Native Pasture & Alternative Fertiliser Trial - Binalong/Bookham NSW -

SPRING FIELD DAY NOTES September 2015

Trial Summary - 2009 to 2014

Conducted by Binalong Landcare Group subgroup of Harden-Murrumburrah Landcare Group with technical support from South East Local Land Services & NSW DPI.

Project Supported by:

Table 1 - Description of fertiliser products used

Fertiliser product	Description
Single superphosphate	Granulated fertiliser containing 8.8% Phosphorus (P) (8.6% of this is soluble P), 11% Sulfur (S) and 20% Calcium (Ca). (Single superphosphate containing Molybdenum (0.05%) was used in years 1 and 5).
Agri-ash	A burnt sewage ash product produced at the ACTEW Molonglo Sewage works, ACT. The product contains 6.6% P (1.12% of this is soluble P), 0.85% S and a range of other macro and micro nutrients. It also has an average neutralising value of 65%. It does contain some heavy metals but all below threshold limits. FertSpread, Gunning have the sole rights to the sale of this product.
Trio-min/ Eco-min Balance	Both fertilisers are a crushed rock (semi-granulated) product. Trio-min is made from igneous and metamorphic rocks with added phosphate. It contains 4.5% P plus a range of other macro and micro nutrients. Eco-min Balance is also made from igneous and metamorphic rocks containing 2.4% P plus a range of other nutrients. Eco-min Balance contains 10% lime. The products were supplied by Munash Fertilsers, Ballarat.
SEP Pig Manure	A waste product from pigs. The liquid and solid manure is put into sedimentation evaporation ponds (SEP) to dry and then manure is scooped into piles for further air drying before being spread on paddocks. The product contains a range of macro and micro nutrients. Nutrient levels vary from batch to batch. The product was sourced from “Windridge Farms”, Young.
Groundswell Compost	This is a food and garden waste compost, which is part of a project called ‘Groundswell’ funded by the Department of Environment and Heritage through an Environment Trust Grant. The product contains small amount of macro and micro nutrients. The nutrient content will vary from batch to batch.
YLAD Compost Mineral Blend	A dry product containing humus compost, lime, soft rock phosphate and gypsum. Refer to Table on reverse side for the varying percentages applied over the 5 years at each site. The compost used is produced from local organic waste. This product was sourced from YLAD Living Soils, Young.
YLAD Bio TX 500 Compost Tea Extract	A liquid product containing 95% humus compost tea extract, 2% molasses and 3% liquid fish. This product was sourced from YLAD Living Soils, Young.
BioAg Blend	A blend of dry and liquid fertilisers was applied. The dry products are a mix of BioAgPhos (reactive phosphate rock treated with a proprietary microbial culture), lime and gypsum. The liquid fertilisers applied in year one were a combination of ‘Soil and Seed’ (product containing nutrients plus microbes marketed by BioAg Pty Ltd), milk thistle and vitamin B5. These products were supplied by BioAg Pty Ltd, Narranderra.
Ecology Fluid Fertiliser/ Dical 64	Ecology Fluid Fertiliser is a liquid foliar fertiliser containing a mix of macro and micro nutrients and microbes. Dical 64 is a granular fertiliser containing 18% P (approximately 2% of this is soluble P) and 24% Calcium. Both products were supplied by Ecology Pty Ltd. Note in Year 5 Gypsum was also applied with the Dical 64.
Urea	Granulated fertiliser containing 46% N

Source: Information presented has been obtained from the respective alternative fertiliser suppliers. Information presented for single superphosphate and urea has been taken from the product label.

Table 2 - Treatments & spreading rates applied each autumn over period 2009 - 2014

TREATMENT	SPREADING RATE					
	Year 1 (2009)	Year 2 (2010)	Year 3 (2011)	Year 4 (2012)	Year 5 (2013)	Year 6 (2014)
Control (nil)	Nil	Nil	Nil	Nil	Nil	Nil
Single Superphosphate	125 kg/ha Molybdenum (0.05%)single superphosphate	125 kg/ha single superphosphate	125 kg/ha single superphosphate	125 kg/ha single superphosphate	125 kg/ha Molybdenum (0.025%)single superphosphate	125 kg/ha single superphosphate
Agri-ash	2.5 t/ha	Nil	Nil	Nil	Nil	Nil
Trio-min/Eco-min Balance	300 kg/ha Trio-min	300 kg/ha Eco-min Balance[1]	300 kg/ha Eco-min Balance[2]	300 kg/ha Eco-min Balance[1]	300 kg/ha Eco-min Balance[1,3]	300 kg/ha Eco-min Balance[1,3]
SEP Pig Manure	4.88 t/ha	Nil	Nil	4.0 t/ha	Nil	Nil
Groundswell Compost	3 t/ha	Nil	3 t/ha	Nil	3 t/ha	Nil
YLAD Compost Mineral Blend	1.1 t/ha[4]	1.235 t/ha[5]	1.58 t/ha (Kia-Ora)[6] 1.23 t/ha (Glenroy)[7] 1.23 t/ha (Te Kooti)[7]	0.81 t/ha (Kia-Ora)[8] 0.41 t/ha (Glenroy)[9] 0.7 t/ha (Te Kooti)[10]	0.5 t/ha Compost	0.40 t/ha (Kia-Ora)[11] 0.29t/ha(Glenroy)[12]
YLAD Bio TX 500 Compost Tea Extract	100 L/ha	100 L/ha	100 L/ha	100 L/ha	100 L/ha	100 L/ha
BioAg Blend	130 kg/ha BioAg Phos + 400 kg/ha lime + 3 L/ha 'Seed & Soil' + 30000 mg/ha milk thistle + 450 mg/ha Vitamin B5	200 kg/ha BioAg Phos + 100 kg/ha gypsum	Nil	200 kg/ha BioAg Phos + 100 kg/ha gypsum	Nil	200 kg/ha BioAg Phos + 100 kg/ha gypsum + Molybdenum (50 grams/ha)
Ecology Fluid Fertiliser (EFF)/Dical 64	50 L/ha EFF	50 L/ha EFF	80 kg/ha Dical 64	80 kg/ha Dical 64	80 kg/ha Dical 64 + 75 kg/ha Gypsum	80 kg/ha Dical 64 + 75 kg/ha Gypsum (+ Molybdenum coated on product to deliver 50 g/ha)
Urea	100 kg/ha	22 kg/ha	100 kg/ha	100 kg/ha	100 kg/ha	100 kg/ha

[1]Treatment contains 10% Lime
[2]Treatment contains 20% Lime
[3]Treatment contains 33.3% Biosolids and 66% Eco-min Balance.
[4]Treatment contains 45.5% compost; 45.5% lime; 9% Soft Rock Phosphate.
[5]Treatment contains 42.8% compost; 38.9% lime; 6.2% Soft rock phosphate; 11.7% gypsum; 0.39% Zinc Hepta.
[6]Treatment contains 31.6% compost; 47.5% lime; 5.1% Soft Rock Phosphate; 15.8% gypsum.
[7]Treatment contains 40.7% compost; 40.7% lime; 6.5% Soft Rock Phosphate; 12.1% gypsum.
[8]Treatment contains 31% compost; 31% lime; 7% Soft Rock Phosphate; 31% gypsum.
[9]Treatment contains 61% compost; 15% Soft Rock Phosphate; 24% gypsum.
[10]Treatment contains 36% compost; 36% lime; 7% Soft Rock Phosphate; 21% gypsum.
[11]Treatment contains 57% compost; 9% Soft Rock Phosphate; 34% gypsum.
[12]Treatment contains 86% compost; 14% Soft Rock Phosphate.

