Evaluating alternative fertilisers and biological products for pastures and crops

Result of the 2009 and 2010 seasons

Woady Yaloak Catchment Group

This report has been prepared by Cam Nicholson on behalf of the Woady Yaloak Catchment Group.

It documents the results of the first two years of a three year project funded by the Caring for our Country Program.

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Introduction

There is growing farmer interest in using alternative nutrient sources and biological soil enhancers instead of traditional manufactured fertiliser to improve productivity and soil 'health'.

The reasons behind wanting to explore alternatives is understandable. This includes the spike in traditional fertiliser prices in the mid 2000's, concerns about the long term supply of rock phosphate to meet future demand and the realisation that some of the phosphorus applied in traditional fertiliser is 'locked up' by the soil and not available for plant growth. As nutrient replacement is essential for sustainable farming practices, possible alternatives need to be examined and their potential benefits and costs understood.

Interest in biological products has also increased in past years and the theory behind improved soil health is sound. Significant amounts of nutrients are stored in organic matter (nitrogen 95%, sulphur 90%, phosphorus 40%). A slow release of these nutrients through the year should provide an ongoing supply to the plants. The growth and breakdown of fungi is of particular importance. Improved biological activity also has the added benefit of enhancing soil structure, increasing water holding capacity and increasing the amount of stable soil carbon.

While the benefits of improved soil health are widely accepted, there are numerous questions around whether the products being sold to improve soil health actually change soil biological activity and ultimately are cost effective in maintaining or increasing production. Many of these products have only recently appeared on the market and while anecdotal stories and testimonials abound, the scientific evidence to support the suggested responses is often limited.

Farmers in the Woady Yaloak catchment were interested in investigating the response of a range of alternative products tested under local conditions. A three year screening trial funded by *Caring for our Country* was established to evaluate:

- alternative nutrient sources (animal manures and non traditional nutrient sources) that are locally available and comparing these to traditional inorganic fertilisers (common practice)
- the impact of some recently promoted biological products to change soil biological activity and in turn plant production.

The results presented are the first two years of the initial three year trial.

Treatments

Eight sites were identified by farmers in the catchment. The sites represented a range of typical pastures and crops. All sites were soil tested before the trial commenced. This included a traditional soil test, as well as a test to measure biological activity in the soil (appendix 1). All sites will be retested after three years.

Twelve products were tested, some repeated at multiple sites, some at only one site (table 1). The choice of product was determined by local farmer interest. A description of each alternative product is provided (appendix 2).

Eight products were tested at each site (referred to as treatments). At each site one treatment was assigned no product. This was considered the NIL treatment and all other products have been compared to the response of the NIL treatment. A 'standard' fertiliser recommendation was also made for each site based on recommendations from Jen Clarke and Cam Nicholson, based on the traditional soil test results (appendix 3).

Table 1: Type and number of products tested

Broad product category	Product	Sites tested
NIL – used for product comparison	Nil	**8**
Alternative nutrient source	Common inorganic fertiliser	**8**
	Pig manure	**6**
	Poultry manure	**5**
	Biosolids	**1**
	Guano	**1**
Nutrient source and biological enhancer	TM21 & common fertiliser	**3**
	Twin N & common fertiliser	**5**
Biological enhancer	Seasol & Powerfeed	**8**
	Nutrisoil	**8**
	Worm caste & lime	**8**
	Munash products	**1**
	Compost tea products	**2**

Treatments (products) were applied in a completely randomised block design with four replicates. Each treatment plot was 4m x 16m, with the edge of each 4m plot providing a buffer to the adjacent plot.

Solid products were applied by hand and foliar products by a 2 m boom spray (nozzles at 50 cm spacing, coarse nozzles at 2.0 bar pressure). Where higher water rates were required, repeat applications were performed.

Dry matter cuts (with a lawn mower) were taken from the middle of each pasture plot and then $0.1m^2$ sub samples were cut down to ground level. The two were added to calculate the total dry matter production. Crop samples were harvested with a plot header.

The rate and time of application of products was made in consultation with the product suppliers (table 2).

Table 2: Rate of products applied and time of application

Product	Application rate	Timing Pasture/Lucerne	Timing on crops
Inorganic fertilisers	See appendix 3	**Annual** in late May	**Annual**, post sowing, pre - emergence
Pig manure	4.2 t/ha (6.4 m^3/ha), pasture/lucerne 6.2 t/ha (9.6m^3/ha) crop	Late May **as a once off application in 2009**	**Once off in 2009**, post sowing, pre – emergence, none in 2010
Poultry manure	2.1 t/ha (5m^3/ha) pasture/lucerne 3.2 t/ha (7.5m^3/ha) crop	Late May **as a once off application in 2009**	**Once off in 2009**, post sowing, pre – emergence, none in 2010

