonstration site co-operator meetings.
 - Regular meetings to interpret and reflect on data and discuss further activities. Initially meetings were monthly, and then quarterly when the project was established.
 - Sharing information
 - Bus trip associated with Beef 2009.

- Analysis and interpretation of test results from research activities extended to the wider community through media, industry newsletters and field days.



Figure 1: Elaine Ingham (President of Soil Food Web) discussing the soil food web to a captive audience of 75 farmers in Biloela, 1-2 June 2009.

4.0 Establishing on-farm research trial and demonstration sites

The research trial site was established in September 2008 on Mr Noel and Marie Moretti's property, "La Terre Riante" to review the innovative farming practices of pasture cropping, green manures and the use of biological soil treatments. Initial biological soil treatments were undertaken with paddocks prepared for pasture cropping and conventional cropping rotations. Due to the unfavourable climatic conditions experienced between March 2009 and June 2010, no pasture cropping or conventional cropping treatments occurred.

A total of eleven demonstration sites were established on eight grazing properties and one mango farm within the local vicinity of the townships of Biloela, Baralaba, Calliope, Kingaroy and Mareeba. The landscape characteristics of all properties varied considerably from softwood scrub uplands through to brigalow alluvial plains interspersed with gilgai formations to soft forest silverleaf ridges. Each property was primarily selected on the basis that the owner expressed a desire to be a long-term committed partner of the project.

5.0 Trial protocols including treatments

5.1 Research Trial Site

A replicated trial was designed under the guidance of a biometrician within the existing cell paddock layout on one grazing property. Individual cell paddocks surrounding a cell centre were assigned either a Control, Pasture, Past Crop (Pasture Cropping) or Conv Crop (Conventional Cropping) treatment (Figure 2).

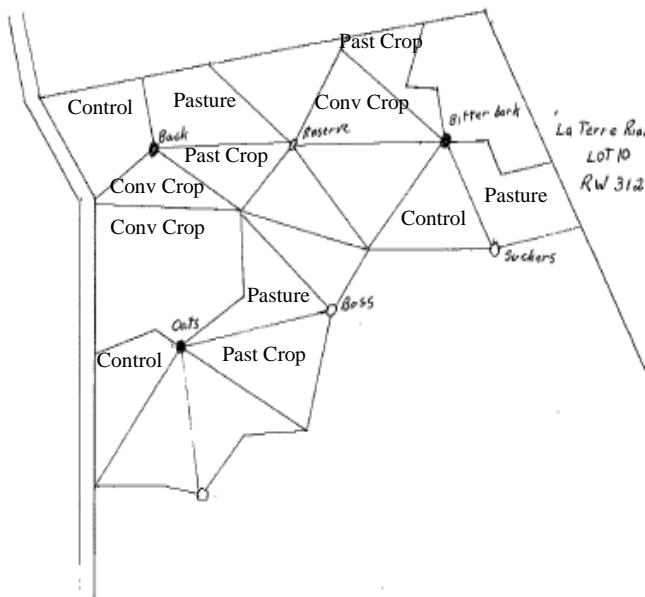


Figure 2: Trial layout with three replications of control, pasture, past crop and conv crop treatments. The black dot (with paddock name) represents a central watering point or cell centre.

Individual treatments originally adopted within the research trial site were as follows:

- Control: Pasture only,
- Pasture: Biodynamics foliar applied to pasture,
- Pasture Crop: Biodynamics foliar applied (same time as Pasture treatment) with the establishment of a winter cereal using the pasture cropping technique, and
- Conv Crop: Conventional cropping a winter cereal under zero-tillage management into bare soil.

5.2 Demonstration Trial Sites

The demonstration trial sites were established as paired sites on individual cell paddocks. Individual treatments adopted within this project were as follows:

- Control: Pasture only,
- Tea: Compost tea foliar applied,
- BD: Biodynamics foliar applied, and
- Food Only: Biological foods foliar applied.

5.3 Establishing a Monitoring Pattern

The monitoring patterns for the research and demonstration trial sites were developed using the same procedure. Individual paddocks/cells within each grazing property contained four permanent monitoring locations. Natural and man-made impediments such as roads, trees, fencelines, contour banks, seismic line surveys, landscape patterns (melonholes), watering points and paddock access were considered in the original monitoring plan. Monitoring points were GPS referenced and located between 30 and 50 m apart in a straight line transect so repeat sampling could traverse a similar directional path.

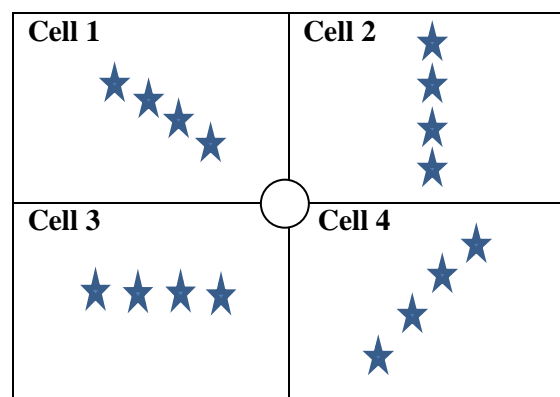


Figure 3: Monitoring pattern layout for trial sites on grazing properties (not to scale). The pattern within Cell 2 was routinely adopted for the replicated and demonstration trial sites.

5.0 Sampling Protocols

Sampling protocols were established for a range of soil and plant health indicators. NATA accredited laboratories were engaged where possible to provide specific analysis of requested indices.

Baseline monitoring conducted prior to the commencement of treatments consisted of:

- Soil nutrients (0-110 cm) including soil carbon,
- Bulk density (0-110 cm) including gravimetric soil moisture
- Soil biology (0-10 cm),

- Pasture sap analysis of the dominant pasture species.

Monitoring throughout the course of the project including repetition of the baseline monitoring assessment as well as:

- Annual soil nutrients (0-110 cm) including soil carbon,
- Annual bulk density (0-110 cm) including gravimetric soil moisture,
- Compost, Compost Tea and Extract sampling for biology,
- Plant tissue analysis, and
- Plant feed analysis.

6.0 Results

The following results relate specifically to the data collected from the research and demonstration sites within the Fitzroy Basin (Northern Gulf results are located in Appendix 1). The discussion will evaluate all results and establish any potential correlation in improving soil health from the application of compost teas and biodynamics.

6.1 Compost, Biodynamic preparations, Compost Tea and Biodynamics Biology

Compost teas and biodynamic brews were analysed by Soil Food Web Institute (SFI) for specific biological organisms. Inoculums were not tested for soluble nutrient levels as the amount of compost/biodynamic preparation used in the manufacturing process was deemed insufficient to benefit soil and plant nutrient levels directly.

Major finding: The average bacterial and fungal levels (total and active) of all compost teas analysed by SFI were either within or above desirable levels (Table 2 and 3). One individual tea registered nil bacterial activity with another tea registering slightly less than desirable levels for total and active fungal biomass ($\mu\text{g/L}$). Bacterial levels within the biodynamic brews exceeded the desired levels with active levels similar to the compost teas. Total and active fungal biomass was below desirable levels in the biodynamic brews except for total fungal biomass in 2010.

	Total Bacteria ($\mu\text{g/mL}$)		Active Bacteria ($\mu\text{g/mL}$)	
	2009	2010	2009	2010
Inoculum				
Tea	8747	3968	27	40
Biodynamics	423	896	29	30
Desirable	150 to 3000		10 to 25	

Table 1: Average total and active bacterial biomass ($\mu\text{g/ml}$) of compost teas and biodynamics in 2009 and 2010.

	Total Fungal ($\mu\text{g/ml}$)		Active Fungal ($\mu\text{g/ml}$)	
	2009	2010	2009	2010
Inoculum				
Tea	149	22	134	17
Biodynamics	1	6	0	1
Desirable	2 to 20		2 to 10	

Table 2: Average total and active fungal biomass ($\mu\text{g/ml}$) of compost teas and biodynamics in 2009 and 2010.

Minor finding: Except for active fungal biomass levels, all other bacterial and fungal indices for compost and biodynamic preparations were within or above the desired levels (Table 3 and Table 4). Active fungal biomass levels of both inoculums were low or at the minimum desired levels. The compost teas manufactured from the compost analysed in Table 4 resulted in higher fungal levels than the original composts. In contrast, the biodynamic brews showed little to nil active fungal levels when extracting from the biodynamic preparations.

	Total Bacteria ($\mu\text{g/g}$)		Active Bacteria ($\mu\text{g/g}$)	
	2009	2010	2009	2010
Compost				
Tea	1626	1145	190	81
Biodynamics	1428		168	
Desirable	100 to 3000		15 to 25	

Table 3: Average total and active bacterial biomass ($\mu\text{g/g}$) of compost and biodynamic preparations in 2009 and 2010.

	Total Fungal ($\mu\text{g/g}$)		Active Fungal ($\mu\text{g/g}$)	
	2009	2010	2009	2010
Compost				
Tea	2024	1120	0	14
Biodynamics	1130		15	
Desirable	100 to 300		15 to 25	

Table 4: Average total and active fungal biomass ($\mu\text{g/g}$) of compost and biodynamic preparations in 2009 and 2010.

Overall: The quality of compost, biodynamic preparations, manufactured compost teas and biodynamic brews was deemed to be of sufficient standard to demonstrate beneficial responses in soil and plant health. Lower than desirable fungal activity within the compost and

biodynamic preparations could have resulted in higher levels recorded with the compost teas and biodynamic brews respectively.

Less than desirable levels of active and total fungi within biodynamic brews were observed. The short brewing time (one hour) and lack of targeted fungal food sources potentially limited the development of fungi. Proliferation of fungi biomass in a compost tea was aided by a longer brewing cycle (16 to 24 hours) and ‘prepping’ of compost with fish hydrolysate a minimum of three days prior to brewing. Additional food sources were added to the compost tea to further enhance bacterial and fungal levels with results indicating that their inclusion is warranted in the manufacturing of compost teas and biodynamic brews.

6.2 Soil Biology

Soil biology monitoring was undertaken from August 2008 until March 2010. During this period it became apparent that soil moisture and spatial variation were significantly biasing results independent to applications of compost teas or biodynamics. Soil biology testing was thus terminated in preference to more proven analysis techniques of soil and plant parameters.

Major Finding: Soil moisture had significantly higher effects on soil biology levels than compost tea or biodynamic applications. Increasing soil moisture levels correlated with an increase in total bacterial and fungal biomass (Figure 4) as well as active bacterial and fungal levels (Figure 5).

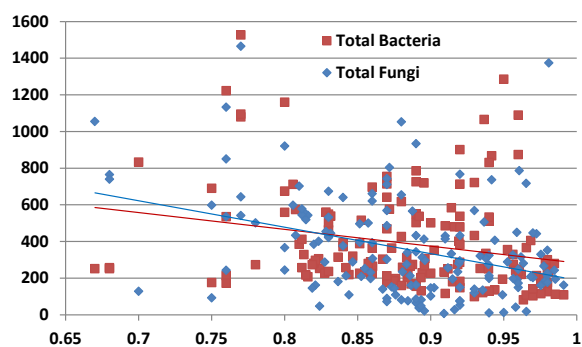


Figure 4: Total bacteria and fungal levels (y-axis) (ug/g) (0-10 cm) compared to soil moisture levels (x-axis). Moisture levels approaching 1 indicate a dry soil.

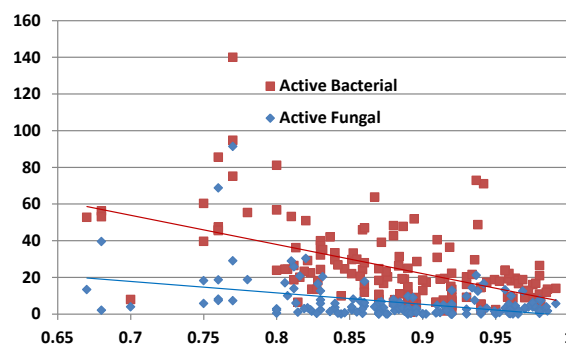


Figure 5: Active bacteria and fungi levels (ug/g) (y-axis) (0-10 cm) compared to soil moisture levels (x-axis). Moisture levels approaching 1 indicate a dry soil.

To assess spatial variation of the major biology groups, one trial site was selected with monitoring conducted in November 2009. Four individual and one composite soil sample were analysed from the four GPS referenced monitoring points. An individual sample was taken at each monitoring point with a composite sample taken as per standard monitoring procedure.

Apart from one individual sample (Sample 4 in Table 5), all remaining individual samples exhibited significant variation between the composite sample. Variation between biological indices for the individual samples was in some cases more than three (active bacteria) and six times (active fungi) higher than the composite sample.

	Total Bacteria (µg/g)	Active Bacteria (µg/g)	Total Fungi (µg/g)	Active Fungi (µg/g)
Sample 1	176	26.4	214	0.85
Sample 2	300	20.9	225	7.66
Sample 3	173	10.9	177	2.75
Sample 4	141	9.0	446	3.38
Average	198	16.8	266	3.66
Comp Sample	140	7.4	464	0.82

Table 5: Total and active bacteria and fungi biomass (µg/g) (0-10 cm) sampled in November 2009 from an individual trial site.

Minor Finding: Total bacteria biomass (Figure 6) decreased for all treatments during the project but remained above the desired range of 100 µg/g of soil (adequate level stated by SFI). A slight decreasing trend in total bacteria was observed with similar findings across other projects suggesting that bacteria was less resilient to environmental stresses from either climate and/or grazing management.

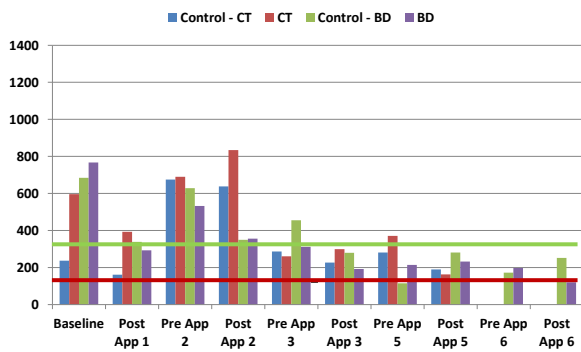


Figure 6: Average total bacteria biomass (ug/g) (0-10 cm) pre and post application of compost tea and biodynamics. Desirable ranges are within the green line (upper) and red line (lower). Note that CT refers to Compost Tea and BD refers to Biodynamics.

Total fungal levels (Figure 7) remained within or above the desired ranges and were not influenced by the application of compost tea or biodynamics. Fungi levels recorded Post App 5 (Figure 7) following a biodynamic application could not be explained as soil conditions were not conducive to demonstrate such a variation between the control and biodynamic treatments.

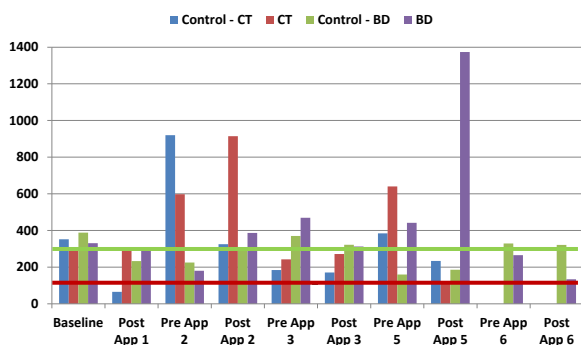


Figure 7: Average total fungi biomass (ug/g) (0-10 cm) pre and post application of compost tea and biodynamic brews. Desirable ranges are within the green line (upper) and red line (lower). Note that CT refers to Compost Tea and BD refers to Biodynamics.

Active bacteria levels (Figure 8) were within or above the desired range for the compost tea treatment but within or below the desired range for the biodynamic treatment. There was no treatment effect with little difference between the control and comparative treatment (compost tea or biodynamics) following multiple applications.

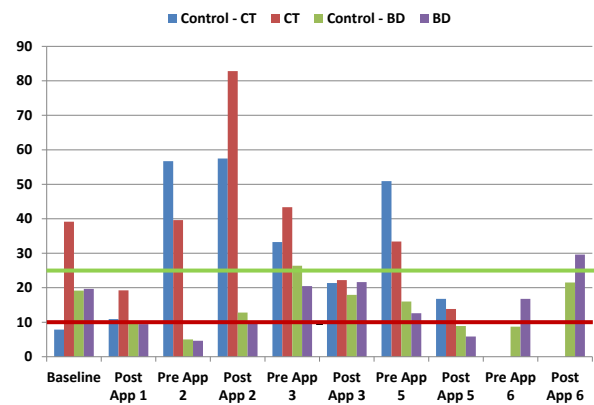


Figure 8: Average active bacteria biomass (ug/g) (0-10 cm) pre and post application of compost tea and biodynamic brews. Desirable ranges are within the green line (upper) and red line (lower). Note that CT refers to Compost Tea and BD refers to Biodynamics.

Active fungal levels (Figure 9) were predominately less than desirable for all treatments with no treatment effect recorded. Increases in fungal activity were more often associated with increases in soil moisture levels.