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Table 3 – Total quantities (kg/ha) of Phosphorus and Sulphur applied to treatments at Glenroy and Kia-Ora trial sites after 6 years.

Treatment	Water Soluble Phosphorus	Citrate Soluble Phosphorus	Insoluble Phosphorus	Total Phosphorus	Total Sulphur
Control	Nil	Nil	Nil	Nil	Nil
Single Super	51	13	2	66	83
Agri-ash	Nil	28	137	165	21
Trio-min/Eco-min Balance	1	6	10	17	13
SEP Pig Manure	6	83	88	177	34
Groundswell Compost	1	9	11	20	15
YLAD Compost Mineral Blend					
- **Glenroy**	No laboratory analysis undertaken on fertilizer applied				
- **Kia-Ora**	<1	3	46	49	71
YLAD Compost Tea	<1		<1	<1	<1
BioAg Blend	<1	2	70	72	29
Ecology FF/Dical 64	<1	8	64	72	22
Urea	Nil	Nil	Nil	Nil	Nil

Table 4 – Total quantities (kg/ha) of Phosphorus and Sulphur applied to treatments at TeKooti trial site after 5 years.

Treatment	Water Soluble Phosphorus	Citrate Soluble Phosphorus	Insoluble Phosphorus	Total Phosphorus	Total Sulphur
Control	Nil	Nil	Nil	Nil	Nil
Single Super	43	11	1	55	69
Agri-ash	Nil	28	137	165	21
Trio-min/Eco-min Balance	1	6	9	16	12
SEP Pig Manure	6	83	88	177	34
Groundswell Compost	1	9	11	20	15
YLAD Compost Mineral Blend					
- **Te Kooti**	No laboratory analysis undertaken on fertilizer applied				
YLAD Compost Tea	<1	nil	<1	<1	<1
BioAg Blend	<1	1	51	52	19
Ecology FF/Dical 64	<1	6	49	55	11
Urea	Nil	Nil	Nil	Nil	Nil

Notes accompanying Tables 3 and 4:

- Samples of all products trialled have been tested annually over the 6 years, 2009 -2014 to help determine their nutrient levels. These test results have allowed the compilation of Tables 3 and 4 highlighting the total P and S quantities in kg/ha applied for each treatment over the life of the study. Note the study was conducted for 6 years (2009 – 2014) on Glenroy and Kia-Ora trial sites (Table 3) and for 5 years (2009 – 2013) on the Te Kooti site. All fertiliser analysis testing has been done by the Environmental Analysis Laboratory, Southern Cross University, Lismore.

- In all fertilizers phosphorus may be present in a number of forms including:
  - water soluble – available to plants immediately,
  - citrate soluble – available to plants over a timeframe of weeks to months,
  - citrate insoluble – available to plants over a timeframe of years. This is a very slow release form of P.
  - organic P – contains varying levels of solubility.

- To have a better understanding of the amount of nutrient applied at each application of the products it is important to look at Tables 3 and 4 in conjunction with Table 2 which details the patterns of application. Tables 2, 3 and 4 are critical in helping to interpret the pasture growth, pasture quality, economic assessment and soil P and S responses measured over the period 2009 - 2014.

Table 5 - Annual Rainfall at each trial site

Site	Rainfall (mm)					
	2009	2010	2011	2012	2013	2014
Glenroy	535	975	619	694	480	659
Kia-Ora	643	1280	798	718	444	824
Te Kooti	660	1235	775	803	459	n/a

Herbage Mass Measurements

- Herbage Mass has been measured predominantly in Spring of each year over the period 2009 to 2014. Spring is usually the time of year when moisture and temperature are not limiting production and hence provide a more reliable indication as to whether or not a fertiliser product has resulted in an increase in herbage mass. However in 2013 and 2014 a winter measurement was taken in addition to a combined winter plus spring measurement. Table 6 defines the period of lockup for herbage mass measurement in each year as well as the mean herbage mass harvested from the control (nil) treatment plots at each site of the period 2009 to 2014.

- At the commencement of lock-up in each year the plots were mown off to an equal height and then allowed to grow for a period (see Table 6). A representative strip was then harvested from each plot with a mower taking each plot back to equal heights. This wet herbage was weighed and three sub samples taken to determine dry matter (DM) percentage for the plot, thus allowing a calculation of mean kilograms of dry matter per hectare (kg DM/ha) grown.

- Note that the Te Kooti trial site was measured for a period of 5 years (2009–2013) while Glenroy and Kia-Ora trial sites were measured for a 6 year period (2009-2014).

Table 6 - Mean herbage mass for the control (nil) treatment at Glenroy & Kia-Ora for 2009–2014 and Te Kooti 2009-2013. Period of lockup also defined for herbage mass measurement at each site over the period 2009-2014.

Year	Site	Control treatment mean spring herbage mass (kg DM/ha)	Period of lock-up for herbage mass measurement	Time of year when measurement taken
2009	Glenroy	801	9 wks 1 day	Spring (Mid Aug – late Oct)
	Kia-Ora	2503	10 wks 6 days	
	Te Kooti	3452	11 wks 5 days	
2010	Glenroy	2132	11 wks	Spring (Mid Aug – late Oct)
	Kia-Ora	2390	11 wks 5 days	
	Te Kooti	3513	11 wks 5 days	
2011	Glenroy	1278	11 wks 1 day	Spring (Mid Aug – late Oct)
	Kia-Ora	2165	12 wks 4 days	
	Te Kooti	2831	12 wks 1 days	
2012	Glenroy	1446	10 wks 6 day	Spring (Early Aug – late Oct)
	Kia-Ora	1314	11 wks 3 days	
	Te Kooti	2238	11 wks 6 days	
2013	Glenroy	1012	22 wks 2 day	Winter + Spring (Mid May – mid Oct)
	Kia-Ora	811	20 wks 5 days	
	Te Kooti	1354	22 wks	
2014	Glenroy	791	20 wks 1 day	Winter + Spring (Early May – late Sep)
	Kia-Ora	707	20 wks 5 days	
	Te Kooti	Not Collected	Not Collected	

Mean Spring/ Winter+Spring Herbage Mass relative to unfertilised control treatment 2009 – 2014