Biosolids	250 kg/ha	**Once off** late May[1]	*Not applied at any crop sites*
Guano	113 kg/ha in 2009, 150 kg/ha in 2010 Guano Gold, 38 kg/ha MOP[2] in 2009, 80 kg/ha SOP in 2010	**Annual** May/June	*Not applied at any crop sites*
Twin N	50 mL/ha in 300 l/ha water PLUS conventional fertiliser (see appendix 3)	**Annual** in May/June and late August, conventional fertiliser in May only	**Annual** with fertiliser, first application after emergence: 3-4 tillers for cereals, 15 cm for broadleaf. Second application early flowering.
TM 21	250 ml/ha in 80 l/ha water PLUS conventional fertiliser (see appendix 3)	**Annual** in May/June, late August/September, conventional fertiliser in May only	**Annual** with fertiliser, post sowing, pre- emergence. Second application late August.
Seasol & Powerfeed	5 l/ha of each in 200 l/ha water	**Annual** in mid June, late August and early November	**Annual**, first application after emergence: 3-4 tillers for cereals, 15 cm for broadleaf. Second application early flowering[3].
Worm Caste	200 kg/ha worm caste 250 kg/ha lime	**Annual** in late May in 2009, June and October in 2011	**Annual,** post emergence and in October
Nutrisoil	5 l/ha in 95 l/ha water	**Annual,** May/ June, August/September	**Annual**, first application after emergence: 3-4 tillers for cereals, 15 cm for broadleaf. Second application early flowering[3].
Munash products	250 kg/ha Ecomin Balance (solid) 2 l/ha Bio N (foliar) 2 l/ha Omniboost K (foliar) in 76 l/ha water	**Annual, s**olid product – mid May. Foliar product – mid June and August in 2010	*Not applied at any crop sites*
Compost products	Compost (solid): 780 kg/ha crop 1.7 tonne/ha lucerne Compost tea (foliar): First application/yr 40 l/ha in 40 l/ha water. Second application 40 l/ha + 15 l/ha Sampi fish oil emulsion in 40 l/ha water	**Once off -** Solid product in early June. **Annual** foliar product first application mid June, second application early September	**Once off** solid product and **annual** first foliar application – post sowing, pre-emergence. Second **annual** application of foliar product – early September

[1] Was intended as an annual application. Difficulty of supply meant only one application in 2009 was possible
[2] MOP = muriate of potash, SOP = sulphate of potash
[3] Not applied to triticale crop in 2009 because of crop height

Results & discussion

The range in soil fertility and biological activity would suggest the potential for a response to the products chosen. The overall biological activity of the soil was reported as being low to very low. The level of macronutrients (phosphorus, potassium and sulphur) was also below desirable levels at most sites. If products were likely to show a positive response, then the sites are favourable for this to occur.

Products were applied at rates recommended by the supplier of the product and not to balance nutrient supply. This was to test what a farmer would experience if buying the product and following the recommendations rather than to test the efficacy of products applied at the same nutrient concentration.

Seasonal conditions sometimes prevented the ideal timing of product application, due to wind, rain, dry or waterlogged conditions. However the delay in application represented what a farmer would be faced with. Also as rates were not adjusted, products did not compare equivalent amounts of nutrient applied. Therefore the important comparison is against the NIL application to determine which products increased yield compared to no application.

The growing seasons in 2009 and 2010 were vastly different. In 2009 a late break and a short growing season, including an unprecedented hot period in November, severely curtailed pasture growth and affected crop yields. This is likely to have prevented any treatment benefits that would normally occurred in the 'spring flush' to occur. For the crop sites, one of the three crops failed and the grain yield of the other two crops showed no difference despite the height and bulk of the crop showing visual different due to the treatments.

By contrast 2010 was wet, with the growing season extending into 2011 especially for the three lucerne sites. Two of the three crop sites failed, with one site completely washed out and the other lodging due to the ongoing heavy late spring and summer rains. No yield data was able to be collected at either site.

The results for total dry matter have been mathematically analysed to take into account the natural variability across the site. The mathematical analysis enables a figure to be derived that separates out whether the differences are due to chance or luck or whether it is due to the product used[4].

Results for the products tested over the first two years are presented by comparing them to the no application treatment. Graphs represent all eight sites. The vertical scale (% difference in dry matter compared to NIL treatment or control) is the same for each graph to convey the size of the difference with each product. Where no bar is represented on the graph, the product was not used at this site or the crop failed. ***These results are for the 2009 and 2010 growing season and are only part of a longer term study. Responses and conclusions may change as later years, so use these preliminary results with caution.***

[4] The mathematical calculation is called analysis of variance (ANOVA). It enables the yield measurements from the products used at each site to be compared to the natural variation at the site and against other products used at the same site. If there is a 95% probability the differences between measurements is due to the products, then a yield value is calculated. This is known as the least significant difference or LSD. If the difference between two treatments is less than the LSD, then even though there may be difference between the numbers, this difference is due to chance or luck. However, if the difference is greater than the LSD, then the difference is not due to chance or luck, it is due to the product used.

Alternative nutrient sources

Pig manure
There was a significant increase in dry matter production from the pig manure compared to the NIL treatment at the two pasture sites and the two lucerne sites during 2009 and 2010. The range of dry matter increase was between 10% and 55% over the two years (figure 1). There was no significant increase in crop yields, although the dry matter from the pig manure treatments were visually greater than the NIL treatment in 2009 and 2010 (significance for grain yield in 2010 was 18% and crop yield over the nil treatment was only 14%).