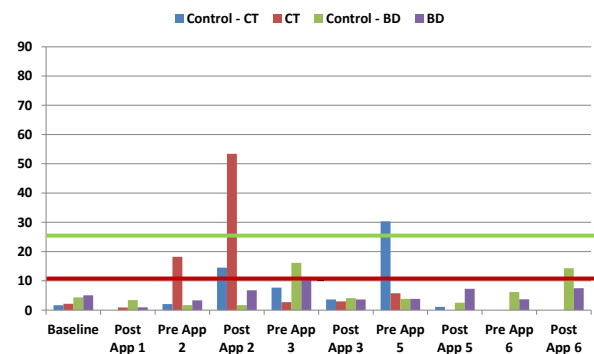


Figure 9: Average active fungi biomass (ug/g) (0-10 cm) pre and post application of compost tea and biodynamic brews. Desirable ranges are within the green line (upper) and red line (lower). Note that CT refers to Compost Tea and BD refers to Biodynamics.

Overall: There was nil treatment effect from the application of compost teas or biodynamics in firstly increasing biomass levels or secondly, maintaining levels (or creating resilience) between applications. Inoculums applied were highly bacterial (section 6.1 Compost, Biodynamic preparations, Compost Tea and Biodynamics Biology) but had no effect on soil bacterial levels. Total bacterial levels showed a slight decreasing trend which may indicate endemic bacterial communities are less resilient to climate and grazing effects than other biological groups. Apart from active fungi, biology levels

within all treatments were at or above desired ranges.

Specific targeted food sources and ideal field conditions at application were observed when trialling compost teas. Biodynamics was most often applied accordingly to the lunar cycle with little consideration for optimum field conditions. Regardless of application methodologies, there were no short or long-term beneficial increases in soil biological levels through the use of compost teas or biodynamics.

Total and active bacteria and fungi biomass were likely to be positively influenced by increasing levels of soil moisture. Prolonging adequate soil moisture conditions may increase the beneficial role these organisms contribute to soil and pasture health.

6.3 Total Soil Carbon

Soil carbon concentrations (%) were converted to stocks (t/ha) using bulk density values taken predominantly at baseline sampling in 2008. Although large variations in bulk density can occur in spatial and temporal scales, particularly within the top 0-30 cm, using the 2008 dataset where possible eliminated the influence from changes in bulk density measured in 2009 and 2010. Bulk density values from 2009 were only used in preference if the 2008 figures were considered to not be representative of the trial areas.

Major Finding: Soil carbon stocks (t/ha) averaged across all treatments increased in 2009 by approximately 3 t/ha for the 0-10, 10-20, 20-30 cm depth intervals. For the 30-60 and 60-110 cm depths, soil carbon increased between 6 and 7 t/ha respectively (Figure 10). In 2010, a decline in carbon levels occurred across all soil depths by an average of 0.5 t/ha with levels remaining above the 2008 baseline values.

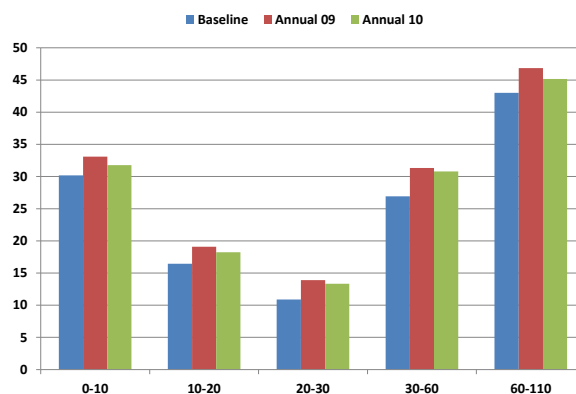


Figure 10: Average total soil carbon stocks (y-axis, t/ha) across all treatments for individual soil depths (x-axis, cm) from 2008 to 2010.

Minor Finding: From baseline (2008) to 2010, soil carbon stocks (t/ha) increased within the Control - CT and compost tea (CT) treatments for all soil depths except for the 60-110 cm depth interval (Figure 11). Initial baseline values were higher in the compost tea treatment however applications of compost tea did not increase these levels above that of the corresponding control treatment.

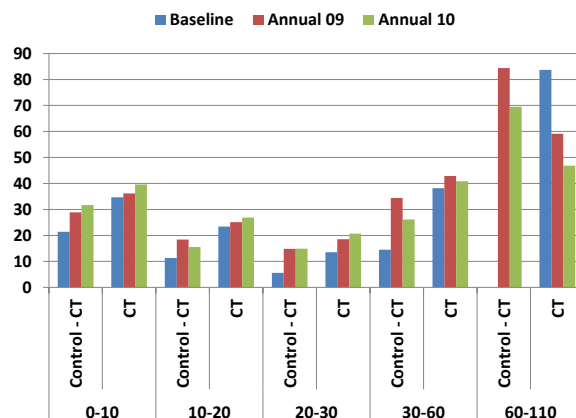


Figure 11: Average total soil carbon stocks (t/ha) for the control and compost tea treatments for individual soil depths (cm) from 2008 to 2010. Note that CT refers to Compost Tea.

Soil carbon stocks (t/ha) increased within the Control - BD and biodynamic (BD) treatments for all soil depths except for the 60-110 cm depth interval between 2008 and 2010 (Figure 12). There was no effect on soil carbon levels from biodynamic applications with similar fluctuations in carbon levels recorded in the control treatment.

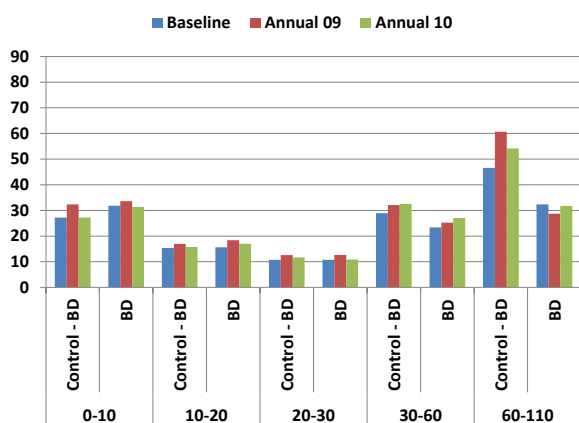


Figure 12: Average total soil carbon stocks (y-axis, t/ha) for the control and biodynamics treatments for individual soil depths (x-axis, cm) from 2008 to 2010. Note that BD refers to Biodynamics.

Overall: Soil carbon stocks increased across all treatments regardless of any treatment effect. The applications of compost tea and biodynamics did not lead to an increase in carbon levels when compared to the respective control treatments. The minor increase in soil carbon was most likely as a direct response to the selective management of cattle and pasture response.

6.4 Soil Nutrients

Compost teas and biodynamics were trialled with the aim of increasing available soil nutrient levels through:

- 1) applied soil biology,
- 2) soluble nutrients to aid existing beneficial soil biology, and
- 3) foliar translocation (from leaf to roots) of soluble nutrients and applied biology.

Plant available soil nutrients were monitored regularly within the topsoil (0-10 cm) in combination with either soil biology or plant nutrient levels. Annual monitoring of total soil nutrients to a depth of 110 cm were collected but have not been included in this report. Given the three year timeframe of the project, any changes to soil nutrient were likely to be observed within the topsoil.

Major Finding: The biodynamic treatment (BD) demonstrated an effect on increasing the availability of seven nutrients when compared to the increase in two nutrients under the control biodynamic treatment (Control – BD). The compost tea (CT) and control compost tea

(Control – CT) treatments increased the availability of five nutrients respectively (Figure 13).

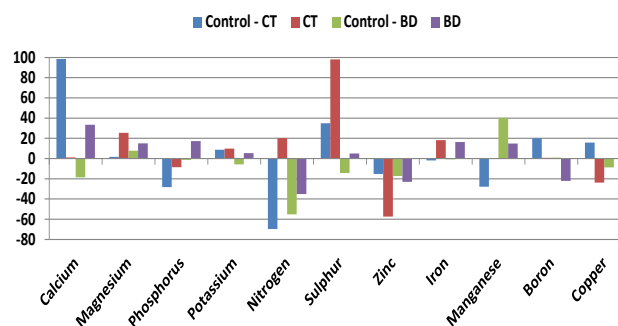


Figure 13: Percentage change (y-axis, %) in major and minor plant available soil nutrients for individual treatments between August 2008 and November 2010. Note that CT refers to Compost Tea and BD refers to Biodynamics.

Minor Finding: Iron was the single element that increased under the compost tea and biodynamics treatment while showing no net increase under both control treatments. Zinc was the only element to decline in soil nutrient availability under all treatments.

Overall: Increases in plant available soil nutrient levels occurred within the biodynamics treatment above that of the corresponding control treatment. Applications of compost tea had nil effect in increasing soil nutrient levels.

6.5 Plant Nutrients

Plant tissue was collected to assess whether compost teas or biodynamics would increase plant nutrient levels. The major indices analysed for plant tissue analysis included crude protein, calcium, phosphorus, potassium, sulphur and various trace elements.

Major Finding: Crude protein levels within pasture species tested did not show any positive correlation under the application of

compost tea or biodynamics (

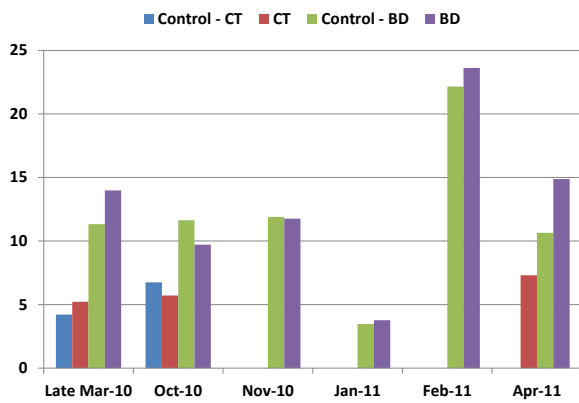


Figure 14). Increases in plant available soil nutrient levels for magnesium (Figure 15) and potassium (Figure 16) didn't translate into increases in plant nutrient levels under the compost tea or biodynamic treatment.

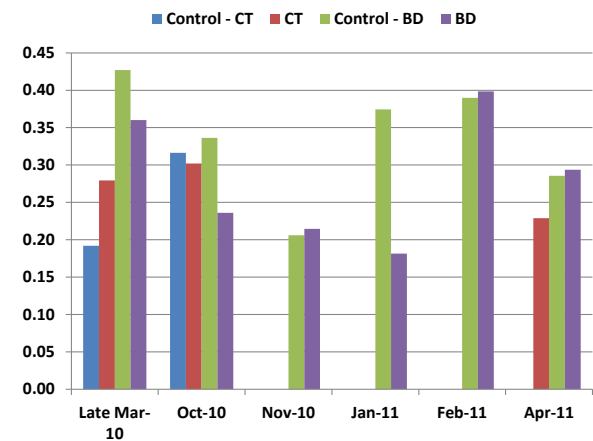
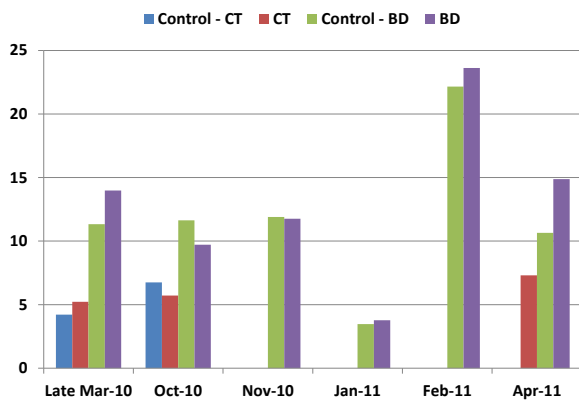


Figure 15: Average magnesium levels (%) of dominant pasture species from March 2010 to April 2011. Ideal levels for magnesium are 0.35%. Note that CT refers to Compost Tea and BD refers to Biodynamics.

Figure 14: Average crude protein (%) of pasture species within individual treatments from March 2010 to April 2011. Note that CT refers to Compost Tea and BD refers to Biodynamics.

Minor Finding: Seasonal fluctuations in plant nutrient levels can be influenced by soil moisture conditions, temperature and stage of plant growth. Soil moisture conditions were not a limiting factor with above field capacity conditions experienced from October 2010 to April 2011.

Figure 16: Average potassium levels (%) of dominant pasture species from March 2010 to April 2011. Ideal levels for potassium are between 2 and 2.5%. Note that CT refers to Compost Tea and BD refers to Biodynamics.

Overall: Plant nutrient levels were not influenced by compost teas or biodynamics nor was it observed that balancing of plant nutrient levels had occurred. Improvements in soil health can result in higher plant nutrition by increasing available soil nutrients and balancing plant nutrient levels.

6.6 Plant Feed Analysis

Plant feed analysis of dominant pasture species within each paired trial site was monitored from March 2010 to April 2011. Earlier analysis was not performed in preference to soil biological and nutrient monitoring.

Major Finding: There was no treatment effect on plant feed quality. Ash levels which

indicate total nutrient status of pastures were expected to increase through the use of compost teas and biodynamics (Figure 17). The addition of biological organisms was expected to increase digestibility (Figure 18) by transforming insoluble soil nutrients into plant available form. These assumptions did not eventuate through the period of testing.

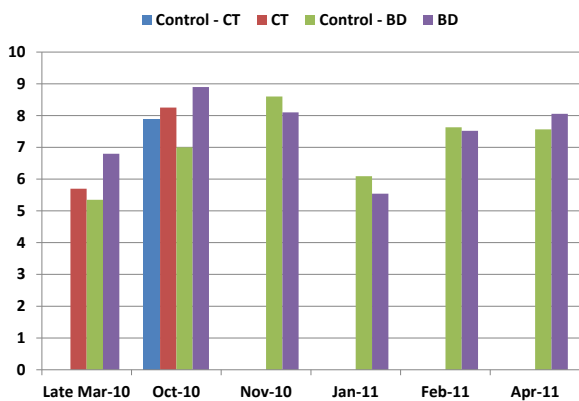


Figure 17: Average ash levels (%) of dominant pasture species taken between March 2010 to April 2011. Ideal levels for Ash are 13%.

Minor Finding: It is unknown whether the use of compost teas or biodynamics positively influenced other perennial pasture species. The dominant pasture species included Buffel grass (*Cenchrus ciliaris* var *Gayndah*, *Cenchrus ciliaris* var *Biloela*), Hyparrhenia (*Hyparrhenia rufa*) and Leucaena (*Leucaena leucocephala* var. *Taramba*). These species were identified as having one or a combination of the following characteristics (dominant; productive; palatable) within Central Queensland grazing lands.

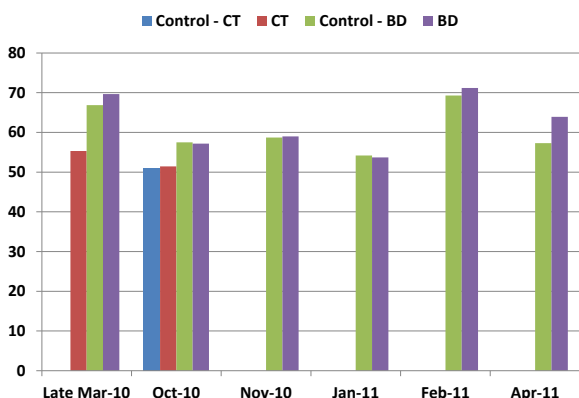


Figure 18: Average digestibility levels (%) of dominant pasture species between March 2010 to April 2011. Ideal levels for digestibility are 76%.

Overall: Pasture feed quality was not influenced by compost teas or biodynamics. Plant

response may have been aided if pasture species were healthier (higher and balanced nutrient levels). The leguminous plant (*Leucaena*) recorded near adequate feed quality levels but was unaffected by the addition of biodynamics (no compost tea applied to this plant species). All grass species analysed recorded feed quality within the expected range of district averages but generally low when compared to desired levels.

7.0 Discussion

Increases in soil and plant health were not apparent from compost tea or biodynamic applications on grazing lands within Central or Northern Queensland. While changes in organic matter, soil biological and nutrient levels were recorded in the Northern Gulf trial, the confidence in the results is limited due in part to the soil sampling strategy and changes in management by reducing potential harmful products within the treated paddocks.

Initial analysis of compost tea and biodynamics were of a high standard that should have benefited multiple aspects of soil or plant health. The quality of compost teas and biodynamics improved as project members gained a greater understanding from the sensitivity of local effects (temperature, water, origin of compost).

Soil moisture and spatial variation significantly biased soil biological results beyond that of changes monitored from either compost tea or biodynamic applications. The background levels of major biological groups (bacteria and fungi) were either within or above the desired ranges as required. The lack of soil biological activity was common throughout and suggested that changes within the soil environment are warranted to enhance and sustain activity levels independent of applied biological inoculums.

Within the period of soil biological monitoring, an outcome of concern was the decline in bacterial biomass. This finding was repeated elsewhere in surrounding grazing properties within the local district. The initial perception from such a result could indicate bacteria are less resilient to the environmental and climatic conditions experienced during this period. The ratio of bacteria to fungi was

approaching 1:1 which is a symptomatic balance of these major soil biological species under a perennial pasture.