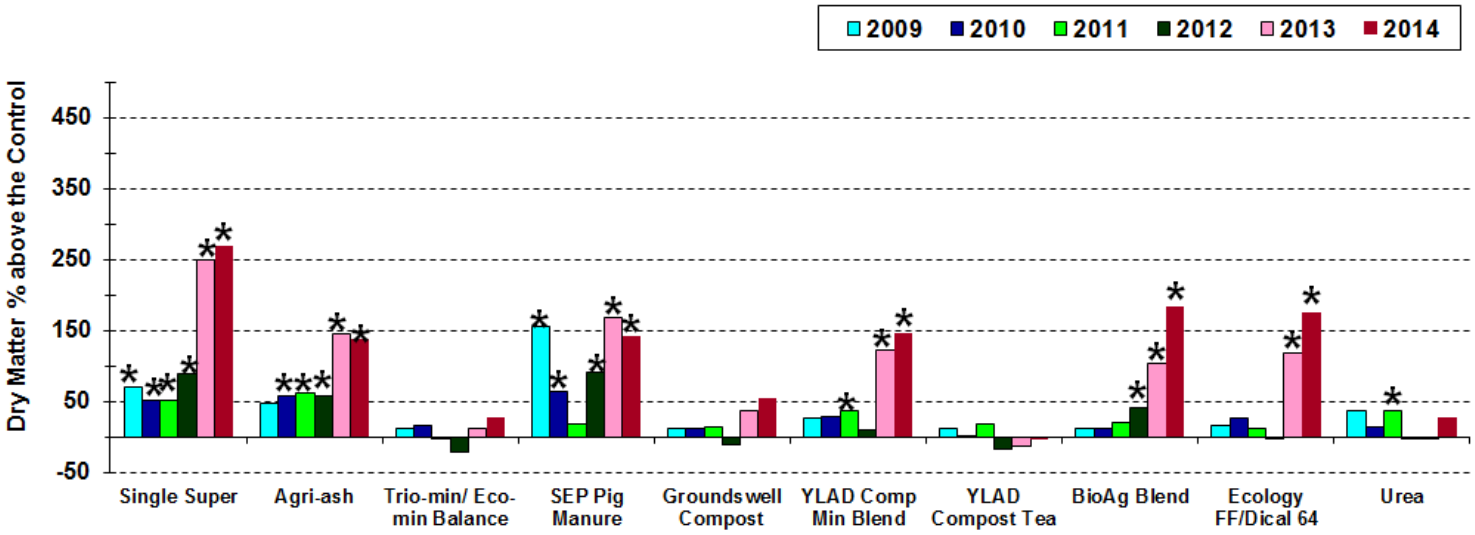

Figure 1: GLENROY

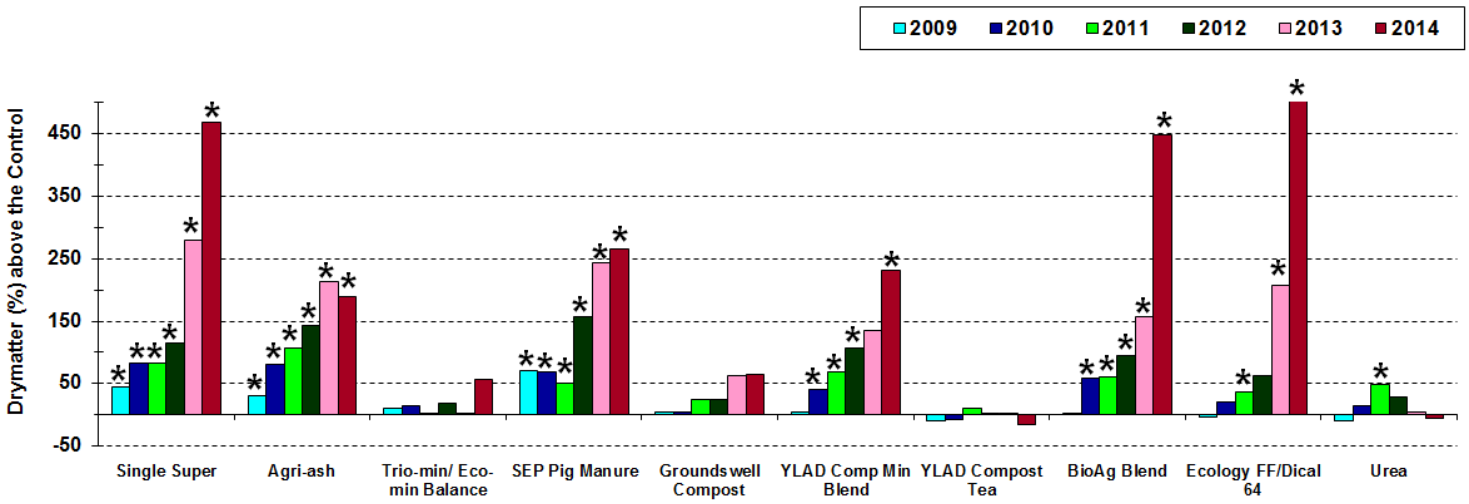

Figure 2: KIA-ORA

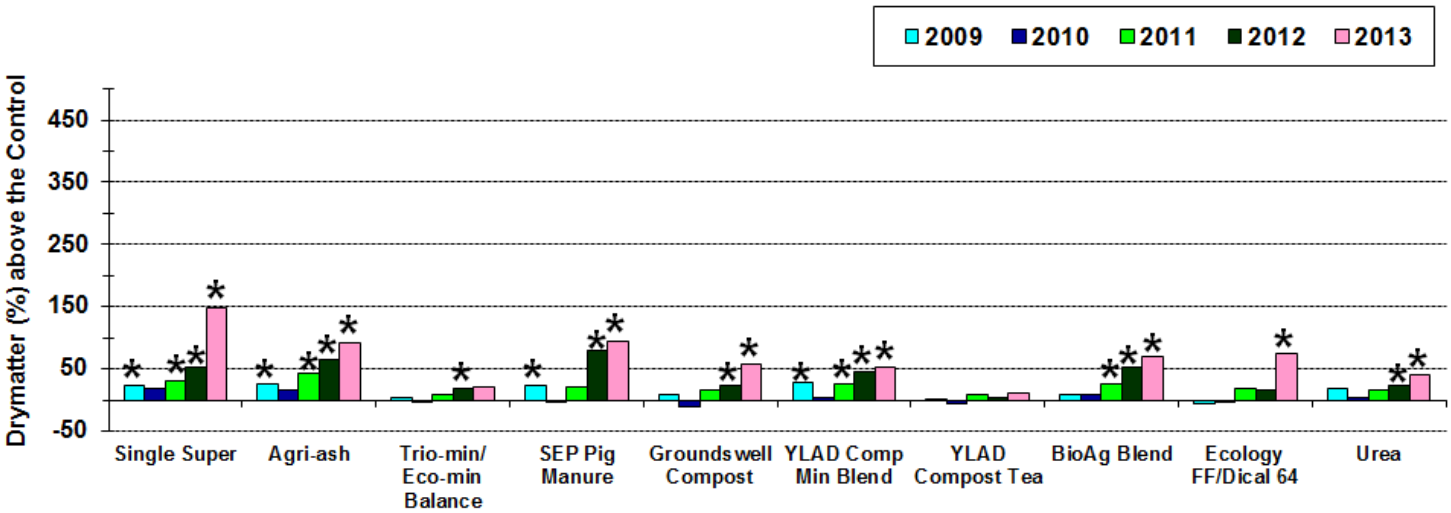

Figure 3: TE KOOTI

Notes relating to Herbage Mass Figures 1, 2 and 3

- Herbage mass data presented for 2009, 2010, 2011, 2012, 2013 and 2014 have been statistically analysed and an asterisk (*) indicates a significant difference when compared to the control (nil) treatment for the year in question. (P ≤ 0.05 using multiple pair-wise comparison tests).
- 2009 - 2012 data = total pasture grown for period Aug to Oct (see Table 6 for period of lockup each year).
- 2013 & 2014 data = total pasture grown for period May to Oct (see Table 6 for period of lockup each year).
- The figures presented must be interpreted in conjunction with Table 2 detailing rates of product spread over the 6 year period (2009 – 2014) and Tables 3 and 4 detailing total quantities of phosphorus and sulphur applied over the period of the study.