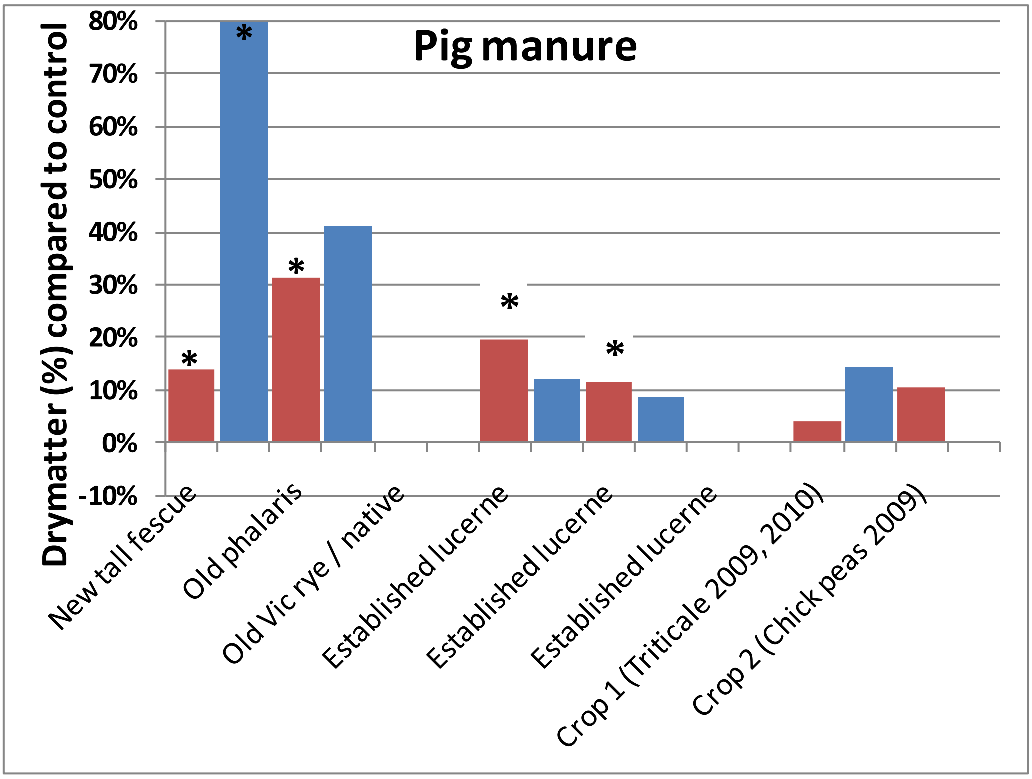

Figure 1: Change in dry matter production for pig manure compared to the NIL treatment for 2009 (red) and 2010 (blue). Asterix indicates significant difference ($p < 0.05$)

Poultry manure
There was a significant increase in dry matter production from the poultry manure compared to the NIL treatment at two of the five sites measured during 2009 and 2010. The increase in dry matter was less than the pig manure (figure 2).

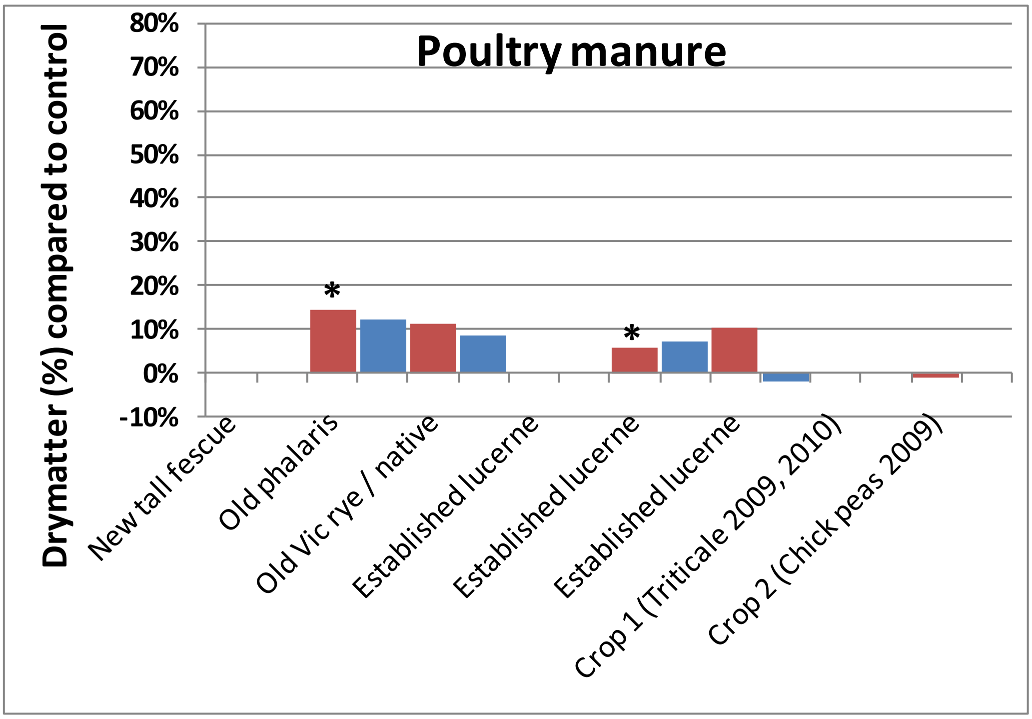

Figure 2: Change in dry matter production for poultry manure compared to the NIL treatment for 2009 (red) and 2010 (blue). Asterix indicates significant difference ($p < 0.05$)

The response to both the pig and poultry manure is not surprising as the heavy application rate supplied significant amounts of nitrogen and phosphorus (table 3). As these manures were applied as a once off application, it is too early to determine how long the response will last.