It was anticipated that with little influence on soil biological biomass or activity from compost teas or biodynamics, plant available soil nutrients would show minimal changes to inherent levels. The biodynamic treatment did demonstrate an improvement in plant available soil nutrients but this response did not correlate with an increase in plant nutrient levels. The addition of specific food sources to assist survival and growth of biology post application in the compost tea treatment did not influence soil nutrient levels. Nor did the food sources enhance activity levels in endemic soil organisms within or above the desired ranges.

The limited number of compost teas and biodynamics applied during the trial may in fact resemble normal practice for large scale properties. Project participants with their own brewers were able to selectively apply inoculums when soil conditions were considered ideal. Even under such conditions, the use of compost teas especially did not show any net positive effect on soil or plant health.

Visual changes to pasture species and topsoil health were more often associated with the treated paddocks. Such changes cannot be solely attributed to the applications of either compost teas or biodynamics as a multiple products were either added (food sources, organic fertilisers) or removed (Roundup, synthetic fertilisers). The removal of harmful products which is most often the cause of the soil and plant fertility issues is most likely why any response albeit visually, is likely to occur in the short to medium term.

For Central and Northern Queensland farmers at the large property level, applying compost teas or biodynamics cannot be justified in relation to increasing soil or plant health. Principal factors such as soil moisture will govern the environment to sustain plant and soil biological activity in turn improving soil and plant health. Future activities should be undertaken to create such an environment where soil moisture is optimised. The creation of such an environment will require changes to present management and may involve establishing new plants. A holistic

systems approach to managing grazing lands encompassing grazing management, ecosystem function and relationship of vegetation, soils and animals is required to create environments for improved soil and plant health. The adoption of targeted 'enhancement' products such as compost teas and biodynamics may then provide additional benefits in a healthier and functioning landscape.

Appendix 1: Northern Gulf Final Report



**NORTHERN GULF
R E S O U R C E
M A N A G E M E N T G R O U P**

HEALTHY SOILS PROJECT (FB NLP09_2A)

FINAL REPORT

Northern Gulf Resource
Management Group

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8.0 Introduction

The final report will address the results of 3 years of compost tea applications on 3 properties within the Northern Gulf Resource Management Group (NGRMG) region. These properties are subset of a larger group project held by Fitzroy Basin Association (FBA) and DEEDI, situated at Biloela Queensland.

The properties being discussed are the following:

John and Kathy Colless (Wetherby Station): Grazing enterprise

Alan and Margaret McKenzie: Grazing enterprise

Graz and Velma Moriconi: Mango enterprise.

The Colless and Moriconi farms have been involved in the project since the inception date but the McKenzie farm has been involved for the last year and a half, this was due to previous project member selling farm.

The average rainfall for these farms is 900mm/year, with the majority falling during the wet season period (December-April).

The soil type for each farm is listed below:

Colless – Clay loam.

McKenzie – Loam.

Moriconi – granitic sand.

All the farms are geographically separated, allowing data to be collected from different environmental conditions. As seen above, all are on different soil types also, to see what effect compost tea has on the differing soils.

The two grazing properties did not add any nutrients or soil amendments to the trial site throughout the project and pasture management practices were the same.

The mango farm put out minimal nutrients, as mango is not a heavy user of nutrients. Both the treatment site and the control site received the same nutritional additions to remove this as an effect on the data. We also could not get bulk density data due to high sand content of soil, making it impossible for hydraulic soil core machine to get viable core for analysis.

Some data for each site was sometimes unable to be sampled due to rainfall events, making access to the trial paddocks impassable for machinery (cars, soil rig and tea spray rig). In the 3 year trial, some wet seasons also started early and finished late, causing issues on both data gathering and compost tea applications.

The project completed baseline assessments on the farms to benchmark where their soil values lay. This included soil cores at the following depths (in both control and treatment sites) 0-10, 10-20, 20-30, 30-60, 60-110 cm. These depths were then tested for nutrients and also soil biology. EAL laboratories completed the nutrient analysis and Soil Foodweb International (SFI) completed the first 2 years soil biology testing. In the 3rd year we went over to Creation Innovation Agriculture and Forestry (CIAFF), so there is a disconnect between identifying trends in the data from year 1. At that point in the project, we felt that CIAFF supplied a more informative report on the soil conditions for the members to act on.

9.0 Results

All results for the project will be broken down to individual farm level. The scientific data will be shown, as well as some discussion of the anecdotal changes noticed by the landowners. This is required as some changes were not monitored under this project but need to be highlighted, as they have implications for farm productivity and profitability.

Another factor in the project was the quality of compost tea used in the first year of the project. Due to lack of compost supplies for the project, the members were using a product called 'Sobec', which was an organic fertiliser with a compost tea extract inserted. This lack of quality reduced the effectiveness of the applications in the first year but there was still a result on farm. In the second year, Alan Mackenzie purchased a brewer for his property and allowed the other members to get compost tea for their farms. This improved the response to the applications. For the results, only the soil and plant aspects that have improved will be discussed as there are large amounts of data. The social/community benefits will be addressed in the discussion session.

9.1 Colless

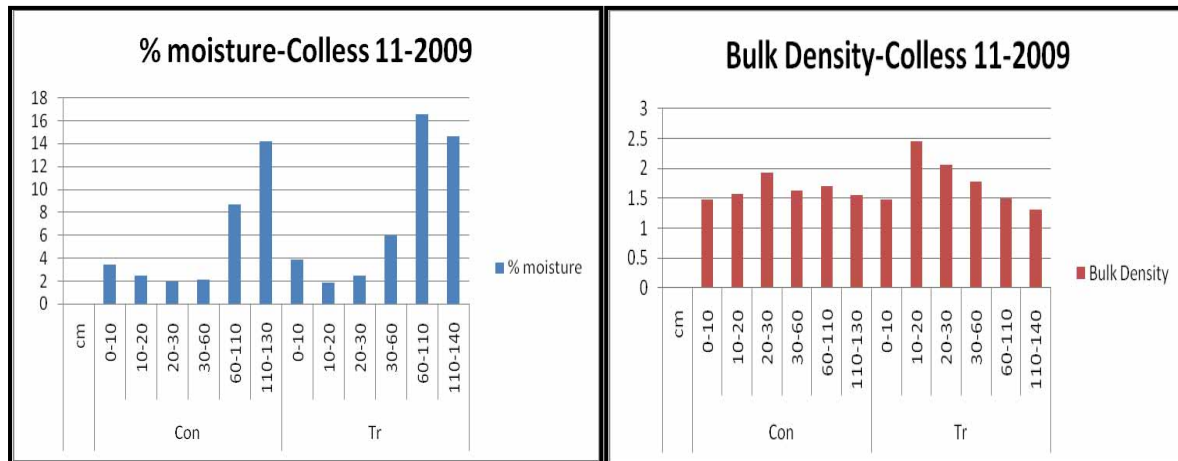
John and Kathy operate a grazing property just outside Mount Molloy, North Queensland. John and Kathy had been wishing to move away from chemical inputs on their farm and found this project a way forward in both practices and information. They have been involved for the full 3 years.

The project completed one deep soil core operation per year, including the initial baseline study. Then further soil and soil biology analysis was completed throughout the year to study the effects of the applications.

Bulk Density, PH and Soil Moisture

The bulk density data was of the soils down to 140cm.

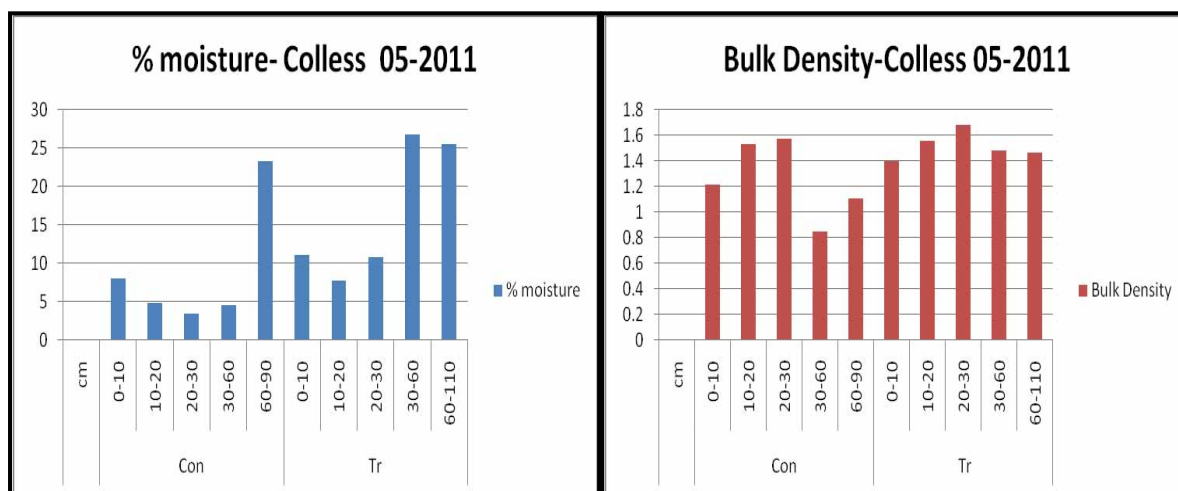
2009



Graph 1: Bulk density and soil moisture content data 2009

The Colless property had extremely heavy clay that was acidic to highly acidic at depth. The site also had a compaction layer at 10cm (due to cattle movement) and another at 60cm, this may be due to the change to heavy clay. Whilst completing the first soil core, the root zone was visually inspected and did not go further than the 10cm compaction zone. This will have serious effects on plant health and nutrient availability. The plant roots also had an issue with the pH level in the treatment site (as seen below in Graph 2), as it sat at 4.2, which would burn root tips. Soil moisture is low at the surface and quite wet at depth, this is due to the change from loam to heavy clay. The weed incidence in this paddock was very high, due to these soil conditions. The majority of the weeds were Sickie pod, Rattle pod, Praxelis and Snake weed. All these indicate compacted soil and low moisture/ nutrient content of soil profile.

2011



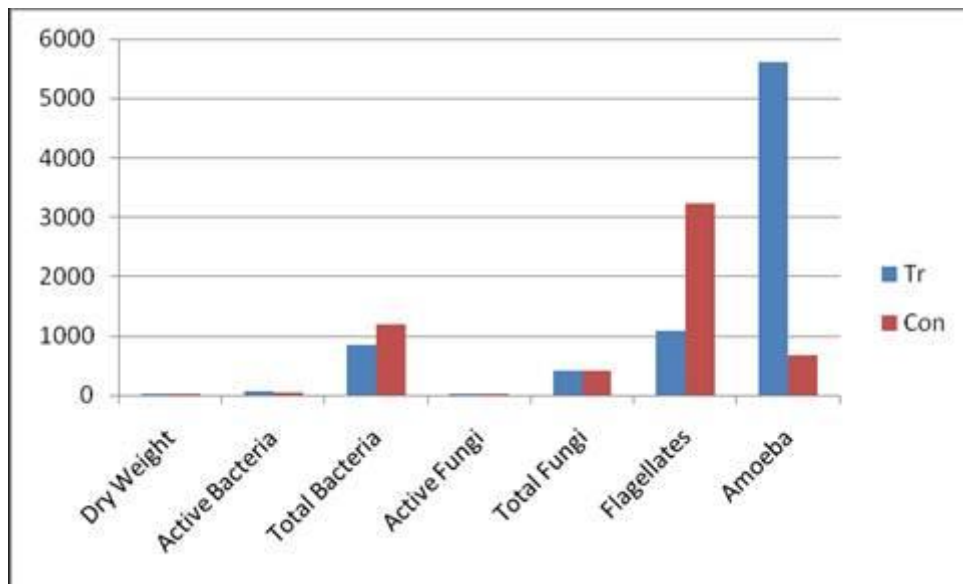
Graph 2: Bulk density and soil moisture content data 2011

As can be seen above, there has been some improvement in both BD and soil moisture in the treatment site. At the 0-10 cm level, the bulk density improved marginally from 1.5 to 1.4, improving the friability and water infiltration capability. It is in the 10-20 and 20-30 cm depth that there has been major improvement. In the 10-20 depth, it has

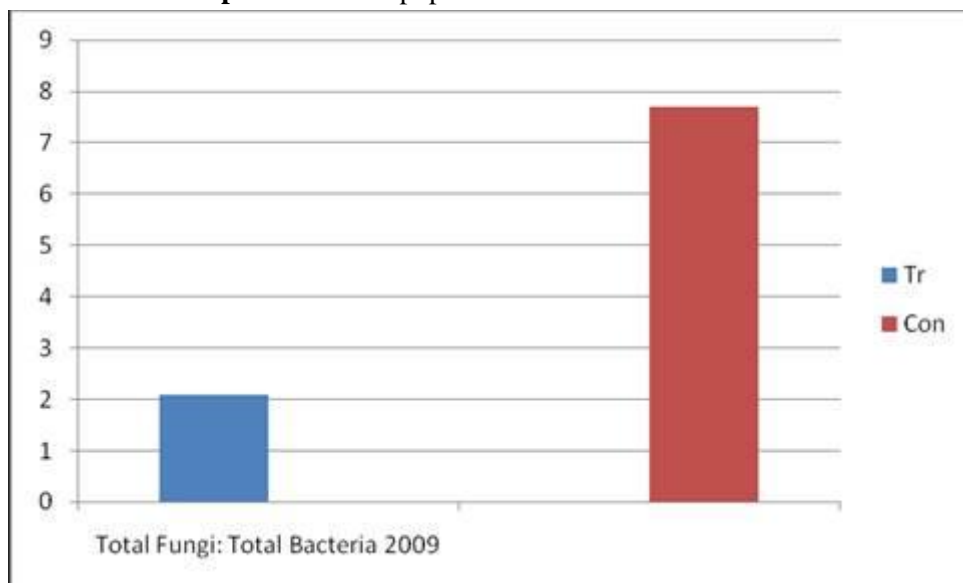
improved from 2.5 down to 1.5; this would improve infiltration, improve air porosity and the plants ability to send its roots down through the profile.

The soil moisture values have also improved markedly within the treatment site, both against the 2009 treatment site benchmark and the control site. This improvement in soil moisture has improved the pasture performance and growth stage across the paddock.

Soil Biology
2009



Graph 3: Baseline population counts for soil microbes



Graph 4: Total ratio between Fungi and bacteria populations 2009

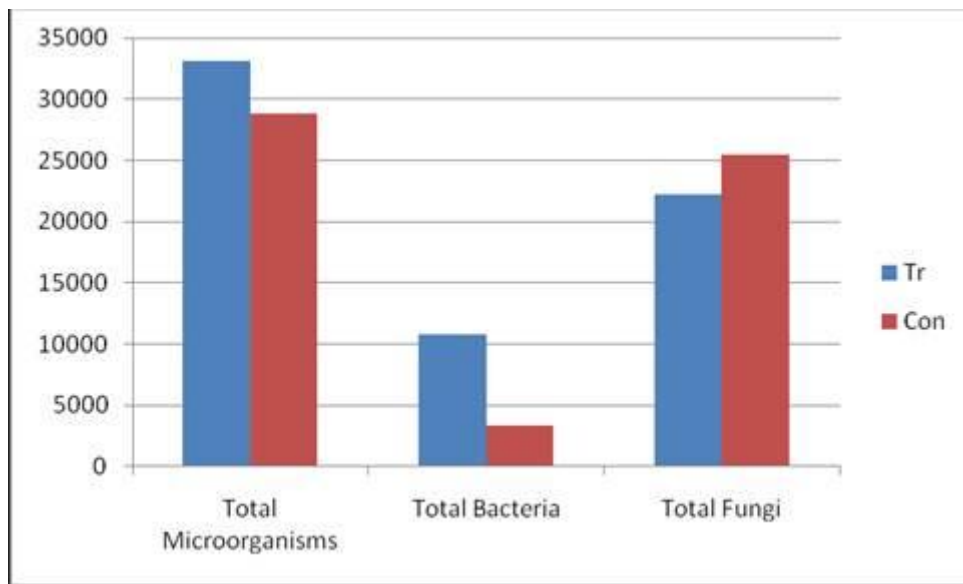
The baseline data collected in 2009 indicated that the site was bacterial dominated and required inoculation with more fungi. The protozoa, flagellates and ciliates were also low indicating a reduced nutrient cycling system within the pasture. This could be due to the soil conditions mentioned above (compacted soil, high pH and reduced infiltration).

In addition, the low quality tea that we had available made it so there was not too much improvement with the soil biology at this site within the first year, at least not within the test parameters that the project had in place.

The results from the first year indicated that there were some issues within the paddock. Increasing the numbers of fungi and soil predators such as the Amoeba and ciliates was needed to improve soil cycling.