Fertiliser Pricing Summary 2009 to 2014

- Figures in Table 7 represent an annualised cost per hectare for each fertiliser based on a product price landed at Yass plus spreading cost on farm (all prices GST exclusive). Fertiliser price, freight and spreading costs are obtained in autumn of each year and are then used to calculate relative cost effectiveness of the various fertilisers based on winter-spring herbage production measured in each year.

Table 7 – Cost of fertiliser landed at Yass and spread on farm ($/ha) over period 2009 to 2014

Fertiliser Product	Annualised cost of product landed at Yass & spread on farm $/ha							
	2009	2010	2011	2012	2013	2014	Average Annualised Cost ($/ha/yr)	Application frequency
Single Super	44.33	43.50	51.63	46.50	49.75	47.25	47.16	Annual
Agri-ash	35.33	35.33	35.33	50.42	53.75	59.58	44.95	Every 6 years
Trio-min/Eco-min Balance	170.50	121.00	128.37	130.68	135.40	136.95	137.15	Annual
SEP Pig Manure	68.05	68.05	68.05	80.00	80.33	80.33	74.14	Every 3 years
Groundswell Compost	116.00	116.00	116.00	117.50	122.00	130.50	119.67	Every 2 years
YLAD Compost Mineral Blend								Annual
Glenroy	188.80	194.25	195.21	115.84	115.00	101.66	151.79	
Kia-Ora	188.80	194.25	221.32	147.74	115.00	109.37	162.75	
Te Kooti	188.80	194.25	195.21	133.35	115.00	n/a	165.32	
YLAD Compost Tea	39.30	39.30	39.50	39.50	39.50	39.50	39.43	Annual
BioAg Blend	134.74	49.50	52.85	53.90	55.65	59.55	67.70	Every 2 years
Ecology Fluid Fertiliser/Dical 64/Gypsum	59.00	59.00	69.84	70.24	77.37	77.37	68.80	Annual
Urea	71.70	20.67	71.00	75.00	74.50	67.00	63.31	Annual

Relative Cost Effectiveness of Fertiliser Products

- An economic comparison of each product tested has been presented in Figures 4 & 5, based on the spring herbage mass measured in 2012 & winter+spring herbage mass measured in 2014. Only products which grew significantly more pasture than the control treatment in each of those years have been presented. Any product which did not yield more than the control was regarded as not cost effective.

- The average annualised cost for each product appearing in Table 7 was used to determine the cost effectiveness of each product. The cost used in 2012 was an average of the annualised cost in each of the first 4 years (2009-2012) while the cost used in 2014 was an average of the annualised cost in each of the 6 years (2009-2014) of the trial. Note that the values presented for the cost of additional pasture grown over the control (nil) treatment are only a relative measure of the cost effectiveness of each product as it is based on pasture grown for only a short period, i.e. spring only in 2012 and winter + spring period in 2014. The relative cost was calculated by dividing the average annualised cost per ha (consisting of a product cost, freight charge to Yass and spreading cost all GST exclusive) by the herbage mass (kg DM/ha). Note that if the total amount of pasture grown throughout the year had been measured, the cost of additional pasture grown would have been much less.

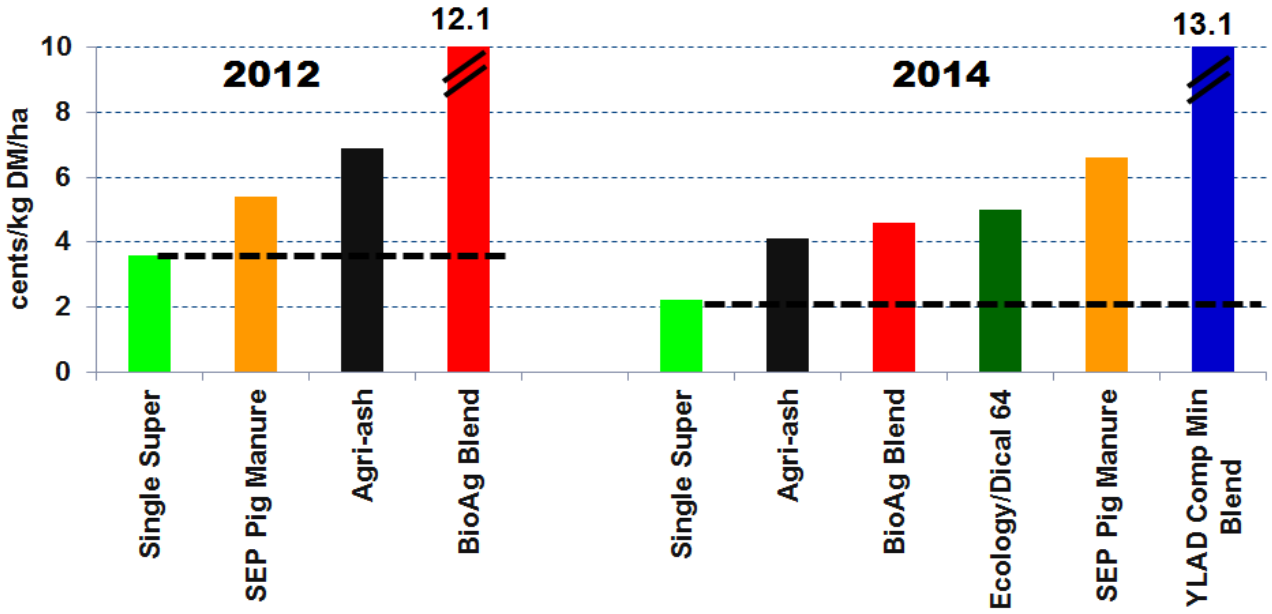

Figure 4: Glenroy site, Binalong - Economic comparison of fertiliser products in 2012 and 2014 showing the cost of additional pasture grown above the control within the measurement period in each of the years.

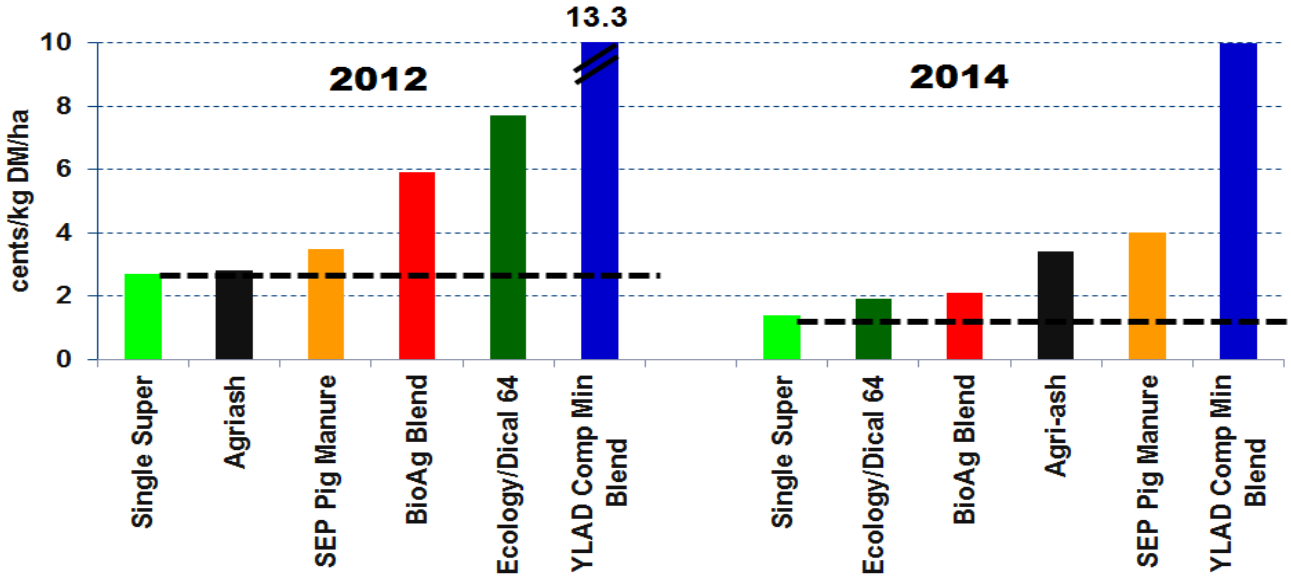

Figure 5: Kia-Ora site, Bookham - Economic comparison of fertiliser products in 2012 and 2014 showing the cost of additional pasture grown above the control within the measurement period in each of the years.