Table 3: Rates of nutrient applied by manures

Product		**N (kg/ha)**	**P (kg/ha)**	**K (kg/ha)**	**S (kg/ha)**
Pig Manure	crop	132	89	90	48
	pasture/lucerne	88	59	60	32
Poultry Manure	crop	63	35	36	11
	pasture/lucerne	42	23	24	7

Biosolids
There was no dry matter response to the application of biosolids over the two years. Unfortunately difficulties in obtaining the product in 2010 meant the product was only used in 2009. The rate used in 2009 only provided approximately 4 kg of P, very little of which was immediately available, on a site that had an Olsen phosphorus of 11.3. The response is predictable given what was applied. No conclusion can be made on the suitability of this product at this stage.

Guano
Guano was only tested at one lucerne site. No significant difference was reported compared to the NIL treatment. At the same site there was a significant response to the application of pig manure. The total amount of nutrient applied was 32 kg of P/ha from the Guano compared with 88 kg of P/ha from the pig manure. The site had an Olsen P of 11.9.

Traditional inorganic fertiliser

Fertilisers commonly used in grazing and cropping were applied at each site with the intention of reaching target nutrient levels at the end of 2011 (appendix 3). The type of crop or pasture, starting nutrient levels, cation exchange capacity and phosphorus buffering index were all taken into account in determining the rate and type of fertiliser to apply. Therefore the total quantity of nutrient applied varied at each site (table 4).

Table 4: Total quantity of nutrients applied by traditional inorganic fertilisers in 2009 and 2010.

Site	Nutrient applied in 2009 & 2010		
	P (kg/ha)	K (kg/ha)	S (kg/ha)
New tall fescue	51	100	3
Old phalaris	35	67	43
Old Vic rye / native	56	60	69
Established lucerne	26	0	33
Established lucerne	33	92	41
Established lucerne	46	0	2
Crop 1 (Triticale 2009 & 2010)	40	0	72
Crop 2 (Chick peas 2009 failed 2010)	40	60	3

There was a significant increase in dry matter production at only two of the eight sites over the two years. These were at the tall fescue and triticale crop sites (figure 3) and were unexpected given the suggested potential responsiveness of the sites (from the soil test results) and the amount of nutrient applied. The lack of extra production in 2009 was attributed to the premature finish to the season, however there is no explanation as to why there were no larger differences measured in 2010 under ideal growing conditions.

Another year of application may be required before the benefits of the application are realised but even so it was anticipated to have seen a more significant response after two years. At two of the three sites where there has been no response to traditional fertiliser, there was a response to the manure. The poultry manure, applied at a lower rate of total phosphorus than the inorganic products, resulted in higher yields. This response may be due to the nitrogen contained in the manure products.

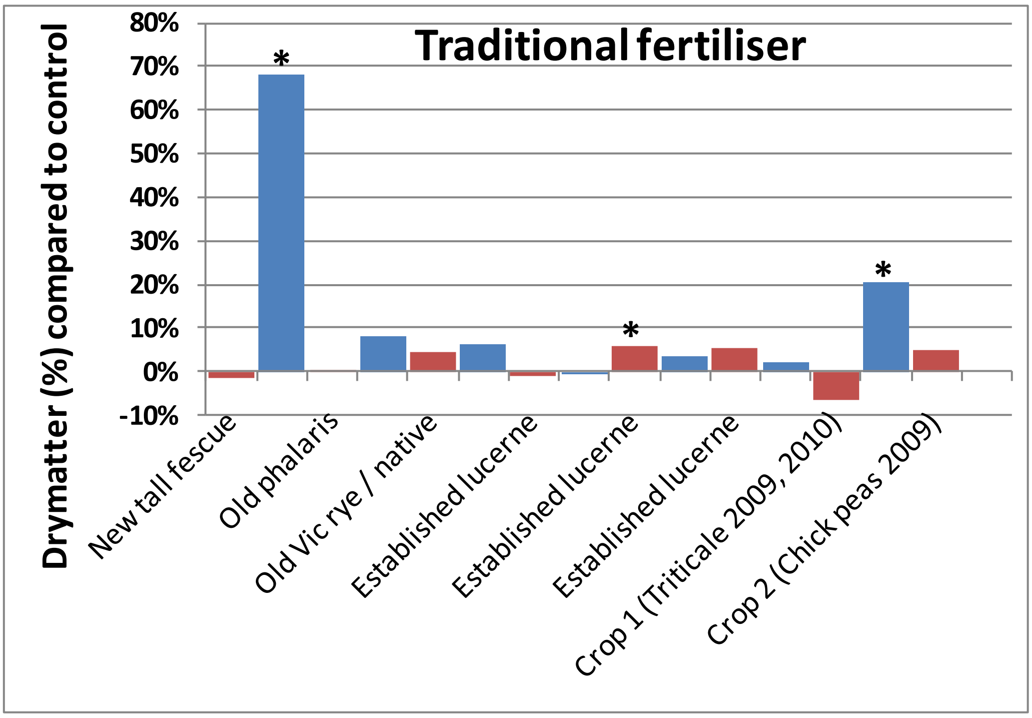

Figure 3: Change in dry matter production for traditional inorganic fertilisers compared to the NIL treatment for 2009 (red) and 2010 (blue). Asterix indicates significant difference ($p < 0.05$)

Nutrient sources with biological products

TM 21 and conventional fertiliser

TM 21 with conventional fertiliser were applied at three sites. No response was recorded at any sites in 2009, but significant responses were measured in 2010 at a pasture and crop site (figure 4).