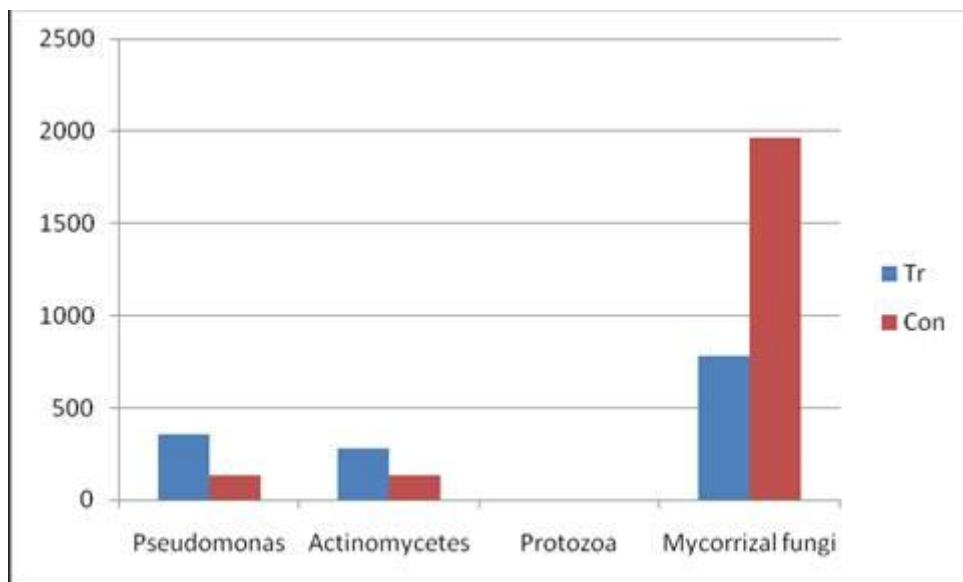
Half way through the trial, the members wanted the project to use another laboratory. So Creation, Innovation, Agriculture and Forestry (CIAFF) were employed to do the final round of testing. This made correlating the data from the SFI to the CIAAF difficult but soil biology improvements were identified by the end of the project. The results were inconclusive in regards to populations but the ratio between fungi and bacteria improved, causing the system to become more balanced.

2011



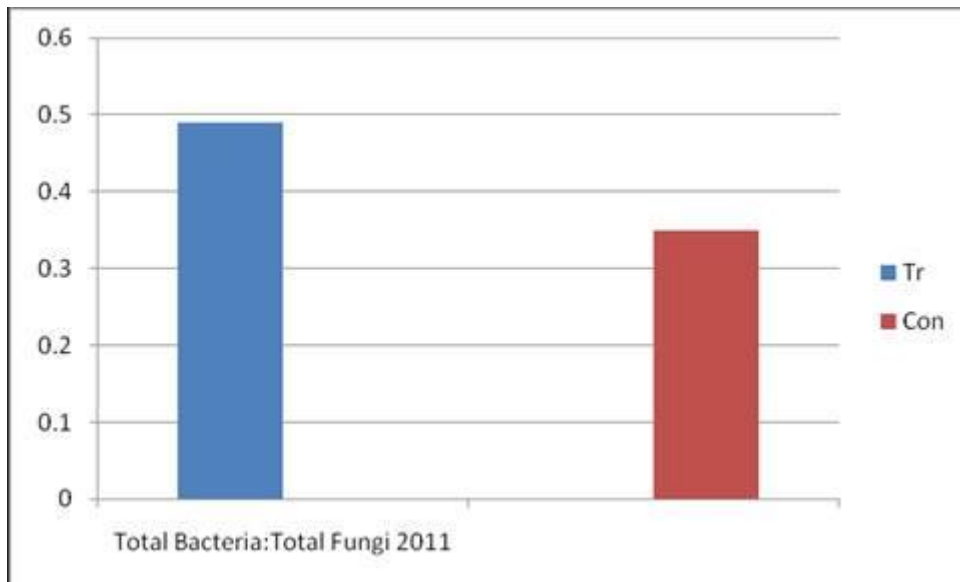
Graph 5: Total population count (kg/Ha) 2011

As can be seen in the above graph, the totals did improve but not at a significant value. The fungi population was still an issue at the end of the trial and will need further work to improve these. As seen in Graph 7, the fungi:bacteria ratio did improve in the treatment site but not significantly.



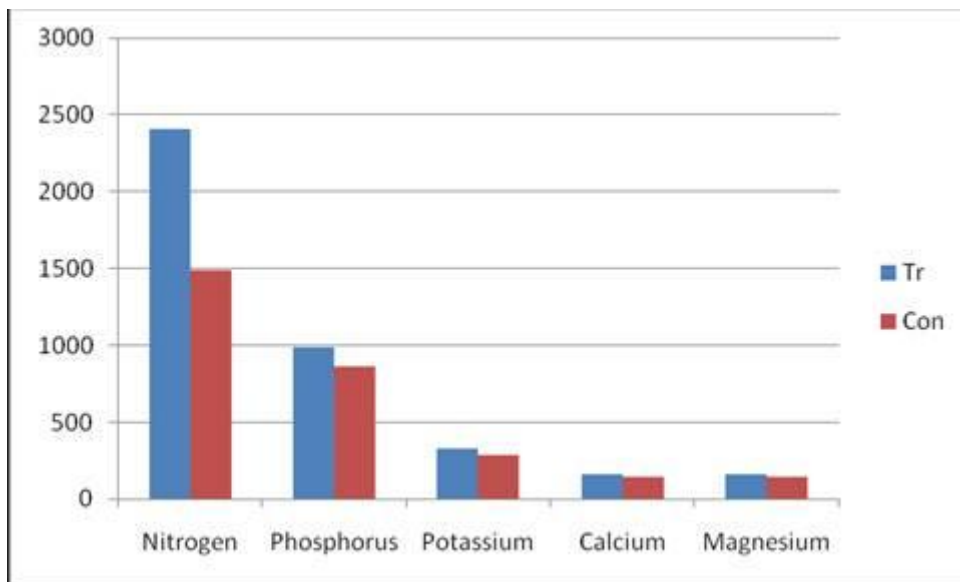
Graph 6: Values of Prokaryotes and Eukaryotes (Kg/Ha) 2011

The numbers of soil predators improved by the end of the trial in the treatment site but the Mycorrhizal fungi was not a positive result. We were unable to ascertain the reasons for the struggling fungi count throughout the trial.



Graph 7: Total ratio between Fungi and bacteria 2011

The totals did balance out due to the application of compost tea when compared with the data in Graph 4. Again, the fungi:bacteria ratio needs to be balanced out. Applying a complete fungal compost tea may be the way forward for this property.



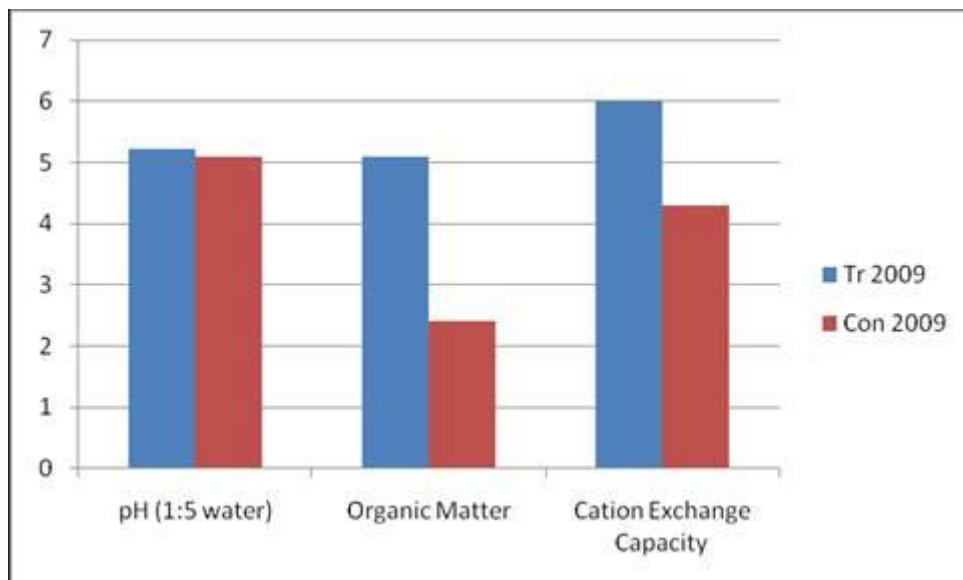
Graph 8: Biomass nutrients from soil biology 2011

The graph above shows what nutrients should be supplied to the soil profile through predation and cycling by soil microbes. We had scientific evidence only for the phosphorus. The nitrogen was not supplied to the system at the rate indicated above.

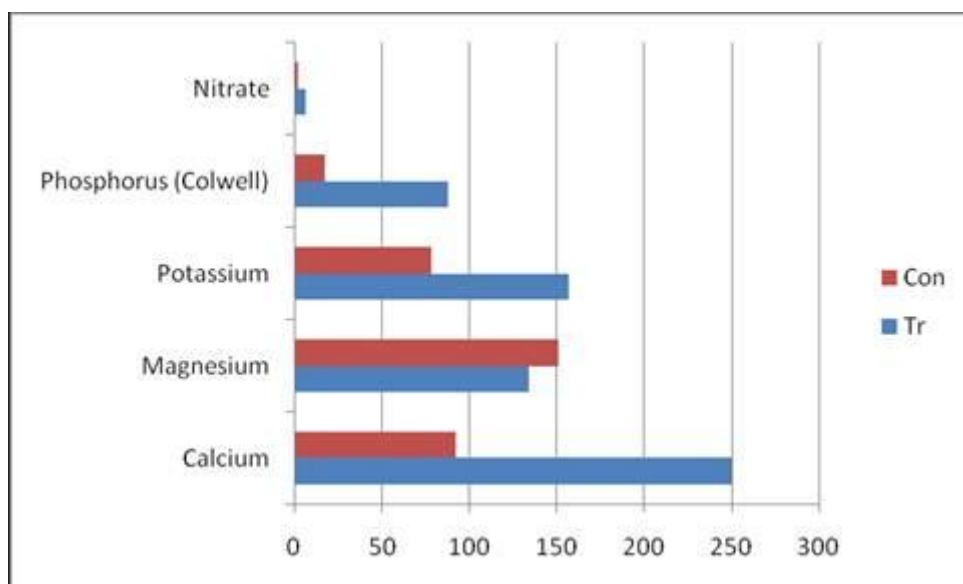
Nutrients

Soil nutrient testing was completed to highlight any change in soil chemistry due to the application of compost tea. The testing was done at the depths mentioned above, including all nutrients as well as organic matter, soil carbon, cation exchange, calcium/magnesium ratio and carbon/nitrogen ratio.

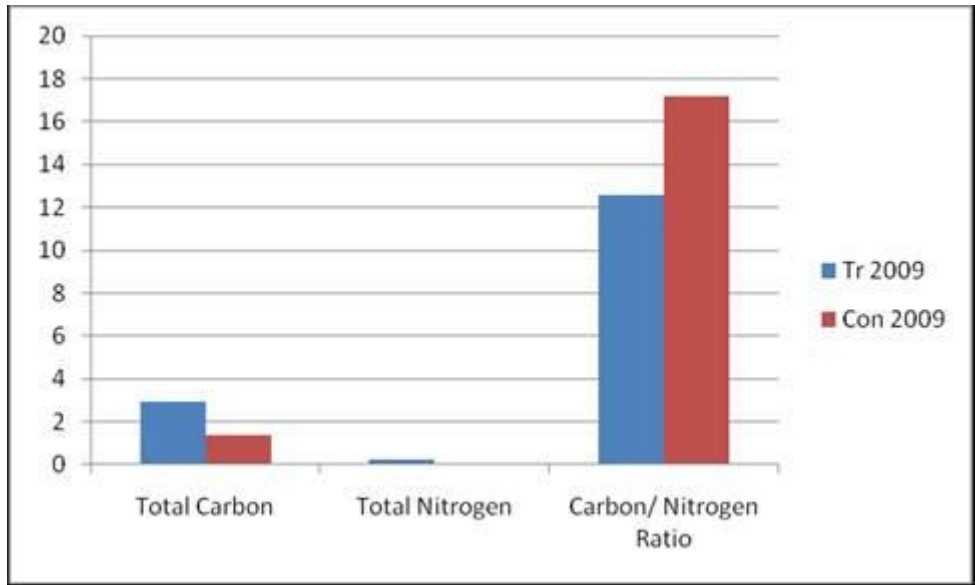
Testing was then completed throughout the year only in the 0-10 cm range. As the compost tea was applied via surface application, this is where any changes should occur in the short term. The data has been broken down to separate soil classifications for ease of perusal.



Graph 9: Baseline soil chemical properties 2009



Graph 10: Baseline Nutrient analysis 2009

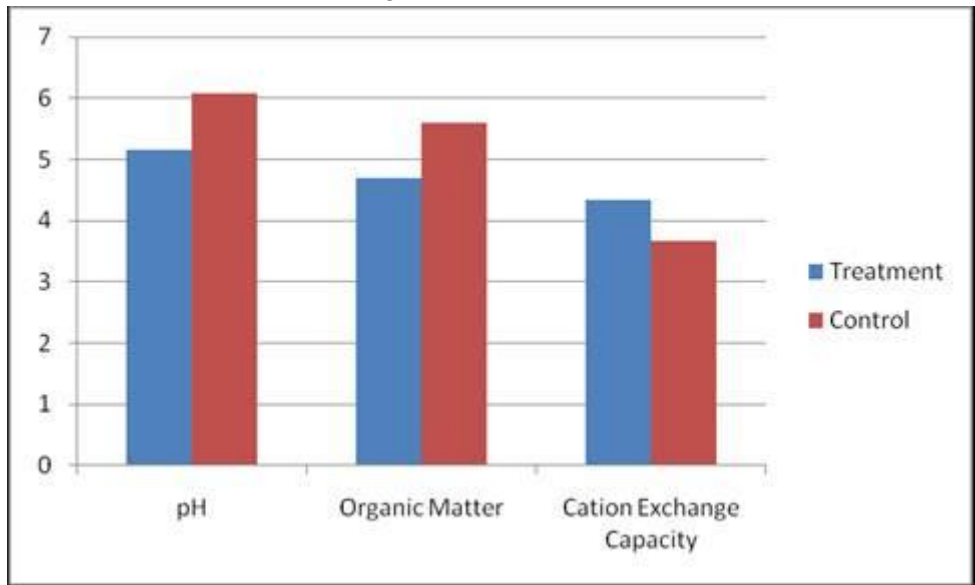


Graph 11: Carbon and nitrogen baseline values 2009

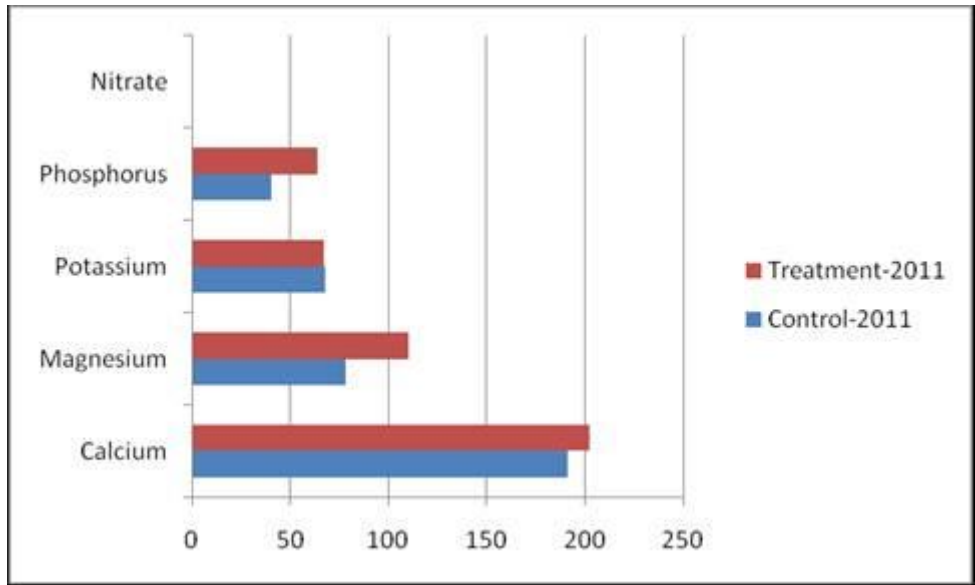
The Colless farm has low values for both carbon and nitrogen but they are in a balanced ratio. The soil carbon rate is generally on line with a pasture operation. The addition of compost tea will improve the carbon/nitrogen cycles of this property.

2011

The results for the nutrients at the end of the project were mixed in the results. Some nutrients were more available but this may skew some ratios such as the calcium/magnesium ratio.