Key Messages – Cost Effectiveness Comparisons:

- In order to interpret Figures 4 and 5 it is important to look at results for one year at a time at each trial site and compare the difference of each product to single super in that year (i.e. follow your eye along the black dashed line within each year). The comparison is made to single super as it has been a product reliably used in the industry over many years and over the 6 year study and across all trial sites single super has proven to be reliably cost effective.

- One of the key drivers of pasture growth from the fertilizer products trialled is phosphorus (P). This response is in line with other pasture field research. The level of solubility of the P in the products and pattern of application has determined the relative cost effectiveness compared to single super.

- Products containing water soluble or citrate soluble P release plant available P into the soil allowing plants to access the P very quickly. In contrast products containing primarily citrate insoluble P release P for plant growth at a much slower rate. The rate of release is also dependent on soil pH and soil moisture content. Citrate insoluble P will be solubilised more quickly in wetter and more acid soils.

- Fertilizer products containing largely citrate insoluble P have shown to become closer in cost effectiveness to single super in the latter years of the study. For example products such as BioAg Blend, Ecology/Dical 64 and YLAD Compost Mineral Blend were not as cost effective as single super in the earlier years of the study but have proven to be closer to single super in the latter years.

- The pattern of application of each fertilizer product has also had a bearing on its relative cost effectiveness. For example SEP Pig Manure was applied every third year (applied in 2009 & 2012) and always resulted in a more cost effective result (similar to single super) in the year of application. In the two years after each application pasture productivity decreased causing it to be less cost effectiveness than single super. SEP Pig Manure contains P ranging in solubility levels but will always release more P under warm and wetter soil conditions.

- Agri-ash is a product containing a mix of both soluble and insoluble P. This product was applied at 2.5 t/ha once in autumn 2009. This product has proven to be close in relative cost effectiveness to single super since the commencement of the trial.

- The study has shown that some of the products tested are not economically competitive at the sites in question.

2012 & 2014 Spring Pasture Quality measured relative to unfertilised control treatment

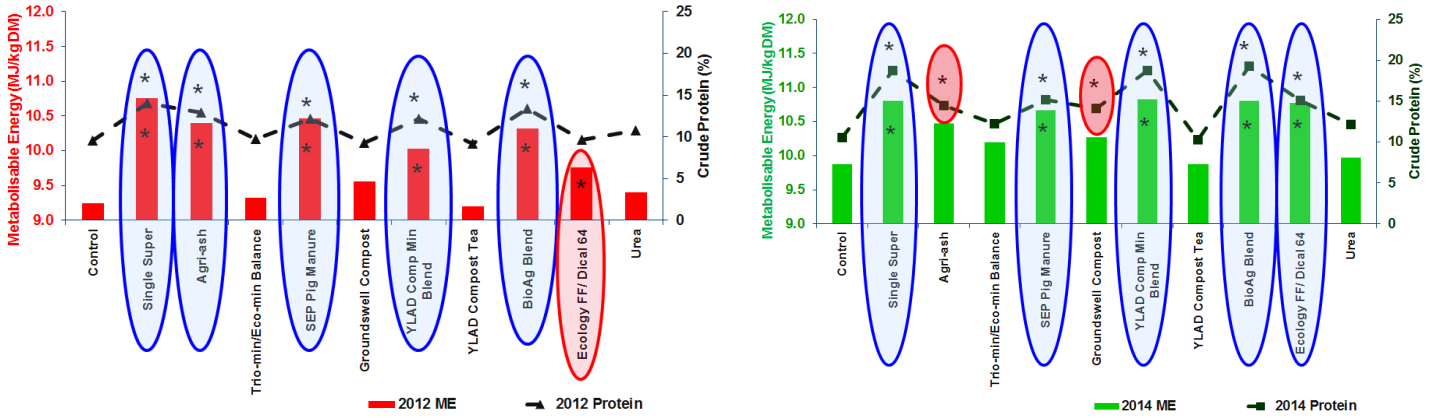

Figure 6: Glenroy, Binalong - Metabolisable Energy (MJ/kg DM) and Crude Protein % for pasture growing in Spring 2012 (graph on left) and Spring 2014 (graph on right) on respective fertiliser treatments as well as the unfertilised control treatment. Circled treatments highlight those measurements that were statistically different to the Control treatment.

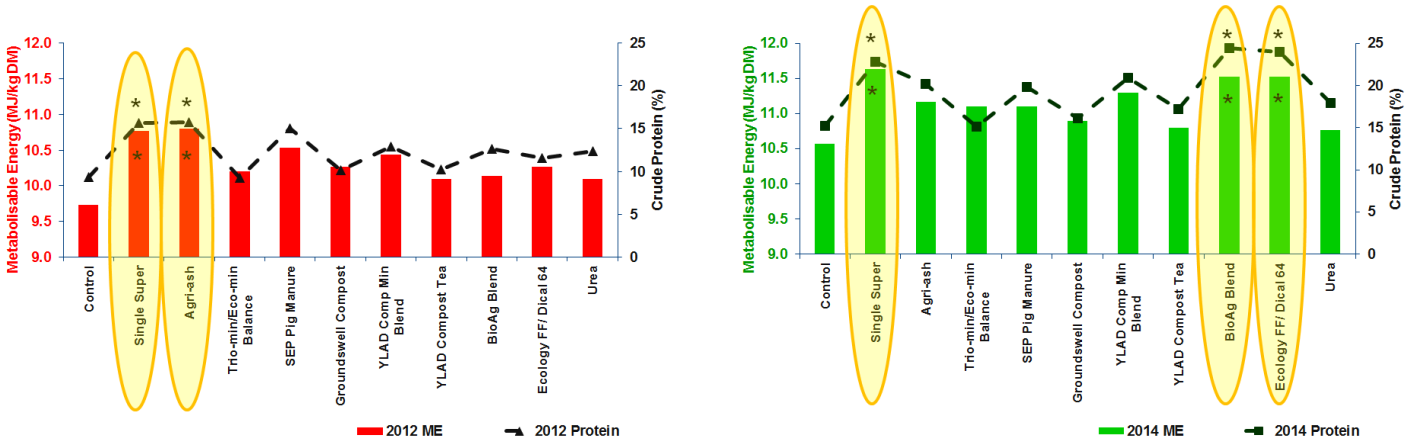

Figure 7: Kia-Ora, Bookham - Metabolisable Energy (MJ/kg DM) and Crude Protein % for pasture growing in Spring 2012 (graph on left) and Spring 2014 (graph on right) on respective fertiliser treatments as well as the unfertilised control treatment. Circled treatments highlight those measurements that were statistically different to the Control treatment.