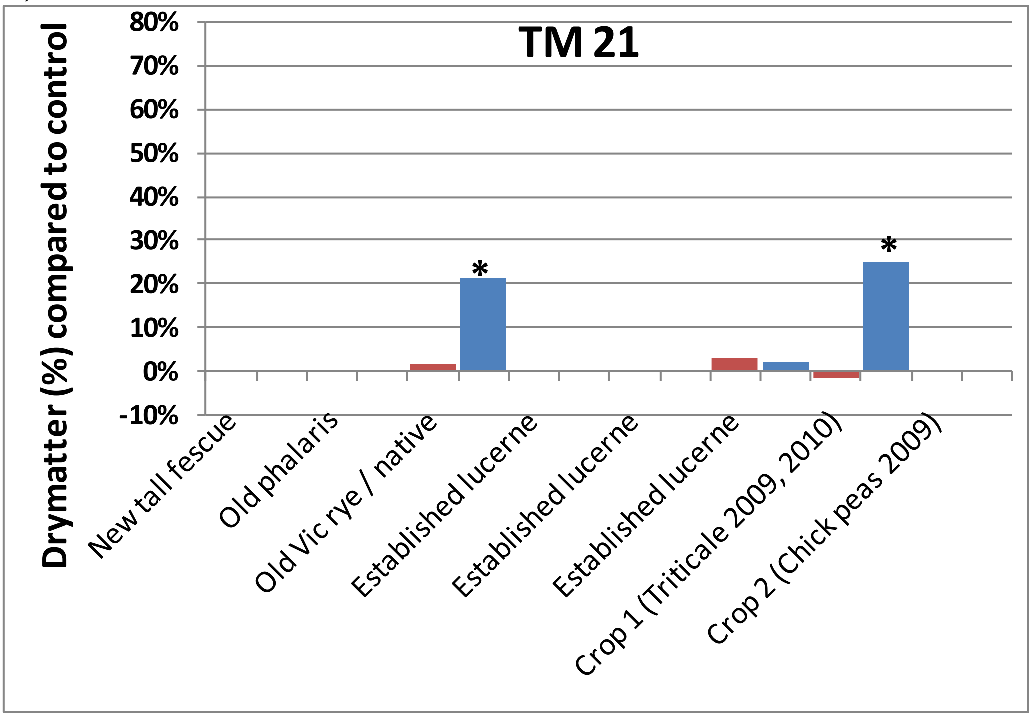

Figure 4: Change in dry matter production for TM21 with traditional inorganic fertilisers compared to the NIL treatment for 2009 (red) and 2010 (blue). Asterix indicates significant difference ($p < 0.05$)

The response in 2010 mimics the yield increase to the equivalent traditional fertiliser at the crop and lucerne sites but not the pasture site (refer to figure 3). The additional grain yield from the TM21 less the response from traditional fertiliser at the crop site was 4% compared to the NIL treatment, nothing at the lucerne site but the dry matter at the old Victorian ryegrass / native grass site was 15% greater due to the TM 21. The inconsistency of response makes it difficult to draw conclusions, although the measurements support comments made by the supplier that improvements would not be expected until two or more years after application.

Twin N and conventional fertiliser
The response to Twin N with conventional fertiliser closely follows the response to conventional fertiliser only. When the yield from the conventional fertiliser was taken into account, yield increases attributed to the Twin N were -4% to + 3%. No results were significant suggesting no dry matter response to this product so far.

Biological enhancers

Seasol and Powerfeed
This product was applied at all eight locations. There was no significant increase in dry matter yield at any site compared to the NIL treatment across 2009 and 2010 (figure 5). The apparent increase at the old phalaris location is explained by the high measured variability of cuts at the site. Dry matter at sites where the variability was much lower showed no response to this product.

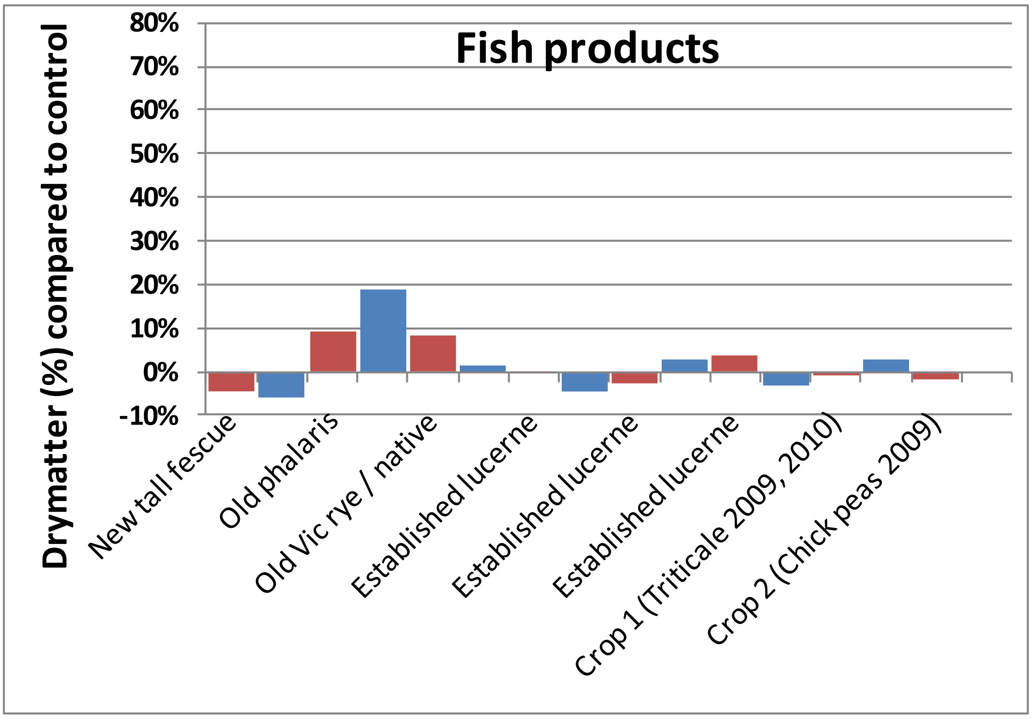

Figure 5: Change in dry matter production for Seasol and Powerfeed with traditional inorganic fertilisers compared to the NIL treatment for 2009 (red) and 2010 (blue). Asterix indicates significant difference ($p < 0.05$)

Nutrisoil
There was no yield response compared to the NIL treatment at any of the eight sites across either 2009 and 2010 (figure 6).

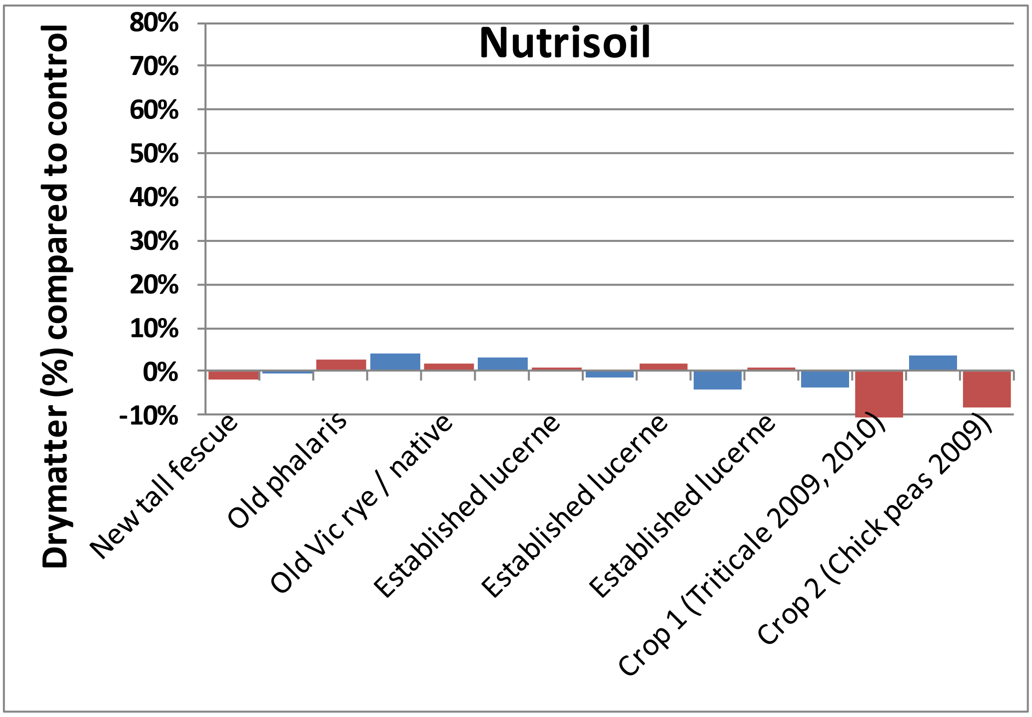

Figure 6: Change in dry matter production for Nutrisoil with traditional inorganic fertilisers compared to the NIL treatment for 2009 (red) and 2010 (blue). Asterix indicates significant difference ($p < 0.05$)

Worm caste & lime

Yield differences were measured on treatments using worm cast and lime. The late advice on the need to accompany the worm caste with lime prevented the two products from being tested separately. Therefore it is impossible to know if the response measured is a result of the worm caste, the lime or a combination of both products, although the sites where the greatest response has occurred had a pH_{Cacl2} of 4.6 and 4.7 and an aluminium level (Al as % CEC) of 3.0% and 2.7%.

Nevertheless the positive response, especially in 2010 (significant at two sites and two falling just inside the LSD value) suggests there may be a yield benefit from applying these products. Further measurement will determine if this positive response is maintained in the future.

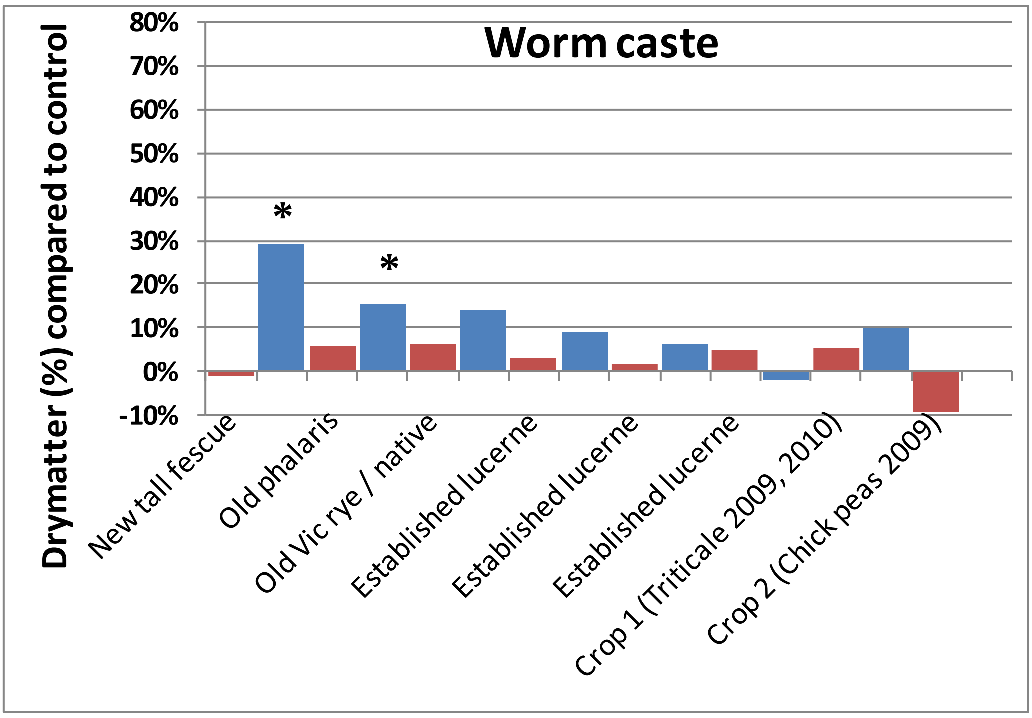

Figure 7: Change in dry matter production for worm caste and lime with traditional inorganic fertilisers compared to the NIL treatment for 2009 (red) and 2010 (blue). Asterix indicates significant difference ($p < 0.05$)

Munash products
This product was only tried at one site. To date no significant response has been measured compared to the NIL treatment.

Compost and compost tea
This product was tried at one crop and one lucerne site. There has been no significant response at either site. At the same sites, significant responses have been recorded with the pig manure (lucerne site) and traditional fertiliser +/- TM21 (triticale crop).

Interim conclusions

The results from the past two years has generated some interesting results and raised some questions.

Only dry matter and grain yield are measured on a regular basis. Observations of the treatments at cutting would suggest there are subtle changes in the composition of the pasture to various products, especially an increase in legume content at the pasture sites. This means there is likely to be an improvement in pasture quality from some of the treatments which is not reflected in the quantity of dry matter produced or recorded. The composition change will be quantified in 2011.

It is clear, even at this early stage, that the manure products applied in large quantities do provide a boost in yield, probably as a result of the nitrogen applied as well as the other macro elements. How long this response will last is still to be determined. The variability in nutrient and moisture content and the degree of composting make these products less consistent in quality, so buyers need to take this into account (along with the transport costs).

The greatest surprise has been the variability in response to traditional inorganic fertilisers, especially given the rate of nutrients applied. The poor response in 2009 was thought to be due to the late application (May) and then the dry finish to the season. Yet 2010 has provided ideal conditions for growth and at several sites little if any response has been measured, despite responses at the same site to other products. While nitrogen in the manures may be a possible reason for the difference, it should not be the case on the well established lucerne stands, where nitrogen should be adequate. Unfortunately limited funds restricts the capacity to undertake deep nitrogen or tissue testing to examine other possible nutrient deficiencies but the variable response is a concern when many farmers would believe application of these traditional products should provide short term benefits.

Application of many of the biological type products are yet to result in an increase in yield, although there appear to be subtle changes to pasture composition. At this stage no conclusion can be drawn as to the effect these products have on increasing dry matter production. Suppliers stressed the products may take several years to have an effect and the trials have only been going for two years. There are some promising signs with products like worm caste and TM21 showing positive, albeit inconsistent responses to date.

The results also raise the question about the value of light application rates of lime. While the current lime application is combined with worm caste, the response to this combination is interesting. It is beyond the capacity of these trials to determine how effective small, repetitive rates of lime may be, but is certainly an area for further investigation.

Finally no costs or returns have been calculated to date. This is deliberate as some products are applied once at the beginning of the trial yet the benefits accrue over many years. Doing the calculation over a short time frame misrepresent the potential net benefit (or cost). Similarly some biological products would be biased against if economic analysis was conducted now, as the costs are being incurred but little response is expect until three years after first application. Economic analysis will be conducted at the end of 2011 to provide some guidance on this question.

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The author also wishes to thank the many helpers who applied products or took measurements in the past two years. These include Jennifer Clarke, Michael Wilson, Tom Braun, Simon Caldwell, Toby Campbell, Jim Caldwell and Simon Falkiner.

Appendix 1:

Table A1: Key soil test results (traditional soil test) – tested Spring 2008

Site	Site description	P (Olsen)	K (Colwell)	S (KCl 40)	pH ($CaCl_2$)	Al (%CEC)	PBI	CEC
1	New tall fescue pasture	11.3	90	13.6	4.6	3.0	115	14.51
2	Established lucerne	11.9	93	11.3	5.0	0.7	33	4.12
3	Crop site 1	18.5	203	8.9	4.9	1.2	58	6.80
4	Old phalaris pasture	12.1	132	11.0	4.7	2.7	61	6.71
5	Established lucerne	22.7	258	15.2	5.3	0.4	37	7.31
6	Crop site 2	19.2	61	9.3	4.8	5.1	40	4.15
7	Old Victorian ryegrass / native pasture	6.5	123	9.0	4.8	2.3	126	13.10
8	Established lucerne	12.4	295	20.5	5.1	0.8	102	10.30

Table A2: Summary of key biological test results – tested Spring 2008 (warm, moist conditions)[5]

Test	Comment on combined 8 sites
Total and active soil fungi	Total fungi high, especially in older pastures. Active fungi very low to nil at all sites. Severely out of balance, needs additional active fungi (recommend compost or compost tea). Minimal beneficial (mycorrhizal) fungal infection.
Total & active soil bacteria	Total bacteria high, but active bacteria low at all sites. Severely out of balance, needs additional food source to stimulate bacterial activity (sugars or amino sugars)
Type of fungi	Good balance of disease suppressive and normal fungi at all sites
Balance of active fungi to active bacteria	Bacterial dominant. Apply additional fungal foods to address these imbalances
Protozoa	Low in all but one site. Suggested this will limit natural nutrient cycling. Needs additional protozoa from compost or compost tea.
Nematodes	Nematode levels low to very low. Suggested this will limit natural nutrient cycling.

[5] Analysed by Soil Foodweb Institute. Results of individual sites will be compared again in 2011, to examine changes both over time and between treatments

Appendix 3

Table A3: Product used and description of product content based on supplier details

Product	**Comments**
Common inorganic fertilisers	A range of fertiliser commonly used in the district, applied to match deficiencies identified from soil testing.
Pig manure from grower sheds	The sample contained 3.32% Nitrogen, 1.89% phosphorus, 2.61% potassium, 0.82% sulfur, 62.8% DM[6]. It was applied in a stockpiled but uncomposted form.
Poultry manure and wood shavings from broiler sheds	The sample contained 2.74% Nitrogen, 1.52% phosphorus, 1.56% potassium, 0.43% sulfur 73.1% DM[2]. It was applied in a stockpiled but uncomposted form.
Seasol and Powerfeed	Seasol is an organic seaweed plant conditioner. It contains naturally occurring growth regulators, trace elements, alginates, carbohydrate and vitamins derived from kelp. Powerfeed (12:1.4:7:0) is an organic fish fertiliser. It is a source of amino acids, proteins, beneficial bacteria, trace elements and vitamins. Powerfeed has been fortified with extra nitrogen, potassium, a small amount of phosphorus and humates.
Worm Caste	Worm castings claim to act as a plant nutrient and soil conditioner, in a mixture of readily available nutrients, bacteria and enzymes. It is the solid product of vermiculture (worms). The castings are spread in combination with lime. The lime provides a calcium source and neutralises the environment for the microbes in the castings.
Twin N:	Contains a selection of high yielding nitrogen fixing microbes. A proportion of the microbes live within the plant (roots, leaves, stem). The rest establish in the root zone very close to surface of roots and root hairs. A secondary effect is the production of growth factors and release of substances that improve nutrient solubility. **Applied in addition to the standard fertiliser recommendations**. For the cropping sites, where nitrogen was part of the standard fertiliser application, the rate of nitrogen applied in that form was reduced by 50%.
TM 21	A bio-stimulant that feeds and increases the population of micro-organisms in the soil. **Applied in addition to the standard fertiliser recommendations**.
Nutrisoil	Broad spectrum liquid plant food, which includes soil bacteria. It is the liquid product of vermiculture (worms). Typical analysis contains: 492 mg/kg Nitrogen, 130 mg/kg Phosphorus, 700 mg/kg Potassium.
Munash products	A combination of three products supplied by Munash. *Ecomin Balance*, a natural mineral fertiliser containing 2.4% phosphorus, 5% potassium, 1.5% sulfur, 10% calcium, 5% magnesium, plus trace elements. Two foliar products were also applied: *Bio N, a* product which supplies bacteria and enzymes, with the ability to fix atmospheric nitrogen and *Omniboost K*, a product containing 6% nitrogen, 13% phosphorus, 3.1% potassium, 3.3% sulfur, plus magnesium, trace elements, amino acids, fulvic acid and uptake enhancers.
Compost products	A combination of solid and liquid compost products (tea). Supplying organic matter, available nutrients and organisms. Sampi fish oil emulsion was used with the spring application to provide available nutrients and

[6] Tested by SWEP Analytical Laboratories

	discourage insect and fungal attack.
Biosolids	Byproduct from sewerage treatment plants. It contains 1.3 to 1.4% total phosphorus, very little of which is readily available, 1.4 to 1.6% total nitrogen, most of which is immediately available. Almost neutral pH. The product is about 50% organic matter. Also provides trace elements.
Guano	Supplied as Guano Gold Kwik start. This product contains 11.6% phosphorus (total P), 28.8% calcium (total Ca) and 8.8% silica. It provides a combination of available nutrients and slow release nutrients. Silica increase exchange sites for nutrient storage. This product was spread in a mix: 75% Guano Gold, 25% Muriate of Potash.

Appendix 3

Table A4: Rate and type of inorganic fertiliser applied in 2009 and 2010

Site	Description	Rate (kg/ha/yr)	Product
1	New tall fescue pasture	125 100	Triple superphosphate Muriate of potash
2	Established lucerne	280	Super potash 2:1
3	Triticale	100 185	DAP Gypsum (for sulphur)
4	Old phalaris pasture	265	Super potash 3:1
5	Established lucerne	150	Single superphosphate
6	Chick peas	100 60	DAP Muriate of potash
7	Old vic rye / native pasture	375	Super potash 5:1
8	Established lucerne	115	Triple superphosphate

Table A5: Target nutrient levels by the end of 2011

Site	Target nutrient levels by 2011		
	P (Olsen)	K (Colwell)	S (KCl_{40})
New tall fescue	15	185	15
Old phalaris	15	185	15
Old Vic rye / native	12	170	12
Established lucerne	18	200	15
Established lucerne	15	185	15
Established lucerne	15	185	15
Crop 1 (Triticale 2009 & 2010)	20	120	18
Crop 2 (Chick peas 2009 failed 2010)	20	120	18