Graph 12: Soil chemical properties 2011

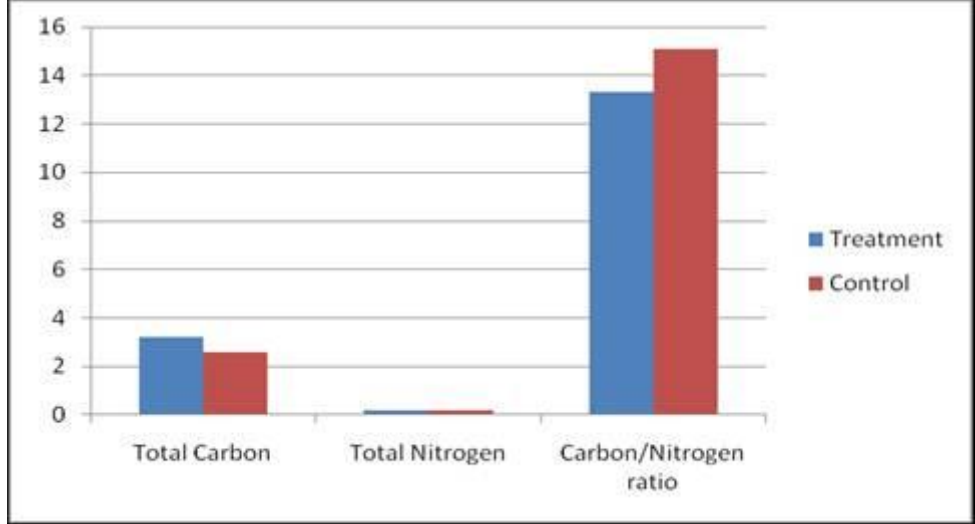


Graph 13: Nutrient analysis for end of project 2011

Phosphorus uptake has improved due to the compost tea applications and this has important implications for John’s cattle productivity, as phosphorus is one of the hardest to get to cattle. This has improved markedly since 2009, as seen in Graph 10.

The nitrates have dropped since the start of the project. This is probably due to the low numbers of Protozoa’s and Pseudomonas, as their predation cycles nitrogen from bacterial prey. The low counts of fungi would also affect nitrogen cycling.

Magnesium and calcium have also significantly changed in the project, with the treatment site becoming more balanced in the Mag/Cal ratio. This would have impacts on the bulk density and porosity of the site, opening up the heavier clay in the soil. This has reduced the compaction layer impacts in the top 10 cm of the profile.



Graph 14: Carbon and nitrogen baseline values 2011

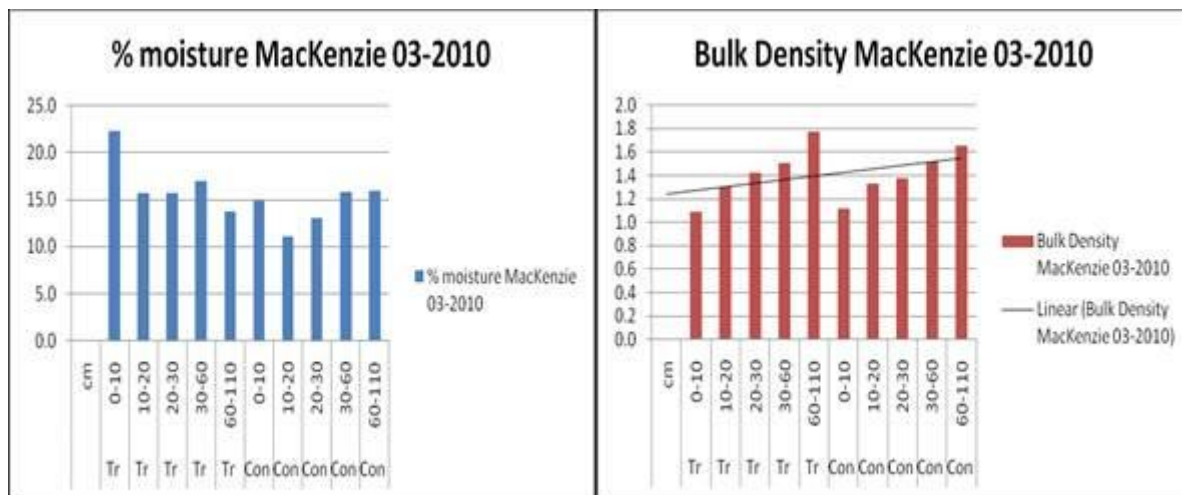
9.2 MacKenzie

The Mackenzie's were drafted into the project after one of the former members sold his farm half way through the project. Due to this late start, the baseline data gathered for the soil biology was completed by the SFI lab but months later the project members voted to use CIAFF for the rest of the project.

Alan and Margaret had just purchased the property, which had been vacant of cattle and farming for 11 years previously. They also did not want to use expensive and toxic fertiliser, as this was their retirement property. They were also situated on the Walsh River and didn't want any farm runoff affecting the natural ecosystem adjacent to their farm. Margaret had already approached me regarding compost and compost tea so they were perfect members for the project. Alan purchased a 1000 L compost tea brewer for his own use and agreed to let the other members be supplied with his tea. The property was only 550 acres, so a good model for the peri-urban hobby farmer that has become common throughout the area.

Bulk Density, PH and Soil Moisture

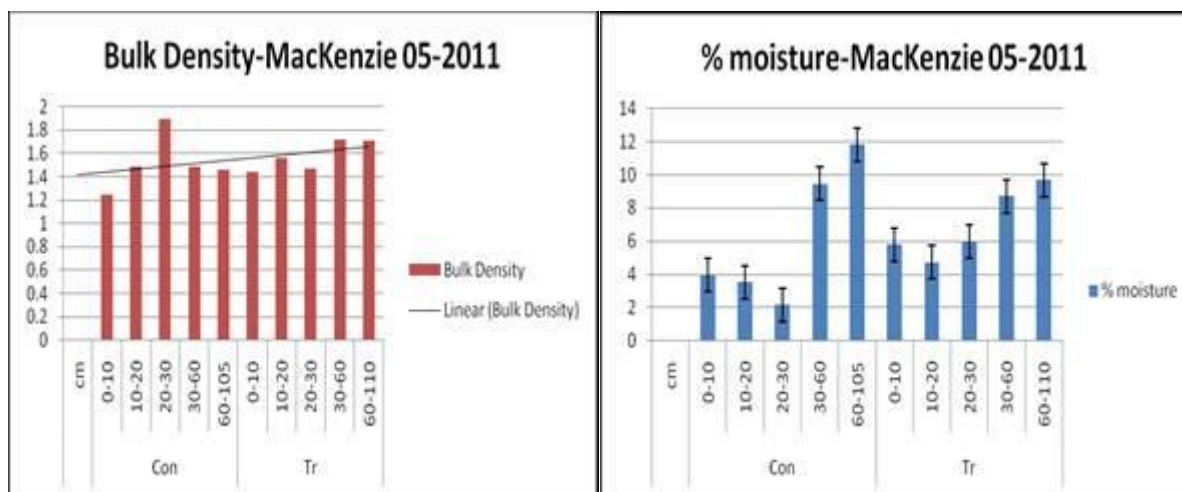
2010



Graph 15: Soil moisture and Bulk density Baseline data 2010

The MacKenzie farm had a fairly high moisture content at this time due to the end of the wet season but also due to their proximity to the river. The soil type was a river deposited clay loam and had a pH of 6-6.5 across the treatment paddock and the control paddock. There were some patches of sodic soil across the farm but not enough to create issues with the sampling. The bulk density was very close to each other with no significant difference between them. The density increased down the profile, which was to be expected. Overall, this property has healthy conditions in which to add the compost tea. There are no major physical issues that are visible in the sampling tests nor through visual appraisal of the soil profile.

2011

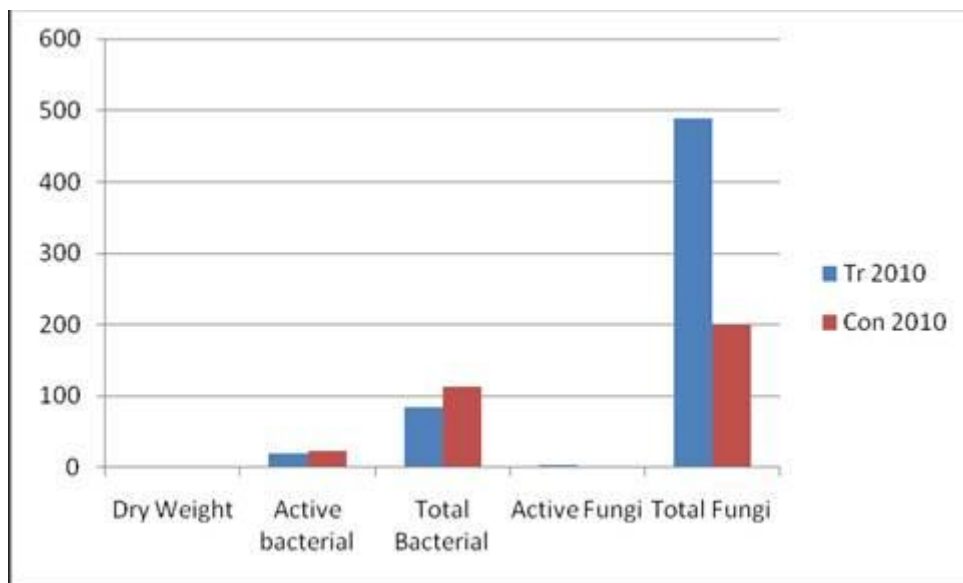


Graph 16: Soil moisture and Bulk density 2011

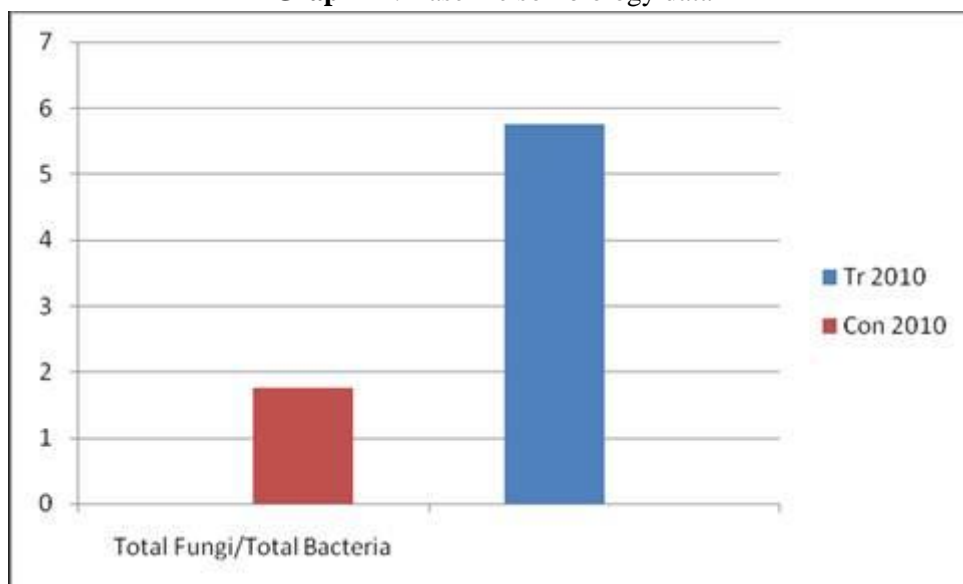
The moisture content was improved within the treatment site, with significant differences in the 0-10 and 20-30 depth. This would have a major effect on extended growth of the pasture after the wet season had finished. If this improvement can add another month to the grass growth period, it would give the Mackenzie's longer weight gain period for their cattle. This makes their pasture management more profitable in the long term. Or it can mean saving money on supplementary feed to get the weight gain after pasture growth has slowed due to lack of moisture.

The bulk density increased, this may be due to the extra water holding in the soil or there may have been some compaction caused. This may also be explained if there was a change with the calcium/magnesium ratio, as this would also cause the soil to bind closer if the magnesium ratio has increased against the calcium value. The trend within the profile is still a positive gradient as you go down the profile, so no real issue there.

**Soil Biology
2010**

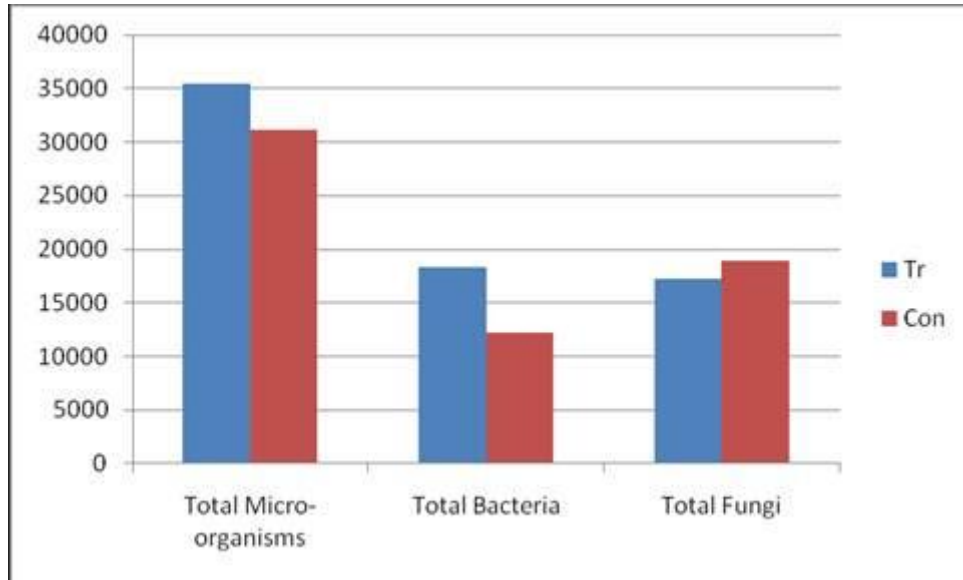


Graph 17: Baseline soil biology data



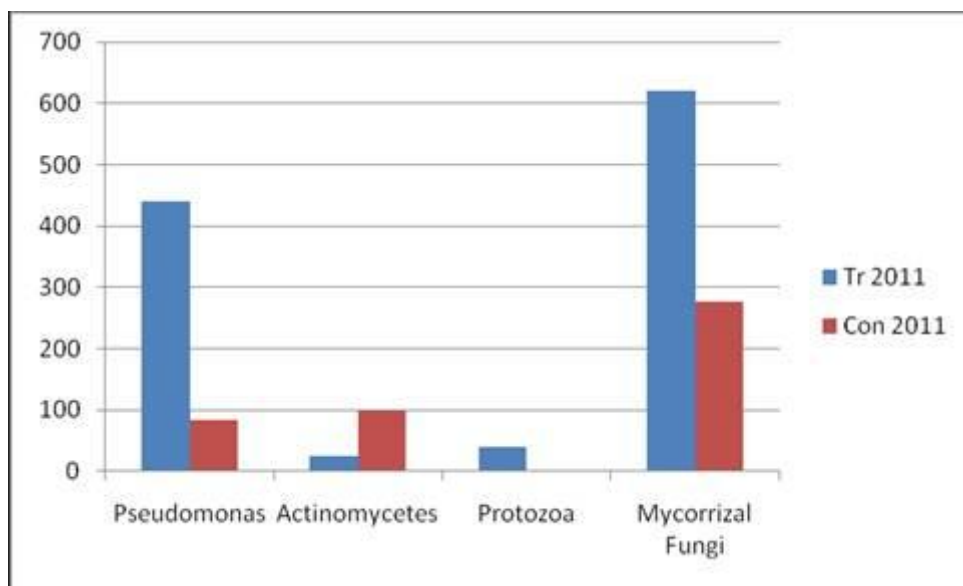
Graph 18: Total ratio between Fungi and bacteria populations 2010

From the two graphs above, it can be seen that the two sites are fungal dominated, which is not usual for a pasture grassland. While in Graph 17, it seems as the numbers of active fungi are very low but this is just in the comparison with the numbers of active bacteria. The numbers of bacteria need to be balanced at this site.



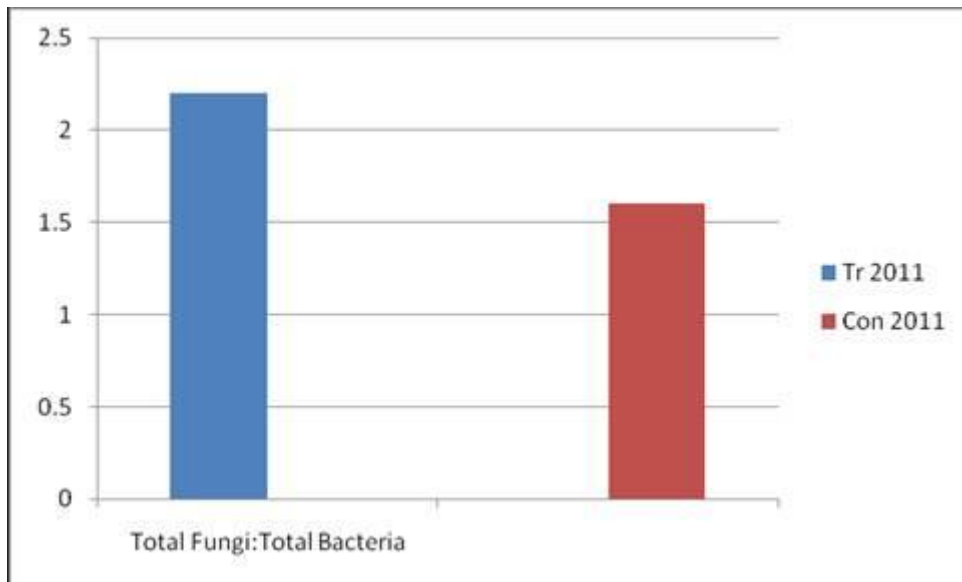
Graph 19: Total population count (kg/Ha) 2011

From the graph above, it can be seen that the bacterial population has increased in the treatment site and the ratio has equalised between groups. This would balance out the grass dominated pasture from Graph 17, where the fungi count was out of balance.