Key Messages – Pasture Quality Comparisons:

- All pasture samples were analysed using the Feed Quality Testing Service laboratory, NSW DPI, Wagga Wagga.
- Data presented has been statistically analysed and an asterisk (*) indicates a significant difference when compared to the control (nil) treatment ($P \leq 0.05$ using multiple pair-wise comparison tests).
- Those treatments without an asterisk indicate the result is not different from the control treatment.
- The fertilizer treatments showing a significantly higher value than the Control treatment for Metabolisable Energy and Crude Protein % are largely the same treatments that grew the highest levels of herbage for the period of measurement.

Soil Available Phosphorus (Colwell) Results

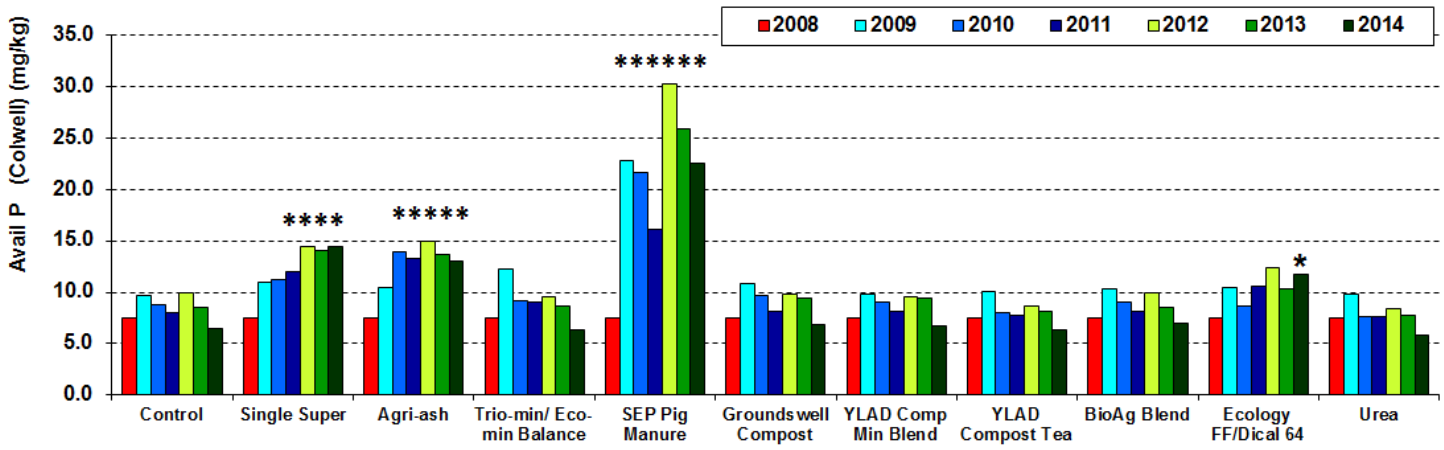

Figure 8: GLENROY

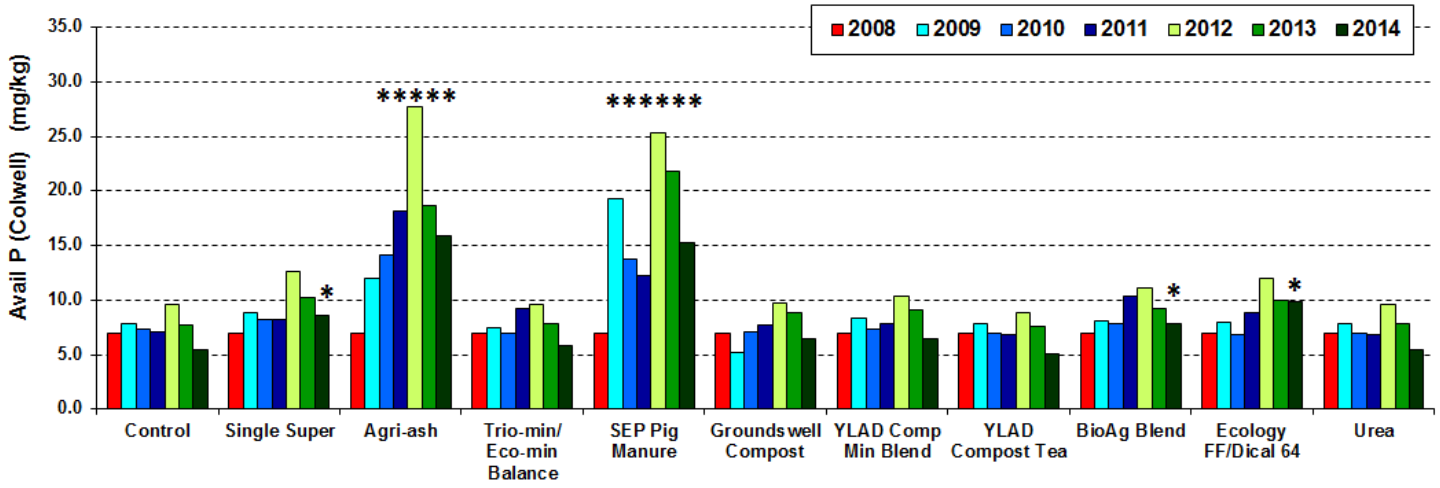

Figure 9: KIA-ORA

Key Messages – Soil Available Phosphorus (Colwell):

- In late spring 2008, at the commencement of the trial available phosphorus (Colwell) was measured (red bar) before any fertiliser product was spread. The results for 2009 (light blue), 2010 (sky blue), 2011 (dark blue), 2012 (light green), 2013 (green) and 2014 (dark green) were measured in late spring of each respective year. All soil samples have been tested using the NSW DPI Soil Testing Service, Wollongbar.

- Data presented has been statistically analysed and an asterisk (*) indicates a significant difference when compared to the control (nil) treatment ($P \leq 0.05$ using multiple pair-wise comparison tests).

- 2008 - 2013 soil available phosphorus (Colwell) test results for Te Kooti trial site have not been analysed at this point in time.

- Building available soil P (Colwell) at all sites is likely to be a function of (i) the amount of P applied in each product (this varies among the products; Tables 3 and 4), (ii) herbage production leading to P removal in harvested pasture, (iii) the rate of release of available P from the various fertilizer products and (iv) the rate at which the soil accumulates P in less plant-available forms (this is sometimes incorrectly referred to as “P-fixation”).

- Kia-Ora has been a wetter site than Glenroy and has resulted in more herbage grown for similar amounts of fertilizer applied and probably also longer (warm & moist) conditions where soil phosphate reactions are occurring. This probably explains why we are seeing differences in the available soil P (Colwell)

levels between Kia-Ora and Glenroy under equivalent treatments (e.g. single super - which has increased Colwell P more at Glenroy, and Agri-ash - which appears to have increased Colwell P by ***slightly*** more at Kia-Ora).

- Products containing citrate insoluble P are likely to be more readily solubilised in moist acid soils. Both Glenroy and Kia-Ora sites have very acid soils however Kia-Ora was a significantly wetter and slightly more acid site than Glenroy. Consequently, we might see products like Agriash, BioAg Blend and Ecology FF/Dical 64, which contain substantial quantities of citrate insoluble P, to result in higher soil P levels at Kia-Ora compared to Glenroy despite the same application rates at both sites. This has been the case for Agri-ash, but not for BioAg Blend or Ecology FF/Dical 64. However, BioAg Blend has also not raised soil available P levels significantly above the control treatment except on one isolated occasion, so there may be other factors at play: e.g. insufficient P applied in this product to counter the factors that remove P from the available pool (i.e. pasture growth and harvest and P accumulation in less available forms). Ecology FF/ Dical 64 has resulted in marginally higher soil P levels at Glenroy compared to Kia-Ora also suggesting that at Kia-Ora factors that remove P from the available pool are greater than what is being fed into the soil available P pool.

- Again the pattern of application is also helping to determine the rise and fall of available soil P (Colwell) levels. For example SEP Pig manure which is applied every third year is showing a sharp increase in available P in the first year of application (2009) and then a decline in the following two years prior to building again in 2012 when the second application occurred. The product Agri-ash was applied as a one off application in year one. As mentioned earlier it contains both citrate soluble and insoluble P and at both Glenroy and Kia-Ora has peaked in available soil P (Colwell) in 2012 and then declined in the years following.

Soil Available Sulphur (KCl_{40}) Results

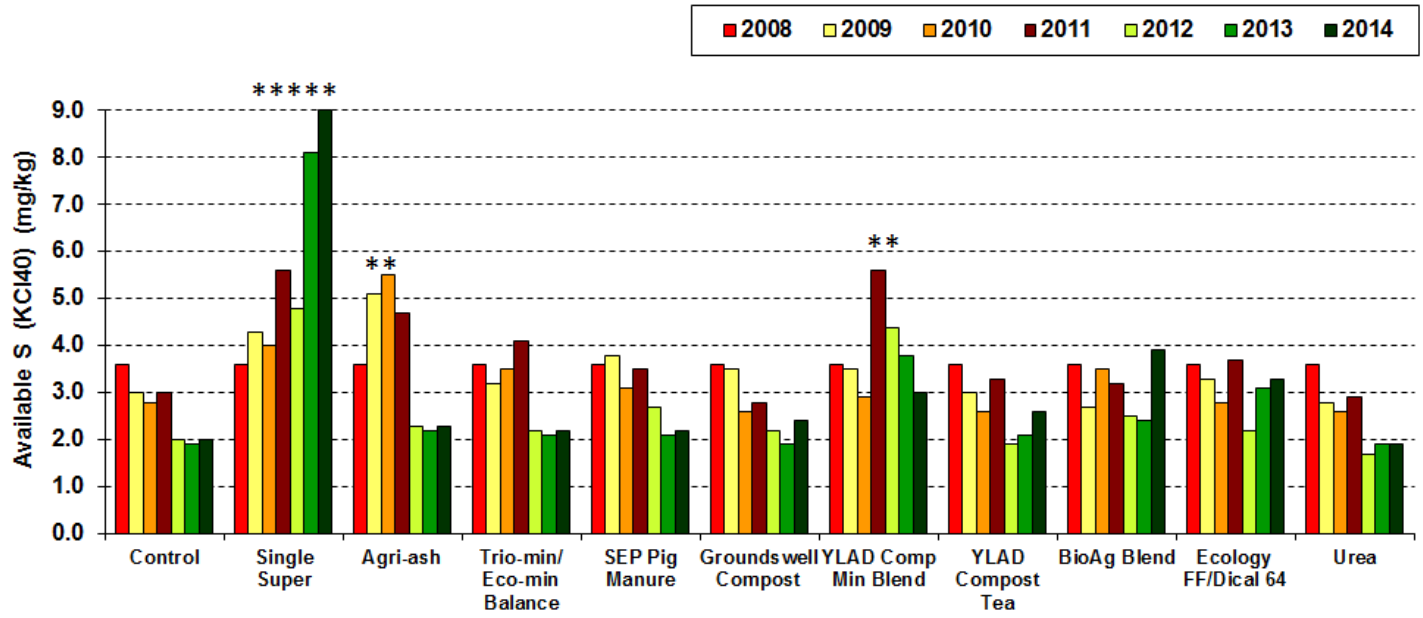

Figure 10: GLENROY

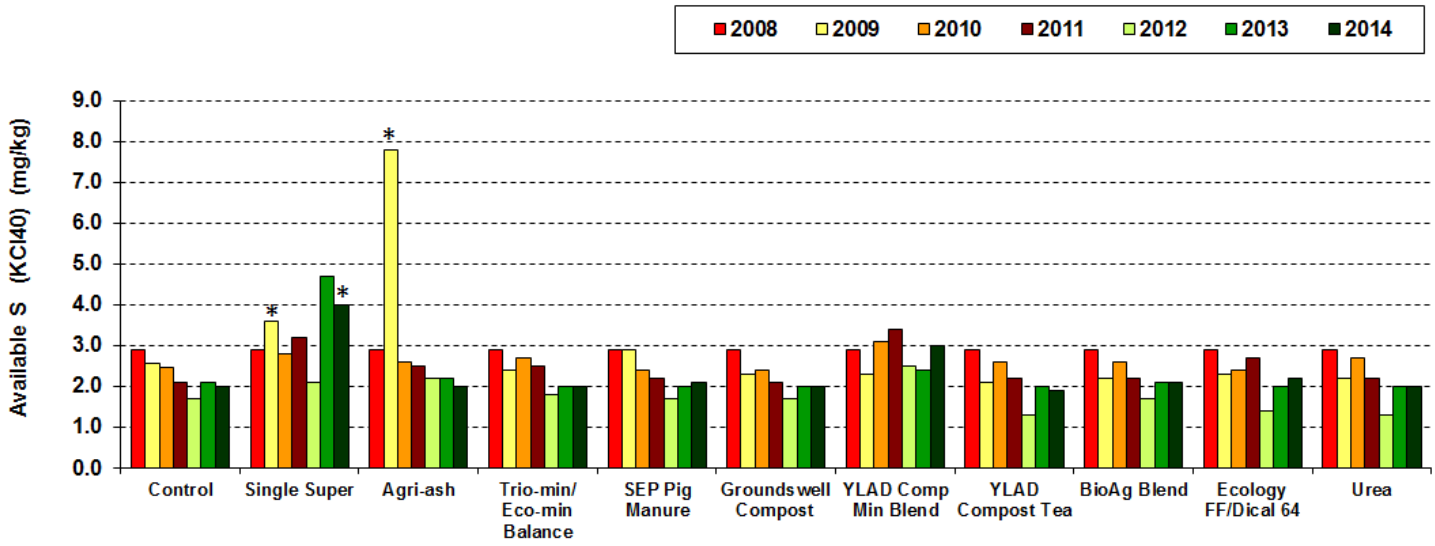

Figure 11: KIA-ORA

Key Messages – Soil Available Sulphur (KCl_{40}):

- In late spring 2008, at the commencement of the trial available sulphur (S) (KCl_{40}) was measured (red bar) before any fertiliser product was spread. The results for 2009 (yellow bar), 2010 (orange bar), 2011 (brown bar), 2012 (light green), 2013 (green bar) and 2014 (dark green bar) were measured in late spring of each respective year. All soil samples have been tested using the NSW DPI Soil Testing Service, Wollongbar.

- Data presented has been statistically analysed and an asterisk (*) indicates a significant difference when compared to the control (nil) treatment ($P \leq 0.05$ using multiple pair-wise comparison tests).

- Available sulphur (KCl_{40}) test results for Te Kooti trial site have not been analysed at this point in time.