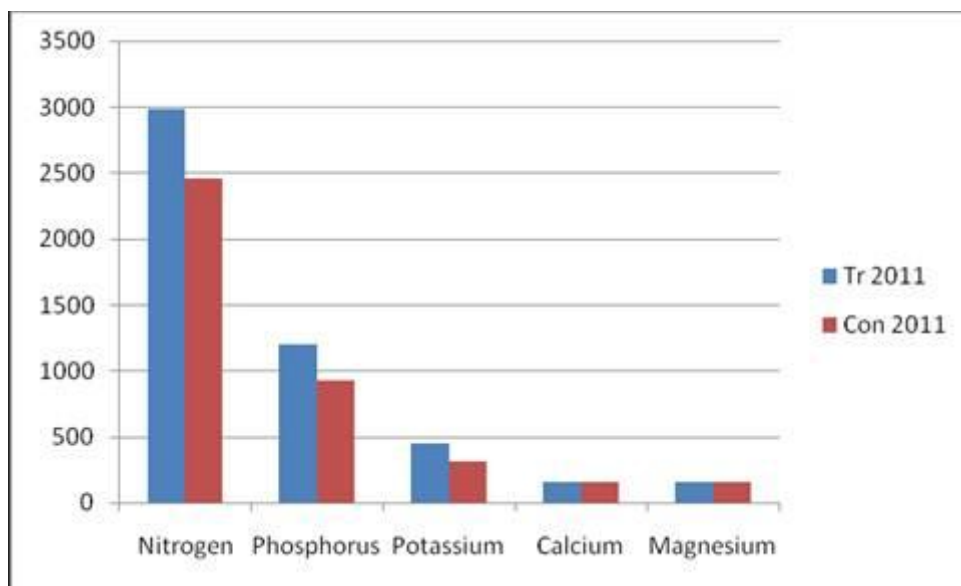
Graph 20: Values of Prokaryotes and Eukaryotes (Kg/Ha) 2011

Although we do not have the same format of data going from SFI testing to CIAFF testing, it can be seen that the soil ecosystem within the treatment site has greater numbers of predatory microbes as well as greater incidence of the nitrogen fixing Mycorrizal fungi. The predatory microbes would be feeding upon the increased bacteria introduced through the compost tea applications, causing these predatory populations to follow the bacterial increases. The surprising aspect of this data is the mycorrizal fungi, as this is significantly higher than the control. The MacKenzie’s treatment paddock does contain more legumes on a visual count, this could be a factor.



Graph 21: Total Fungi: Bacteria ratio 2011

From the data seen in the graph above, the treatment site has become a more balanced system. The value of 2.3 is the optimum value and the treatment is very close at 2.1. This indicates that the system has a finer balance in the treatment site than the control site. The addition of compost tea has brought about a change to the treatment site, this paddock is close to equilibrium. The population numbers for each group is not high enough to greatly improve the performance of the paddock but it is not skewed towards fungal or bacterial domination.



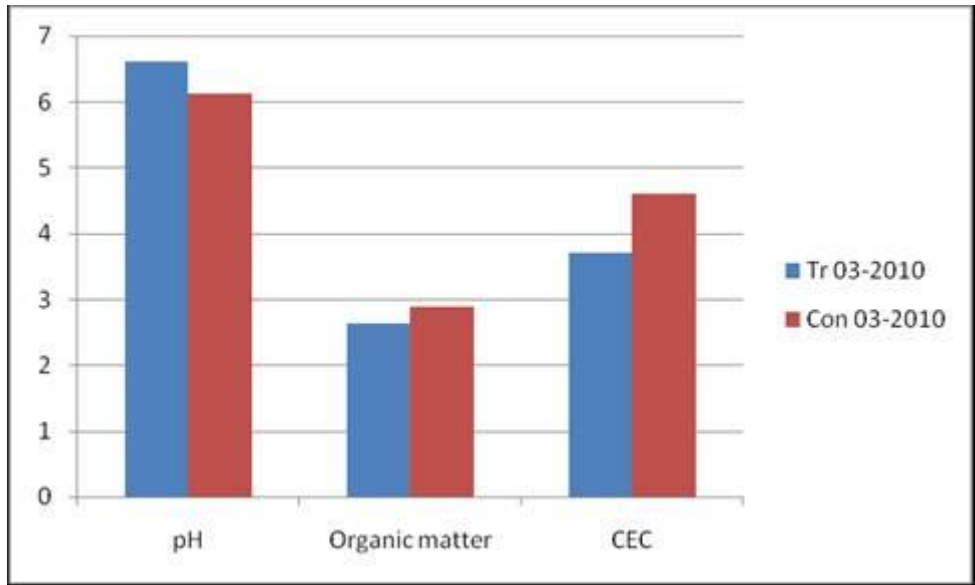
Graph 22: Biomass nutrients from soil biology 2011

From the CIAFF data above, the results indicate a cycling of both nitrogen and phosphorus within the treatment site. The nitrogen will be advantageous to grass growth and the higher phosphorus will give cattle greater health from the pasture. The calcium/magnesium remains the same as the control. We need to correlate this data with the soil nutrient data to see if the cycling is actually occurring.

Nutrients

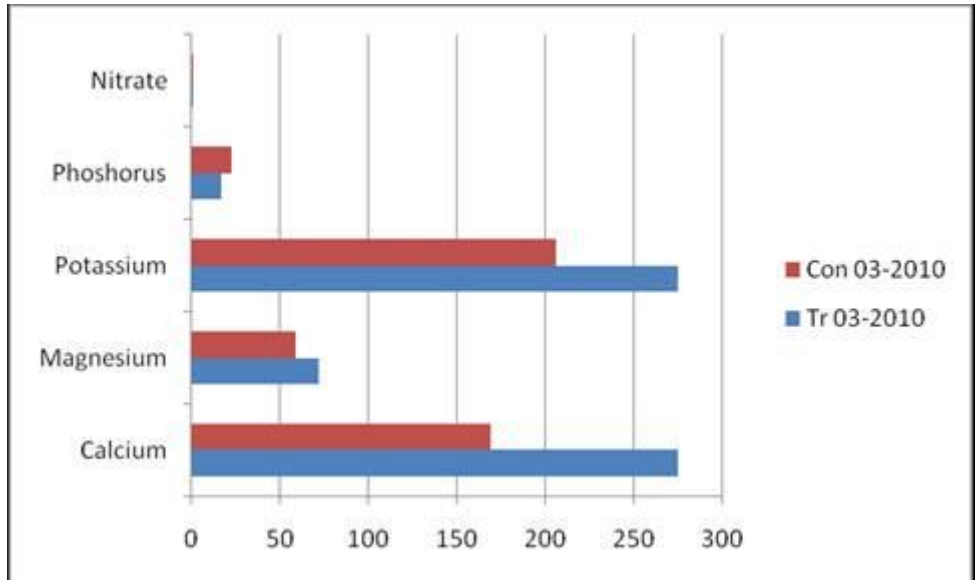
Because Alan and Margaret had purchased the property recently and it had not been used for production before that, we didn't expect to see any major deficiencies. The stocking rate that was currently on the two paddocks was at the lower scale of the carrying capacity. There were also no visible weed infestations, which can sometimes indicate nutrient deficiencies in the soil profile. There were also a few patches of sodic soil across the trial sites but not enough to skew the sampling and analysis.

Alan and Margaret had not placed any fertiliser of any kind on the two paddocks, so no residual after effects from those.



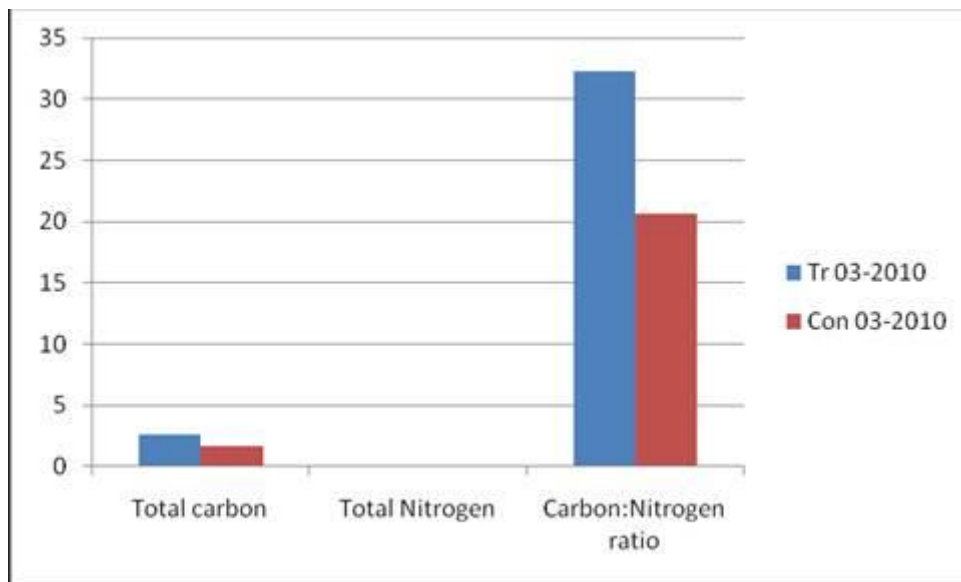
Graph 23: Baseline soil chemical properties March 2010

The baseline data shows that the two paddocks have virtually the same values. Only the CEC in the control paddock is better than the treatment site. Improving the organic matter and the CEC in the treatment soil profile will improve the water and nutrient holding capacity of the treatment paddock. Applications of the compost tea should assist in doing this.



Graph 24: Baseline Nutrients

The results of the baseline sampling indicate that the values are almost identical except for the Potassium and the calcium. The higher calcium value in the treatment site puts the calcium/magnesium ratio out and this needs rebalancing through the trial. There were some deficiencies also in some of the trace elements including boron, copper and zinc. These need to be added separately but are outside of this project. These trace elements have impacts on the uptake of other nutrients in the trial sites and need to be taken into account.

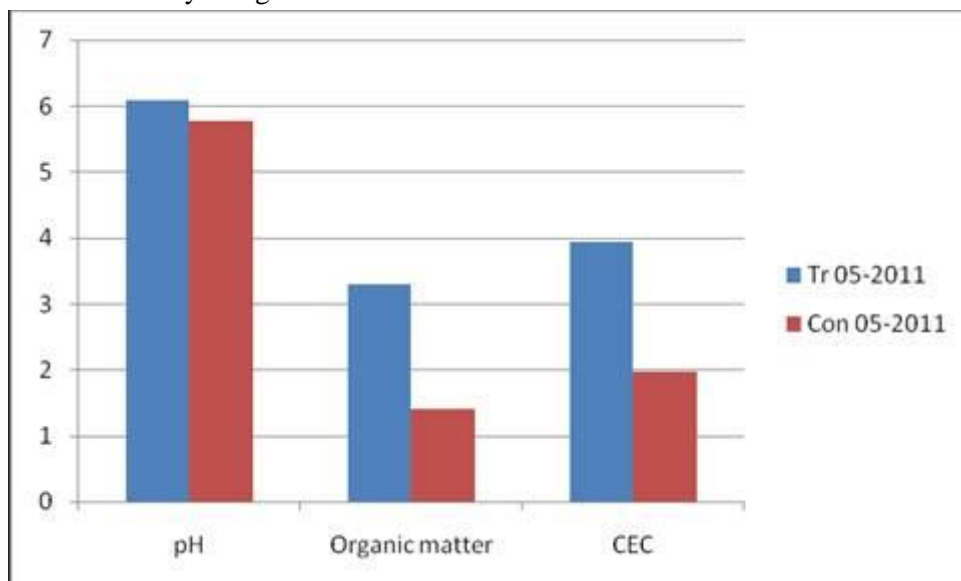


Graph 25: Baseline carbon and nitrogen 2010

For the treatment site, the carbon:nitrogen ratio is out of balance. This would cause any nitrogen that is added to the system to be taken away by the carbon value, causing nitrogen drawdown. This may have impacts on the ability of the treatment site to supply a viable amount of nitrogen for plant growth. Adding a compost tea high in fungi can turn this imbalance around.

2011

After 13 months in the project, the final sampling was completed in 05/2011. Alan and Margaret were very happy with the compost tea applications, as they could see visible change to the treatment paddock. The top 20 cm of topsoil was visibly in better condition than 1 year ago.

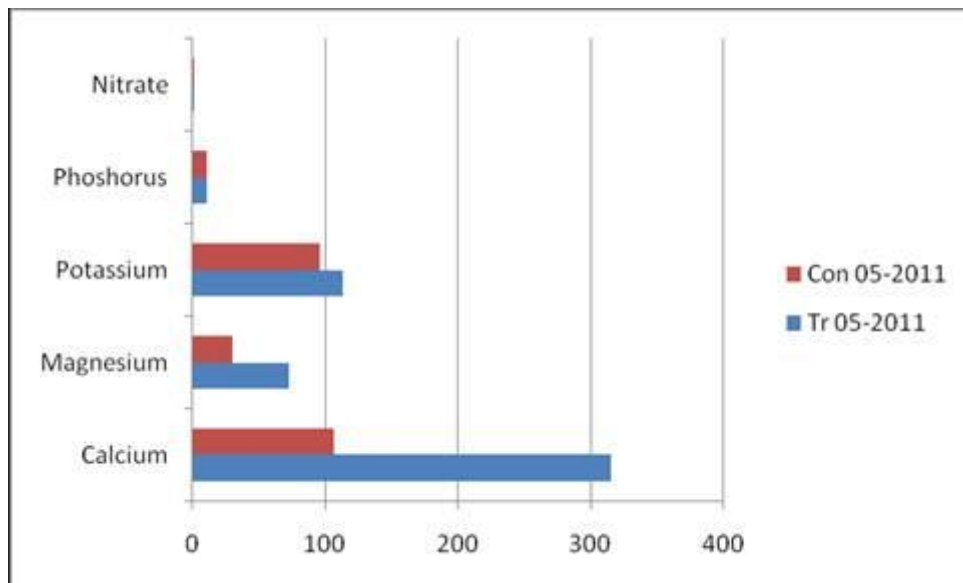


Graph 26: Soil chemical properties 2011

The pH of both paddocks got slightly more acidic but the treatment site managed to stay at 6, making it still reasonable for plant growth and nutrient availability. The control site dropped down to a pH of 5. The extended wet season this year may be an explanation for this drop in pH, as the water caused the organic matter to acidify. The organic matter value for the treatment site was double the control site and improved drastically since the baseline test. This was visible to Alan and Margaret, who saw the topsoil improve markedly over the trial. This will improve all aspects of their farm production and increase water holding capacity and nutrient retention. This increase will improve soil carbon rates also, giving greater resilience to the paddock.

The CEC also improved since the beginning of the trial, and against the control site. This improvement, on top of the organic matter, will make this paddock perform better and be able to adsorb more nutrients and water to the soil particles.

This improvement may be because Alan and Margaret were very conscientious in their application of compost tea throughout the trial. They also had the brewer, so made applications easier and able to spray when climatic conditions more suitable.



Graph 27: End of project nutrient values

The nutrient values, apart from calcium and potassium remained the same. The change in calcium brought the calcium/magnesium ratio closer to being in balance, assisting in improving soil condition and porosity. This would reduce the incidence of compaction by cattle on the treatment paddock.

All of the nutrient values were less than the baseline and that may be due to the leaching effect of the large rainfall wet season that occurred 2010/2011. This result is not in contrast with the increase in CEC and organic matter, which should have improved the retention of nutrients.

9.3 Moriconi

Graz and Velma’s farm sits at the northern end of the Mareeba-Dimbulah irrigation scheme. They are very close to the end of the irrigation area. They also sit on very sandy, granitic soils that do not hold moisture or nutrients well. This is the reason NGRMG included this farm in the project as we wished to see improvements on some of our marginal soils.

Another reason that were included was that their crop is mango trees, which make up the majority of farms in the irrigation area. NGRMG wanted data for this type of crop, as the practices by these growers are not conducive to improving soil biology.

The mango growers, in general, do not allow organic matter or plant biomass to accumulate under the trees. They also spray large amounts of herbicide and pesticides on and around the trees to control weeds and pests.

Mango growers also put out minimal nutrients, as they want to stress the tree causing greater fruiting (supposedly). This trial will see whether soil biology may assist the plant in obtaining nutrients more efficiently from the supplied source.

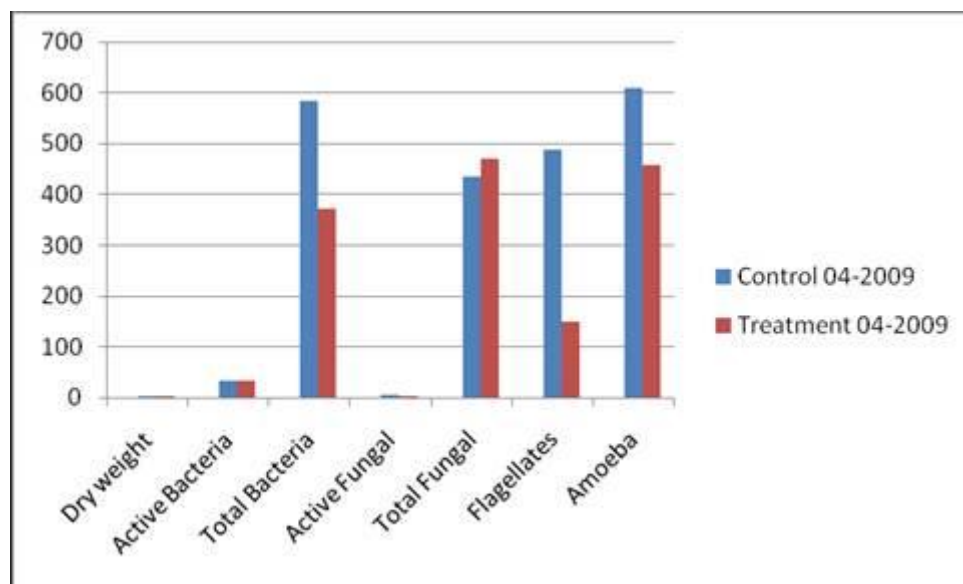
This farm used to be a tobacco farm, which has a high history of chemical use and physical tilling of the soil. There may be residual chemicals and effects from this cropping practice but these are not identifiable under this project.

Bulk Density, PH and Soil Moisture

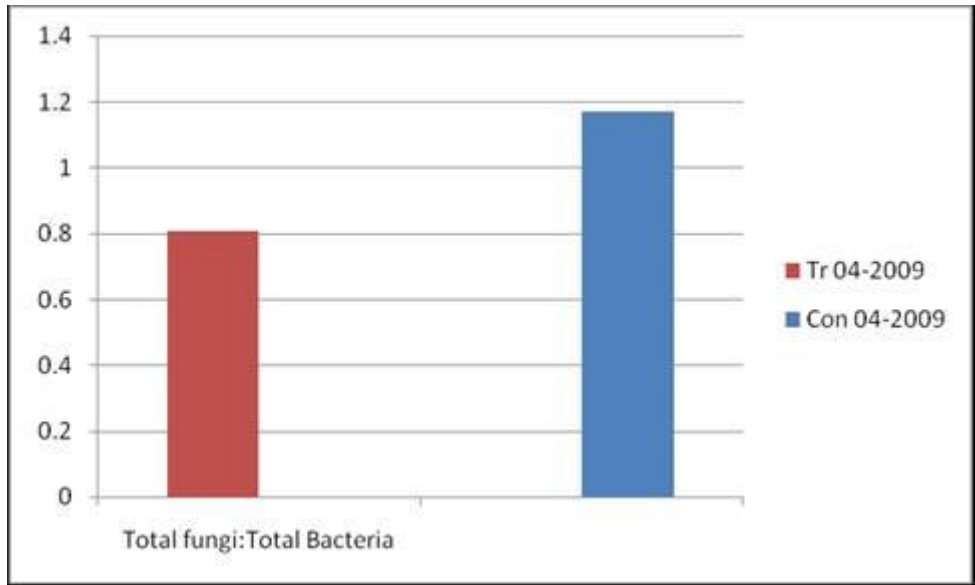
The Moriconi’s soil is so sandy that the soil rig could not bring up any cores, as the sand kept slipping out of the corer. Multiple attempts were made with no success over the course of the project. NGRMG advised for an excavator to dig a test pit to retrieve some data but the Moriconi’s declined due to fear of damaging the Mango tree roots. From past experience with this soil type, there would have been very little change in both bulk density and soil moisture content. For the purposes of this trial this aspect was left out.

Soil Biology

2009



Graph 28: Baseline soil biology 2009



Graph 29: Total ratio between Fungi and bacteria populations 2009

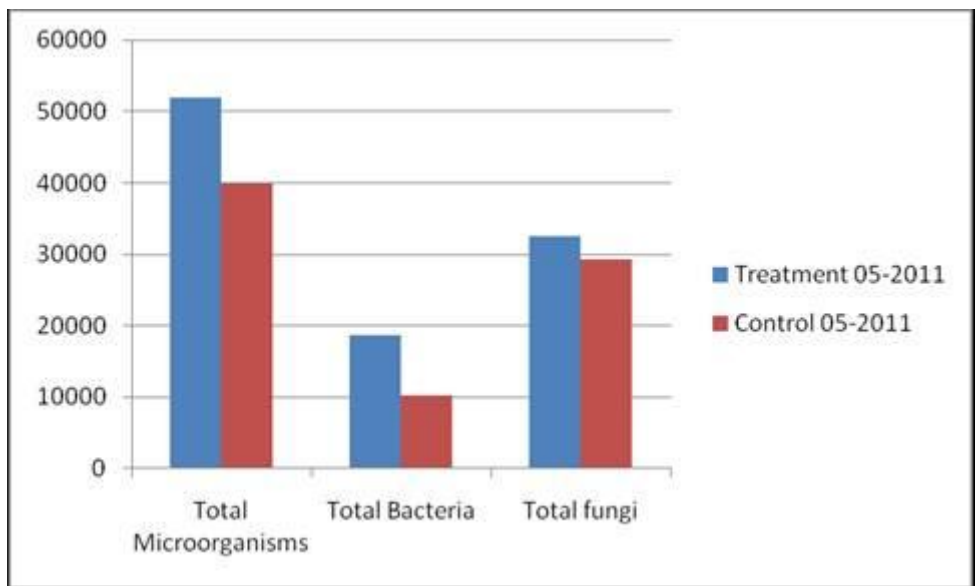
From the graphs above, it can be seen that this farm has very low numbers of all soil biology, especially when compared to the other farm site's data. This is due to the sandy soil profile, which has very low organic matter, soil carbon and CEC. Basically, the soil is only used to hold up the tree and nutrients are supplied almost hydroponically. It is the reason why NGRMG wanted this farm in the trial, to see if there is a cost effective way to improve soil and soil biology in this industry.

We would like to see nutrients being held in the soil better so that they do not leach into the watertable of the area. The amount of active fungal activity is close to zero, for a tree crop this is a major concern as there is no nitrogen cycling nor symbiotic relationship occurring. Also the site is bacterially dominated which may cause disease issues. Overall, this was the expected idea of the condition of the soil on this farm.

It does have good numbers of predators in the treatment site, although this is probably due to the number of bacterial prey available.

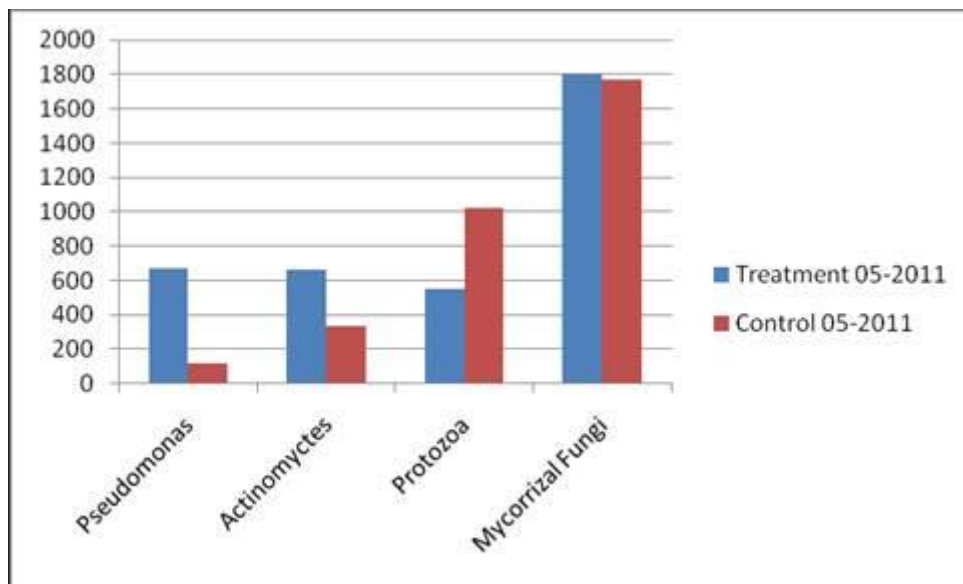
2011

By 2011 NGRMG had persuaded the Moriconi's to stop spraying Roundup under the trees (on entire farm) and to also push mown plant material under the tree drip line. This had an effect on totals and diversity, although some sections of the soil food chain was still struggling to maintain numbers. Again the extended wet season may have had an effect on the numbers, as these soils were waterlogged for over 10 weeks.



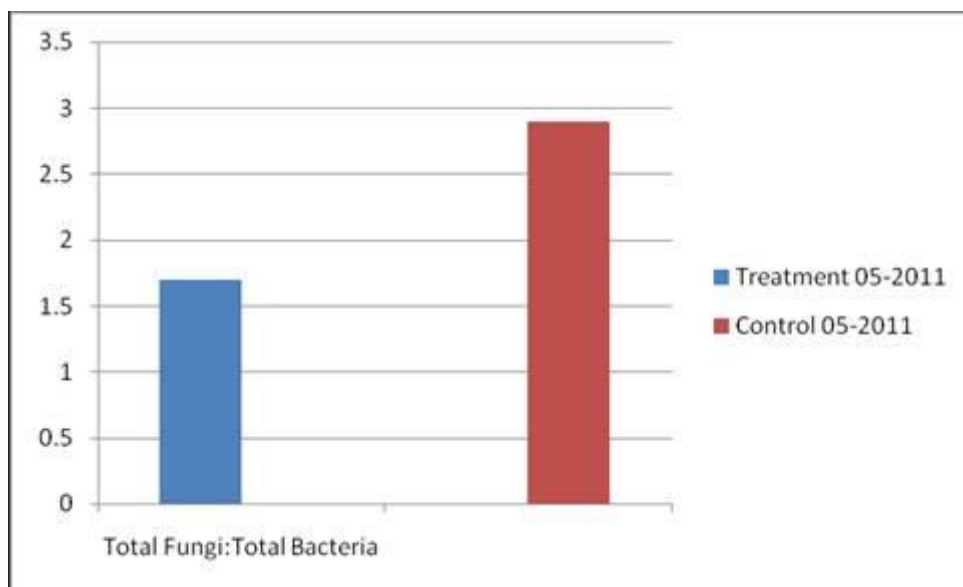
Graph 30: Total population count (kg/Ha) 2011

Graph 30 indicates that the treatment site has greater numbers of micro-organisms now and that the imbalance between fungi and bacteria has lessened. This trend also occurred in the control site; just the numbers are higher within the treatment site. The application after the wet season assisted building numbers back up in the treatment site, although further refinement of the type of compost tea is required as this farm has different requirements to the two grazing properties.



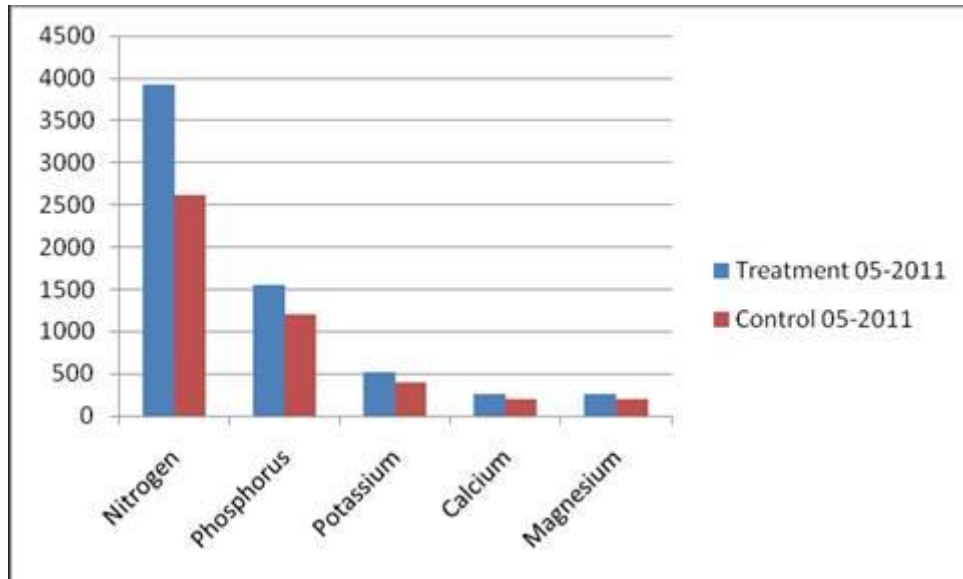
Graph 31: Total number Prokaryotes and Eukaryotes

Due to the application of compost tea, there has been improvement in the treatment site of predators. Protozoa numbers are low and this is hard to explain as the numbers of bacteria are still high in treatment site. Again, this is difficult to account for and there must be a factor within the soil profile that is hindering Protozoa numbers.



Graph 32: Total ratio between Fungi and bacteria populations 2011

While there has been improvement in total numbers, the treatment site is still unbalanced within the food chain. It may be that the compost tea was adequate for this site and that further adjustment of the brew is required.



Graph 33: Biomass nutrients from soil biology 2011

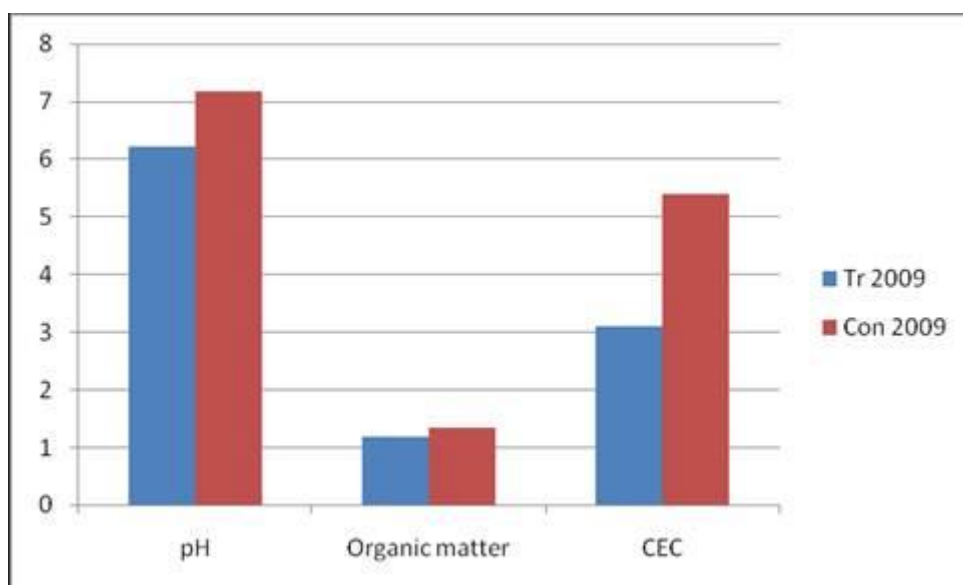
Available nutrients from microbial biomass is greater within the treatment site for nitrogen and phosphorus but not at significant levels for K, Ca and Mg. The supply of these nutrients is still relatively high considering the soil type and organic matter content. The biology results need to be looked at with the soil chemical analysis to divulge any effect that chemistry is having on this site. As mentioned in the farm introduction, this farm used to be a tobacco farm. This crop used to have heavy chemical use which may be residual, as some of the chemicals used use to include DDT. There was also heavy machinery use on the soil profile causing long term impacts.

That the soils are almost pure sand is also a factor that may be affecting this site. Compost tea has had an positive impact on the site but due to the above impacts and conditions it is less than on the other two properties. A way to improve this farm would be to place compost itself under the treeline, improving the organic matter and CEC for the site. This will be the advice given to the Moriconi's, to improve the soil health greater effort and expenditure are needed.

Nutrients

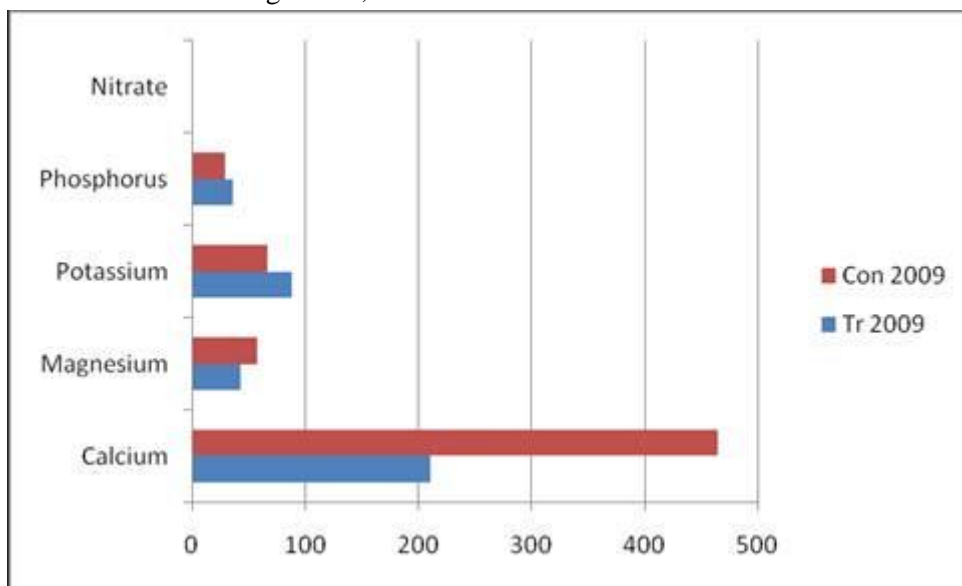
This farm has had a long term tradition of applied nutrients and chemicals. The soil type is not conducive to retaining these nutrients and it generally leaches out quickly, especially if irrigated as this farm is.

The farm has very low soil carbon and soil nitrogen, giving it very little to activate soil biology.



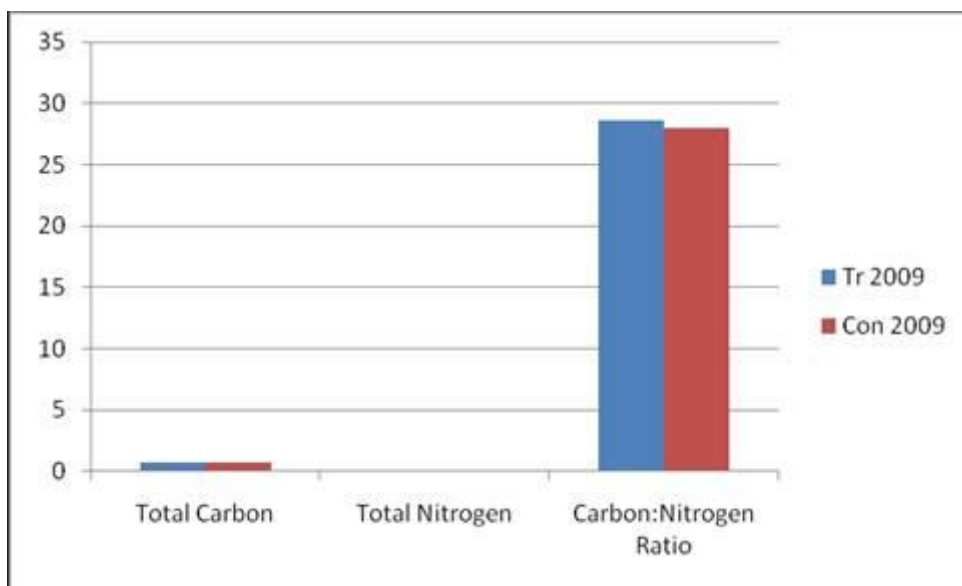
Graph 34: Baseline soil chemical properties March 2009

It is possible to see the marginal soils from the above graph. pH is for the tree is neutral to alkaline, affecting nutrient availability. Organic matter is very low, which again would affect soil performance. The CEC is not what we expected, especially the difference between the two sites. One explanation is that the control is up slope to the treatment site and also borders native vegetation, so there could be effects from those.



Graph 35: Baseline Nutrients 2009

Low readings of nutrients, especially as it is a fertilised farm site. The calcium levels may be high due to the pH values and the soil types. The calcium:magnesium ratio is much more balanced within the treatment site than the control site.

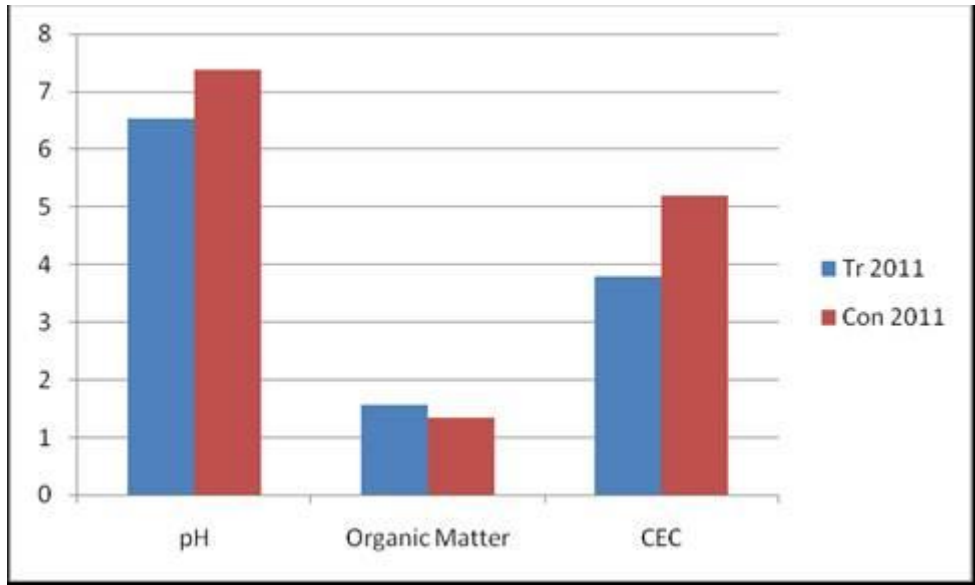


Graph 36: Baseline carbon and nitrogen 2009

Very low values for both carbon and nitrogen, this then throws the C:N ratio out considerably. Soil biology would struggle to operate in this environment, explaining the low active biology counts in Graph 28. Most of the biology would quickly go dormant in this environment. Greater organic matter must be applied for the soil environment to achieve any success.

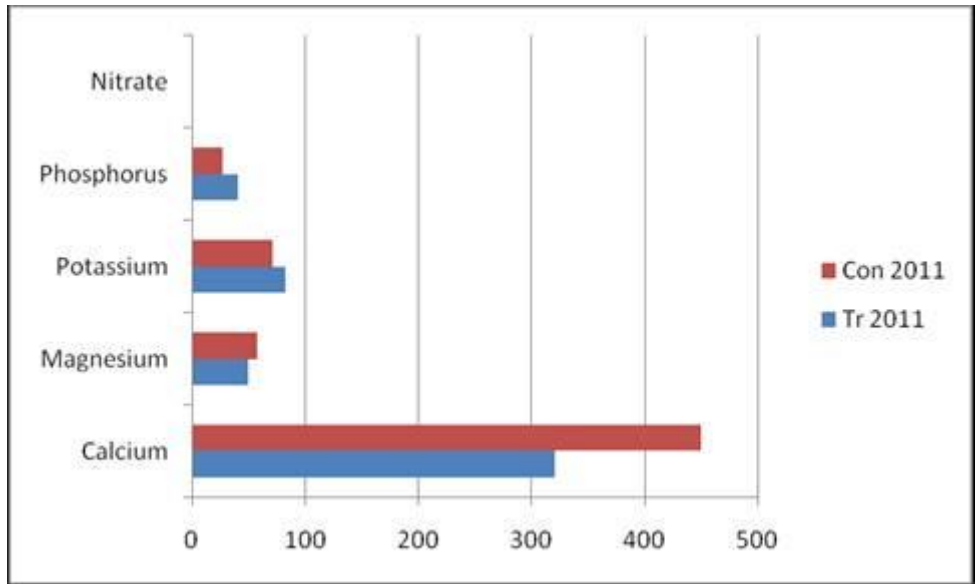
2011

Sampling was completed on this farm in 05-2011, with mixed results. From this trial, it has been observed that to cause change in these sandy soils, more is required than just compost tea applications. There was an effect for the compost tea applications but for an economic concern such as a farm, a more effective way is required.



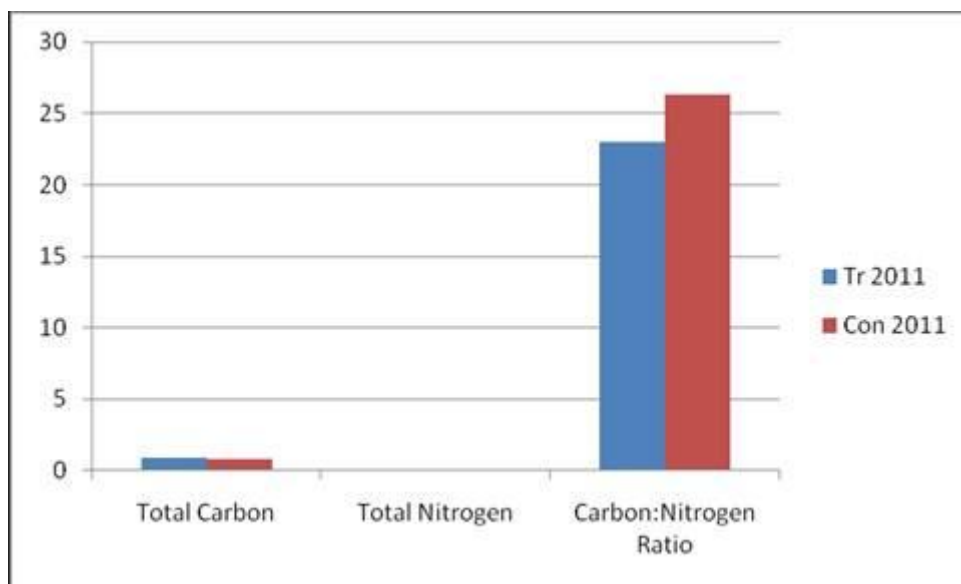
Graph 37: Soil chemical properties 2011-08-01

From the graph above, there are slight improvements in both organic matter and CEC for the treatment site but not at significant values. The organic matter increase may be due to the compost tea in conjunction with the plant biomass added via mowing the inter-row and placing under the drip line. The control site received the same but has not responded as much. For long term improvement (+5 years) compost tea may be useful for farms, as it is cost effective. But the slow change may put off most growers, as no visible change occurs.



Graph 38: Nutrient values 2011

Again, there has been no significant change to the values of nutrients through the trial period. Magnesium and calcium have both increased in the treatment site but not to any discernable factor. Scientifically, no change has appeared through the testing regime within this farm, for nutrient improvements.



Graph 39: Carbon and nitrogen values 2011

Total carbon and nitrogen saw very little change, although the C:N ratio did improve slightly within the treatment zone. This may improve the ability of soil biology to improve their performance and survival rates but it would be hard to quantify such change at this site.

10.0 Discussion

From the results above it can be seen that there were changes within each site. The testing highlighted some of the biological, chemical and physical changes that occurred due to the applications of compost tea. The changes in the first year were quite slow and this comes down to the quality of the compost tea that the project had at hand at that time. It was a commercial biological liquid humate blend, primarily to supply nutrients not biology. In the second year we obtained our own brewer, which improved the project immensely. But the compost we were using in the second year was sourced from Northern NSW and so the effectiveness was again not optimal for this region. At the end of the second year, we obtained compost made in Mareeba with local products and we saw a major improvement on two of the farms. The compost was fungi dominated compost, as it had a lot of woody material added to the mix. With our compost tea, we added humate, fish emulsion and sea kelp as microbial foods. These inputs are also known to improve the soil biota. There would have been some effects from this mixture. The two grazing properties also wanted to add molasses two weeks before the compost tea spray, to improve the bacterial count but we did not do so as it may have skewed the data.

Brix meter

The project used a brix meter across the project on the two grazing properties. There were improvements in the brix reading two weeks after the application of compost tea but then it slowly declined to the original values over the next month. We were unable to explain this but one idea was that the increased nutrition from the compost tea (fish emulsion, sea kelp and humates) improved the brix but then when this food supply was depleted the grasses then fell back to the original levels. Rainfall also had an effect on the grasses, as there was a seasonal difference also. The more extended the dry period the less effect that the application had on the brix levels, so we think that moisture has a large effect on both the soil properties and the soil biology. This aspect of the project was difficult to understand, as there are factors that we do not know that affects the soil system.

Climate

Another major factor with the project was the climatic conditions through the trial. The first and third year had a very extended wet season and the soil moisture was retained longer throughout the season. This had two effects: better growing season for the grasses and reduced soil biology from being waterlogged for up to 10 weeks. So the grasses increased in bulk but not in quality. As seen above, the brix was also affected by moisture available. On the mango farm, as there was no ground cover under the trees, the soil dried very quickly and so affected the soil biology. Even though this farm was irrigated weekly, the soil biology still seemed to struggle as the topsoil dried very quickly due to the heat and low humidity.

Each farm had results that were not picked up in the testing, as they were visual or anecdotal in form. This report will discuss each farm separately and then discuss the overall impact of the project, both on the individual farms and the community around them.

3.1 Colless

When the project was first started, the two trial paddocks were under heavy grazing pressure as they were weaner paddocks. Both had heavy weed issues that reduced the grazing rates. These weeds were indicative of compacted soils, such as Snakeweed, Rattlepod, Sicklepod, Praxelis, Sensitive weed and some Giant Rat Tail grass. John had placed an improved pasture species to improve the paddock but the weeds had suppressed this. The only place the Bracheria was evident was under some trees in the paddock where the weeds did not go.

After a year we began to see change in the species that were in the paddock, with the Bracheria coming down from the trees and also some native species such as Kangaroo Grass, coming back. The weeds reduced slowly over the 3 years until at this point; there is one small patch of sensitive weed. The rest of the paddock is now grazing quality grasses. John has also indicated that the amount of dry matter within the paddock has increased and can now sustain the grazing pressure throughout the year. But again this is dependent on the rainfall that fell. The second year of the trial was quite dry, in comparison with the other years, and even though there was a gain across the farm, it was reduced. John has seen the improvement on the paddock and now knows that improvement is possible and at an economic rate for his property.

The property has a major issue with compaction and heavy closed clay at 30 cm and deeper, so John will be doing some Keyline ploughing using a chisel plough to open up the soil profile. He will then inject compost tea into the rip lines to assist the improvement.

3.2 MacKenzie

Alan and Margaret have only been in the project from the 2nd year but they have seen major improvements on their property.

Their grazing pressure is not high but they did have issues with weed infestations. These have begun to decline and Margaret has not noticed any new areas cropping up. They have also indicated that the pasture legumes are doing better throughout the treatment paddock but struggling in the control.

Another aspect they have noticed, but not wanted, was the amounts of kangaroos and wallabies that enter the treatment paddock. Alan says that there are up to 100 per day and he has to scare them out of the paddock. They were not apparent when they first bought the property.

For this property, moisture is not the factor that is at the Colless farm, this is due to the proximity to the Walsh River and the underlying moisture that comes from it. They also have greater and heavier dew events, which during the dry can have a marked effect on the pasture and soil biology.

Alan also has recently bought a Yeoman's plough, to reduce the impact of some of the compaction layers and also to place compost tea in the subsoil. In doing these passes, he notices that the tractor does less work going through the treatment site.

3.3 Moriconi

Although this property showed the least improvement, it could be explained and management practices can be put in place. The reasons for its slow improvement have already been mentioned but will be condensed below:

- Extremely sandy soil, with minimal organic matter or soil carbon to assist soil biology. Bare soil under trees also not a good environment for biology.
- Long history of chemical and pesticide use, this farm has over 30 years of intensive chemical applications. This would affect any biological soil amendment that was added.

Even though the testing indicated slight improvement, the Moriconi's had some other information for the project. In the 2nd and 3rd year, the mango harvest for the treatment site was one size grade higher (on average) and picked an extra 600 kg for the row. So even though the testing was not conclusive, there was visible change in the harvest. For small scale tree horticulture, this application of compost tea then becomes cost effective as the returns are improved.

Another aspect that was given to us was that because the tea applicator sprayed some on the tree foliage, they had to spray less fungicide in year 2 and almost none in year 3. The other rows (all inclusive) cost the farm approximately \$2000/year in fungicide costs, so another economic bonus.

Through the project, we also persuaded Graz to stop the spraying of Roundup under the trees and to mow the inter-row grass under the trees (for organic matter and weed control). This again saved Graz \$3000/year. This does not include labour time for spraying out the chemicals. So Graz was happy about doing less work too.

In conclusion, there are many aspects of the project that worked well. The highest was the knowledge of soil, soil biology and nutrition that the growers learnt about. They are more confident in their approach to their farm. They now know that what happens under their feet is paramount to their farms health and productivity. They are aware of the relationship between chemical, physical and biological processes and can talk confidently with other landowners about it.

There were other aspects that weren't so successful. Balancing out any nutritional issues with the farms would improve the compost tea applications, such as trace element deficiencies.

In regards to the Moriconi farm, compost or some other form of soil amendment is required in conjunction with tea applications. That is because the soil profile is so depleted of organic matter and carbon.

Overall, for this project, the greatest effect or limiting factor for the project would be rainfall/soil moisture. If the rainfall is good and extends beyond the wet season, then soil and biology will improve faster with compost tea. If it is a dry year or the farm is in an arid to semi-arid area, the farm will struggle to improve the soil profile with just compost tea. The use of mechanical means such as the Yeoman's plough, keyline and contour management and compost may improve the outcomes for farms and make it more cost effective. Each farm has its own issues and needs separate tools to improve its condition; compost tea is not the immediate silver bullet but an effective tool to assist landowners over the long term. Landowners must understand that they should have a 5 year plan and some good advice.

Community Benefits

From the field days and the media articles that were an aspect of this project, the community is now very aware of this practice and we have seen many people start to do it. We know of three new compost tea brewers amongst the project members neighbours and we have begun putting together an information group to support local landowners.

The community is slowly taking up compost tea, biodynamics and other soil health paradigms now that they have seen some of the on ground results. NGRMG has given presentations to all types of farmers; from extensive graziers to small land hold croppers. We had SFI give a presentation in Dimbulah and 73 people attended; the average for our workshops is 15. So the community is on track to learning about soil health and the ways to improving it.