- Unlike P, S is a very mobile nutrient in the soil. The fertilizer products containing S consist of S in the sulphate form which is readily plant available but also easily leached through the profile with significant

rainfall. Hence the drier the site the more likely S will build with S applications due to less leaching as well as less herbage production (i.e. less S used for growth). It is clear that S has built more so at Glenroy than at Kia-Ora in treatments that have received regular applications of sulphate S (i.e. single super, YLAD Compost Mineral blend, BioAg Blend, Ecology FF/Dical 64).

- The available soil S levels in 2014 were highest under the single super treatment. However note the large difference in readings between the Glenroy and Kia-Ora sites. The higher reading at Glenroy may in part be explained due to the fact it has been a drier site with less pasture growth hence less use of S by plants and less leaching of available soil S.

- Agri-ash showed a peaking of available soil S in the year of application at Kia-Ora followed by a significant drop in the years following. Significant quantities of plant available S were applied in autumn 2009 explaining this peak at Kia-Ora. 2009 was then followed by an extremely wet year and sulphate S may potentially have leached lower in the soil profile. Following the rapid decrease in available soil S in 2010, there has been a further slow decline.

- YLAD Compost Mineral has also shown to have built soil available S particularly so on the Glenroy site in the earlier years again most likely due in part to it being a drier site with less pasture growth. However, for this treatment more gypsum has been applied to the Kia-Ora site over the life of the study compared to the Glenroy site which helps to explain the holding of available soil S levels compared to a steady decline at Glenroy.

Soil Carbon Results

- Total soil carbon % has been measured on all trial sites using the Dumas (LECO) method. Statistical analysis has been completed on data collected on both Glenroy and Kia-Ora sites over the period 2008 to 2014. There has been no statistical difference found when comparing each fertiliser product to the unfertilised control treatment.

- Statistical analysis has not yet occurred on data collected from Te Kooti trial site for period 2008 to 2013.

- Statistical analysis has also not yet occurred on labile soil carbon measurements taken on all trial sites for the period 2008 to 2014.

Soil Biology Results

- Two soil biology tests have been taken annually in late spring. These include a Fluorescein Diacetate Activity test (FDA) and a Biomass Carbon test. The tests were conducted by the NSW DPI Wollongbar Laboratory. Both tests are ‘point in time’ tests and comparisons can only be made across treatments within each year’s set of results. The FDA test show whether the microbes are active or not while the Biomass Carbon test is a measure of the weight of carbon present in the soil microbes.

- Statistical analysis of the results for the FDA and Biomass Carbon test over the six year period, 2009 to 2014 on both the Glenroy and Kia-Ora trial sites indicate that no product has consistently resulted in higher or lower microbial status compared to the control treatment.

- The 2009 - 2013 data collected on the Te Kooti trial site has not been statistically analysed at this point in time.

Soil pH($CaCl_2$) and Aluminium (Al) % Results

Table 8 - Rates of lime applied over the period 2009 to 2014 for products containing lime

Product		Lime Applied (t/ha)					
	2009	2010	2011	2012	2013	2014	Total
Agri-ash	1.63	Nil	Nil	Nil	Nil	Nil	1.63
YLAD Compost Mineral Blend – 'Glenroy'	0.5	0.48	0.5	Nil	Nil	Nil	1.48
YLAD Compost Mineral Blend – 'Kia-ora'	0.5	0.48	0.75	0.25	Nil	Nil	1.98
BioAg Blend	0.4	Nil	Nil	Nil	Nil	Nil	0.4
Trio-min/Eco-min Balance	Nil	0.03	0.06	0.03	0.03	0.03	0.18

Table 9 – Soil pH($CaCl_2$) & Al % in 0–10 cm for treatments displaying a lime effect on Glenroy

GLENROY	pH (CaCl)							Aluminium %						
PRODUCT	2008	2009	2010	2011	2012	2013	2014	2008	2009	2010	2011	2012	2013	2014
Control	4.2	4.1	4.3	4.4	4.4	4.3	4.5	28.0	28.9	26.4	23.7	21.7	23.7	21.9
Agri-ash	4.2	4.5	5.3	5.2	4.9	4.8	4.8	24.6	11.4	2.6	2.8	5.3	4.7	4.9
YLAD Compost Mineral Blend	4.2	4.2	4.7	4.9	4.9	4.8	4.8	27.5	19.8	12.3	5.1	3.9	4.7	5.3
BioAg Blend	4.2	4.3	4.6	4.6	4.6	4.5	4.5	25.8	13.7	13.7	13.2	13.4	12.7	12.5
Trio-min/Ecomin Balance	4.2	4.1	4.4	4.5	4.4	4.4	4.4	19.4	19.6	19.8	19.3	13.1	16.7	14.2
SEP Pig Manure	4.2	4.1	4.5	4.5	4.4	4.4	4.5	22.6	20.6	19.7	19.2	12.3	15	13.4

Table 10 – Soil pH($CaCl_2$) & Al % in 0–10 cm for treatments displaying a lime effect on Kia-Ora

KIA-ORA	pH (CaCl)							Aluminium %						
PRODUCT	2008	2009	2010	2011	2012	2013	2014	2008	2009	2010	2011	2012	2013	2014
Control	4.0	3.9	4.3	4.3	4.4	4.3	4.4	31.2	26.6	29.0	29.3	18.7	17.6	19.3
Agri-ash	4.0	4.8	4.8	4.8	4.7	4.6	4.7	31.2	1.0	9.7	6.2	3.8	5.2	5.8
YLAD Compost Min Blend	4.0	4.0	4.4	4.8	5.0	4.7	4.8	31.2	19.4	17.8	6.7	3.4	3.4	4.3
BioAg Blend	4.0	4.0	4.3	4.4	4.5	4.4	4.5	31.2	23.0	23.2	20.9	10.6	14.2	13.7
Trio-min/Ecomin Balance	4.0	3.9	4.3	4.4	4.4	4.4	4.5	31.2	27.2	28.2	22.0	16.3	11.5	13.5
SEP Pig Manure	4.0	4.0	4.3	4.3	4.5	4.4	4.5	31.2	19.9	25.8	23.8	13.6	11.3	12.1

Key Messages – Soil $pH_{(CaCl2)}$ and Aluminium %:

- All soil samples have been tested using the NSW DPI Soil Testing Service, Wollongbar. Data presented has been statistically analysed and a light blue shading of a value indicates a significant difference when compared to the control (nil) treatment ($P \leq 0.05$ using multiple pair-wise comparison tests).

- Statistical analysis has not yet occurred on data collected from Te Kooti trial site for period 2008 to 2013.

- Initial soil pH across all sites ranged between pH_{CaCl} 4.0 and 4.2 and Al levels at all sites varied between 15 and 33%. The products containing lime, i.e. Agri-ash, YLAD Compost Mineral Blend and BioAg Blend have all raised soil pH and lowered Al levels as expected. Table 8 details the amounts of lime applied in these products from 2009 to 2011. Table 9 and 10 detail the change in soil pH_{CaCl} and Al % figures at 'Glenroy' and 'Kia-Ora' respectively. Trio-min/Eco-min Balance and SEP Pig Manure also showed a significant lowering of Al% occurring at Glenroy in 2013 and 2012 respectively. All other products have shown no effect on soil pH and Al levels.

- Despite the raising of soil pH and lowering of Al on plots receiving these three products there was no obvious increase in spring herbage mass solely due to the lime applied. This result is in line with other on-farm demonstrations conducted by NSW DPI in the Binalong district looking at the effects of applying single superphosphate and lime on native pasture and livestock production.

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Copying of notes: