



Local Land
Services
South East

Importance of Soil Nutrients in Grazing Systems

Fiona Leech
South East Local Land Services
Yass

Major & Micro Nutrients for Plant Growth



Major Nutrients

Nitrogen
Phosphorus
Potassium
Sulphur
Calcium
Magnesium

*More likely to be associated with toxic levels.

Micro Nutrients

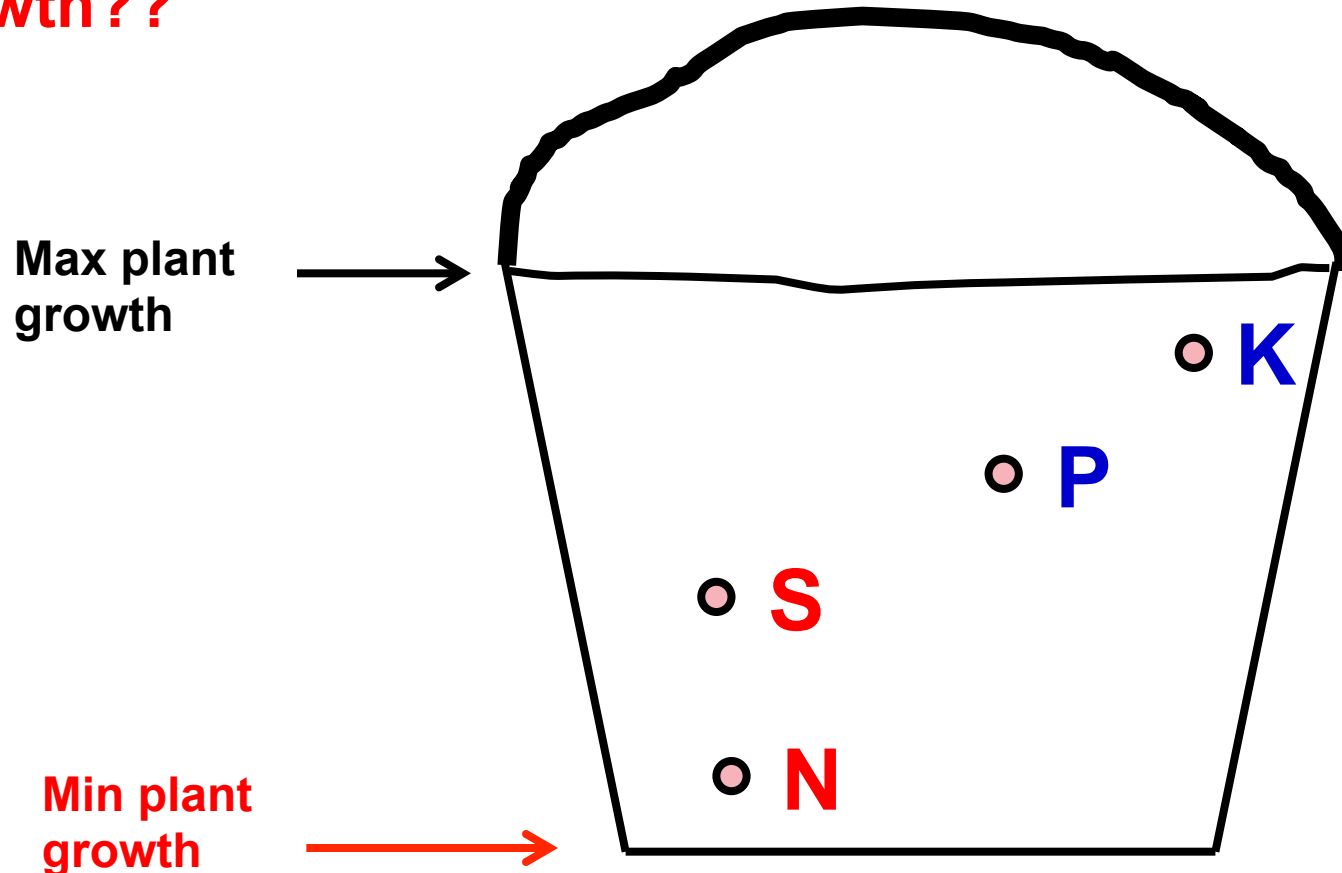
Molybdenum
Zinc
Copper
Iron
Boron
Nickel
Chlorine

* Manganese

Law of the Minimum

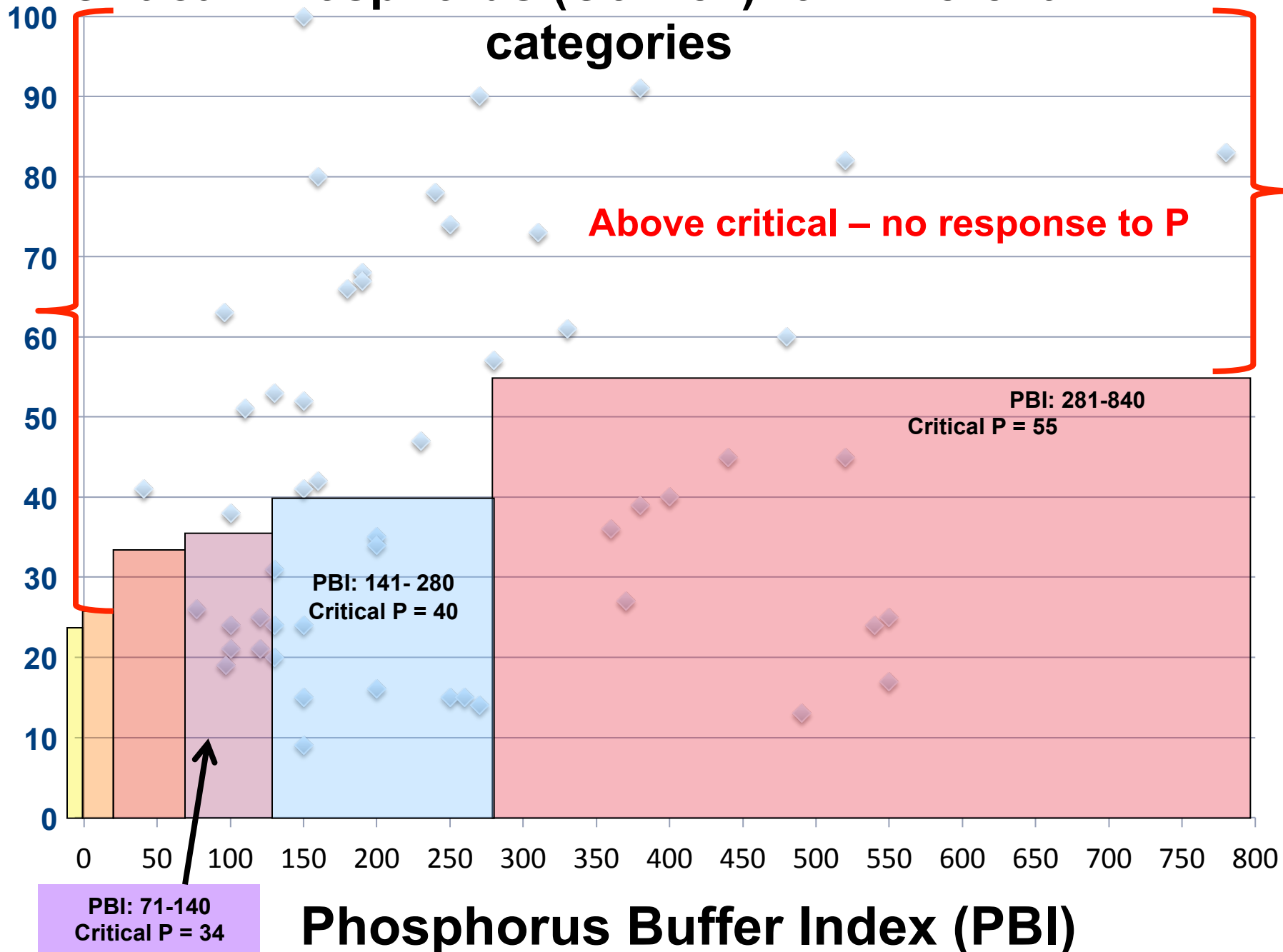
Plant growth likened to a bucket holding water

What is the major factor holding back your pasture growth??

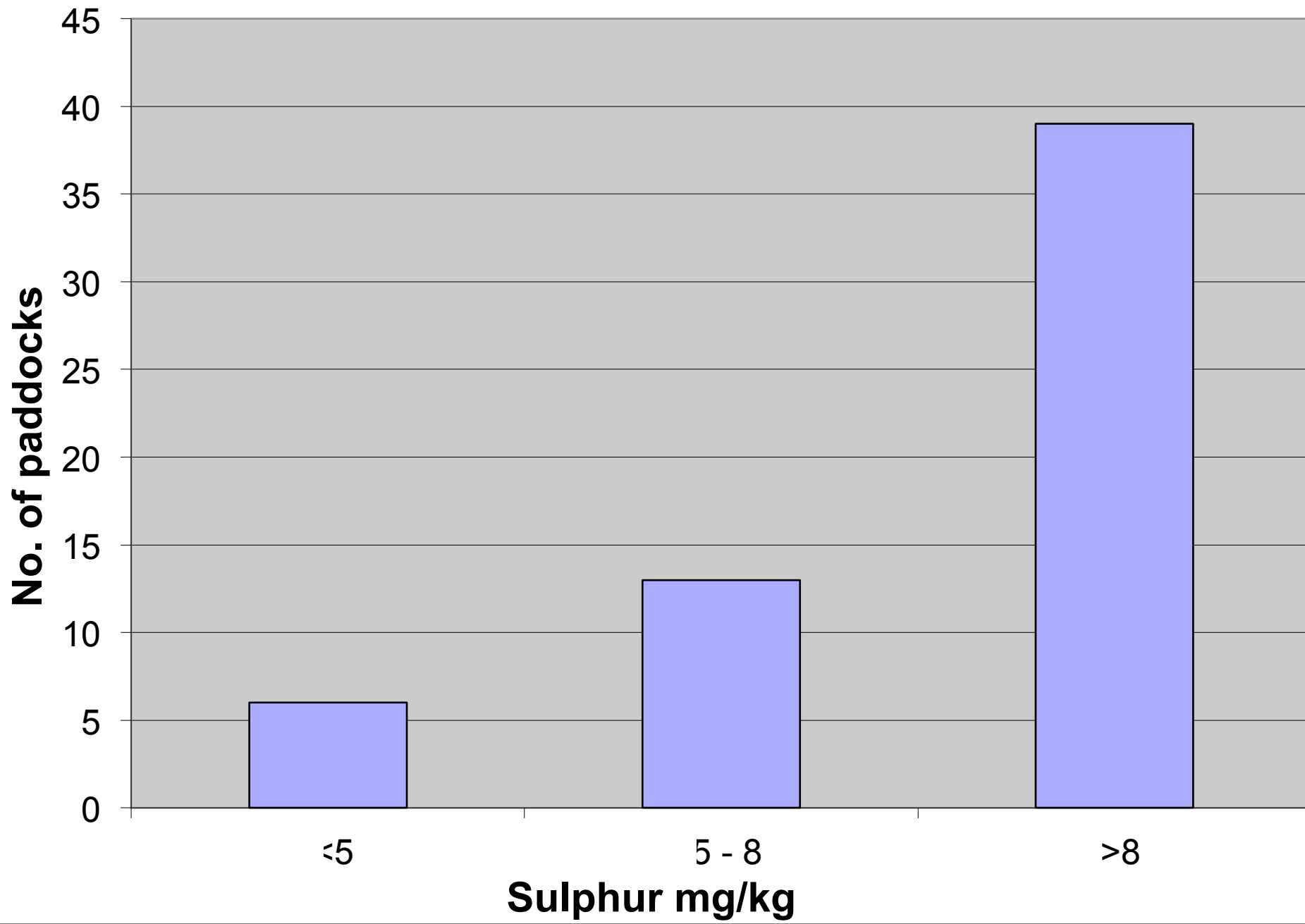


Critical Phosphorus (Colwell) for Different PBI categories

Phosphorus (Colwell)



Frequency of Sulphur KCl_{40} Healthy Soils Project



SOIL NUTRIENT STATUS

Importance of Phosphorus (P)

Control
(all nutrients)

-P

-Ca

-K

-Mg

-N

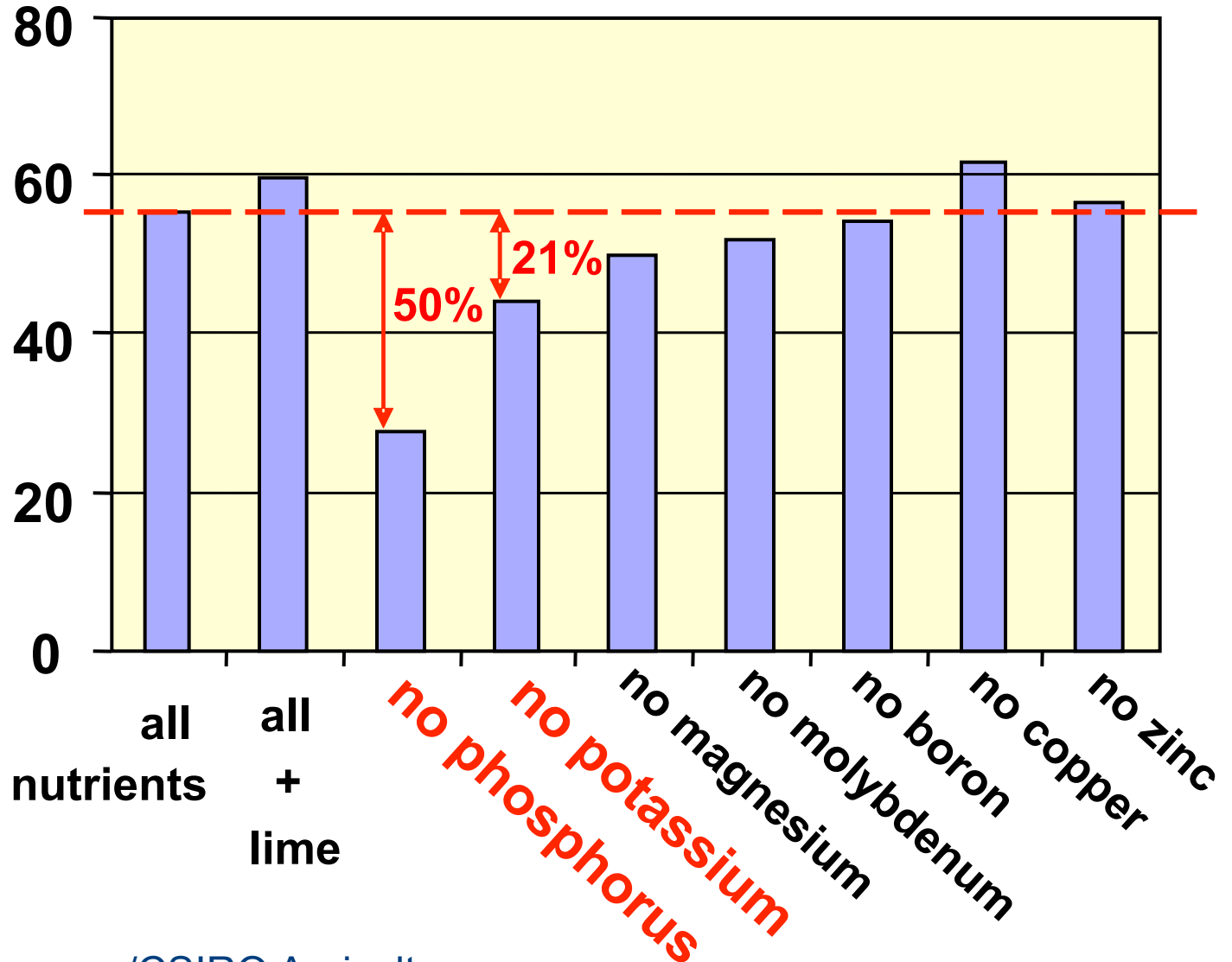


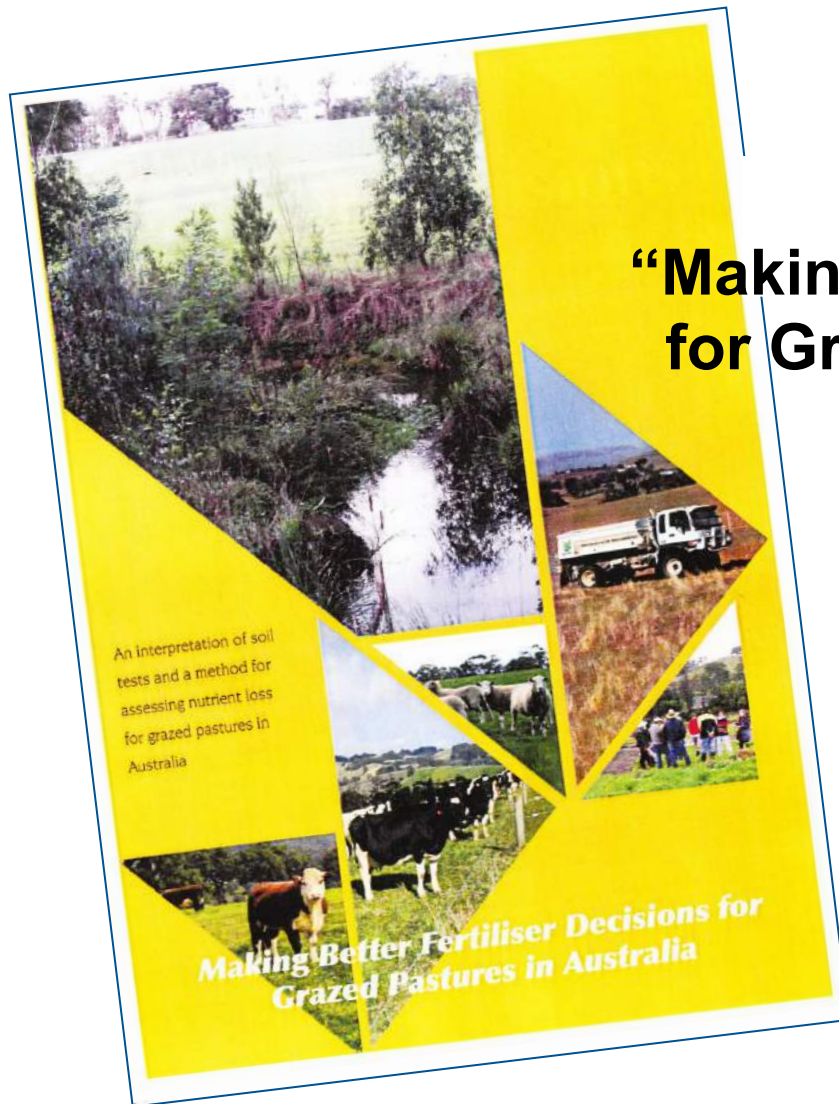
Growth of annual ryegrass in unlimed topsoil from “Kia-Ora” (1 Sep. 03)

Source: Richard Simpson/CSIRO Agriculture

Subclover-based pasture ("Kia-Ora")

**Pasture
growth
rate**
(Sep-Oct 2002)
(kg/ha/day)





“Making Better Fertilizer Decisions for Grazed Pastures in Australia”

available on the web

<http://tinyurl.com/h4vda5d>

Key Soil Nutrients Important

- **Nitrogen** addressed via presence of legumes in pastures or use N fertilizer
- **Phosphorus** important – addressed using fertilizer, key for legume growth
- **Sulphur** important – automatically addressed if using Single Super
- **Potassium** – may be limiting where hay cutting of pasture paddocks as well as on sandier soils.
- **Molybdenum** – trace nutrient essential for legumes to effectively fix atmospheric N into soil. Apply once every 5 years.

Use soil testing , paddock history & performance over time to guide you

Use test strips on farm to clarify responses to 2nd & 3rd order nutrients



Native Pasture & Alternative Fertilizer Trial – 6 year summary



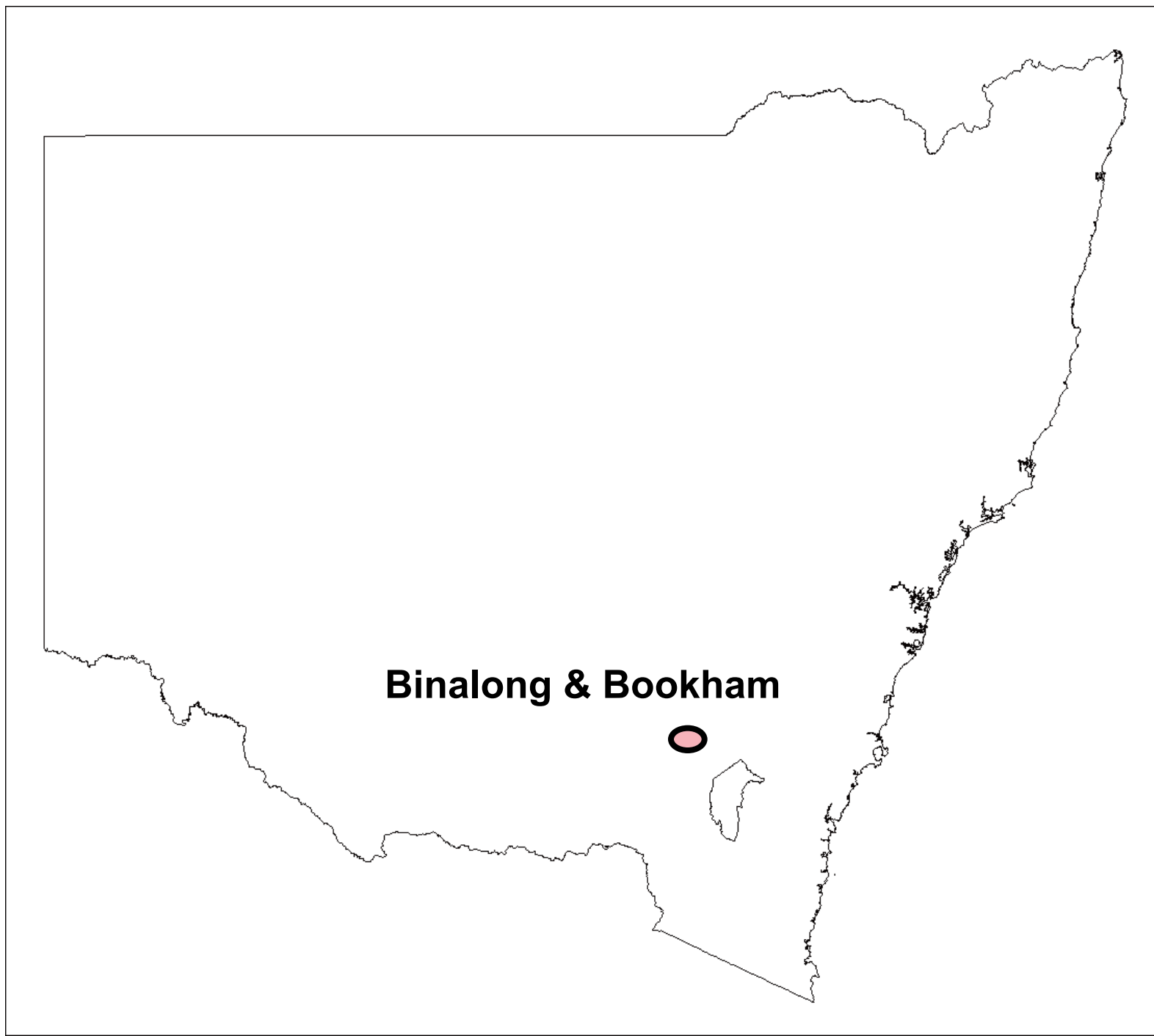
Fiona Leech

South East

Local Land Services, Yass

Technical Support:

**Donna Reid, Rob Gorman, Phil Graham,
Vicki Saville, Jacinta Christie, Bev Orchard,
Rob Smith, Janelle Jenkins, Richard Simpson,
Adam Stefanski, Alan Richardson, Jo Powells,
Vicki Saville, Matthew Lieschke, Felicity Roos,
Michelle Borland, Colin Shields, Dan Hartwell
Melissa Henry, Jonathon Berryman and
Hollie Baileau**



Binalong & Bookham

Trial Details

- **3 Sites -**
 - “Glenroy”, Binalong – 6 years data
 - “Kia-Ora”, Bookham – 6 years data
 - “Te Kooti”, Bookham – 5 years data
- **11 Treatments / 3 replicates**
- **Small plots (10 m x 2 m)**

Fertilizer Treatments

Control (nil)
Single Superphosphate
Agri-ash
Trio-min/ Eco-min Balance
Groundswell Compost
SEP Pig Manure
YLAD Compost Mineral Blend
YLAD Compost Tea
BioAg Blend
Ecology Fluid Fertilizer/ Dical 64/ Gypsum
Urea

- A range of mineral & liquid fertilizers, rock phosphates, organic & compost materials (eg. manures) & microbial-based products (eg. microbial teas)
- Applied (2009 to current) according to fertilizer company recommendations
- Comparisons made to the single superphosphate treatment & effectiveness relative to nil control

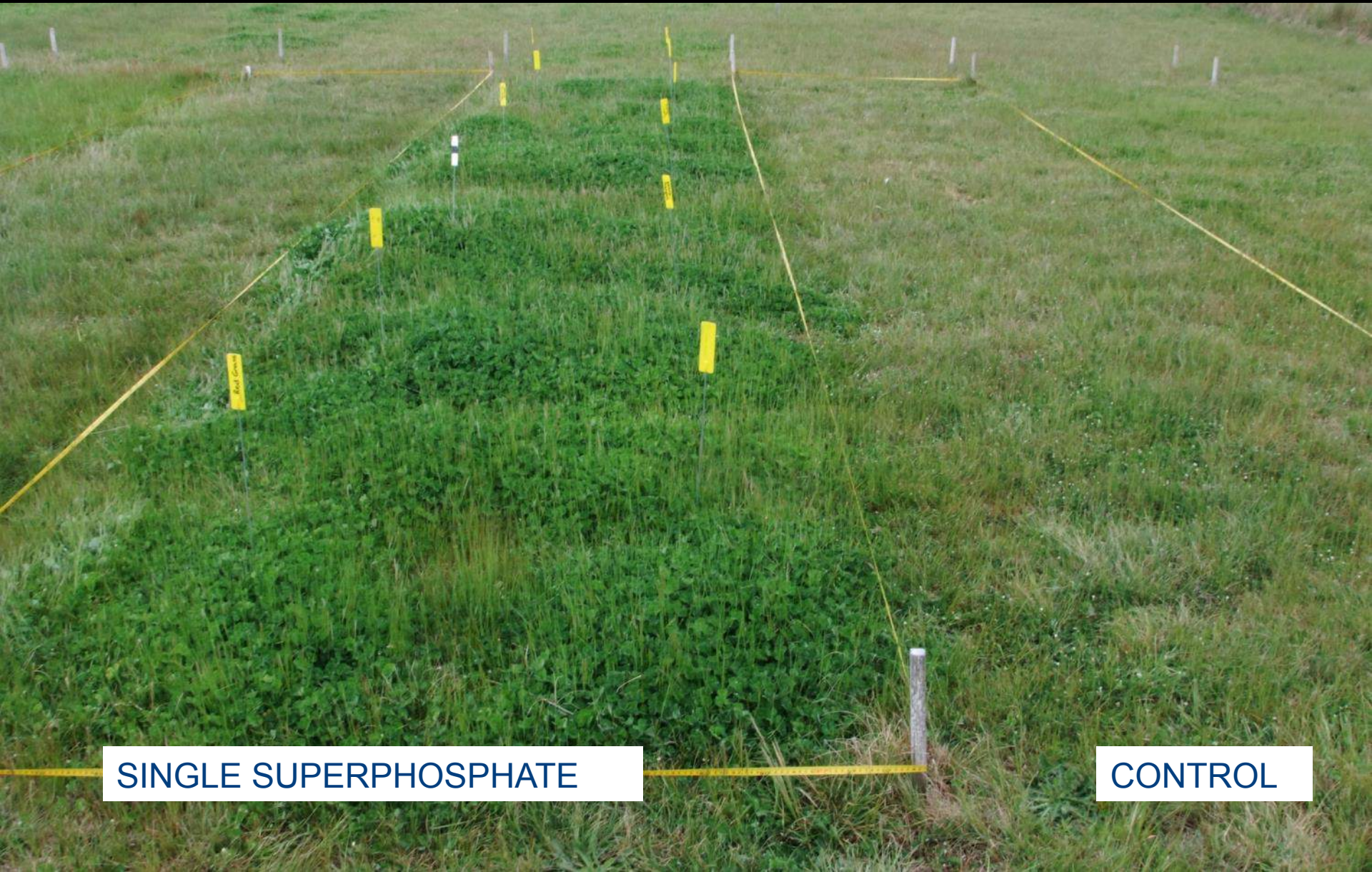
Spreading of fertilizers - autumn



Pasture Lock-up “Glenroy”: 15 May 2013 in preparation for winter/spring biomass measurements



Oct 2012 – Spring Pasture Quality Measurements



SINGLE SUPERPHOSPHATE

CONTROL

‘Kia-Ora’ Bookham

1st Sept 2015



Sep 2014 – Spring Biomass Measurements



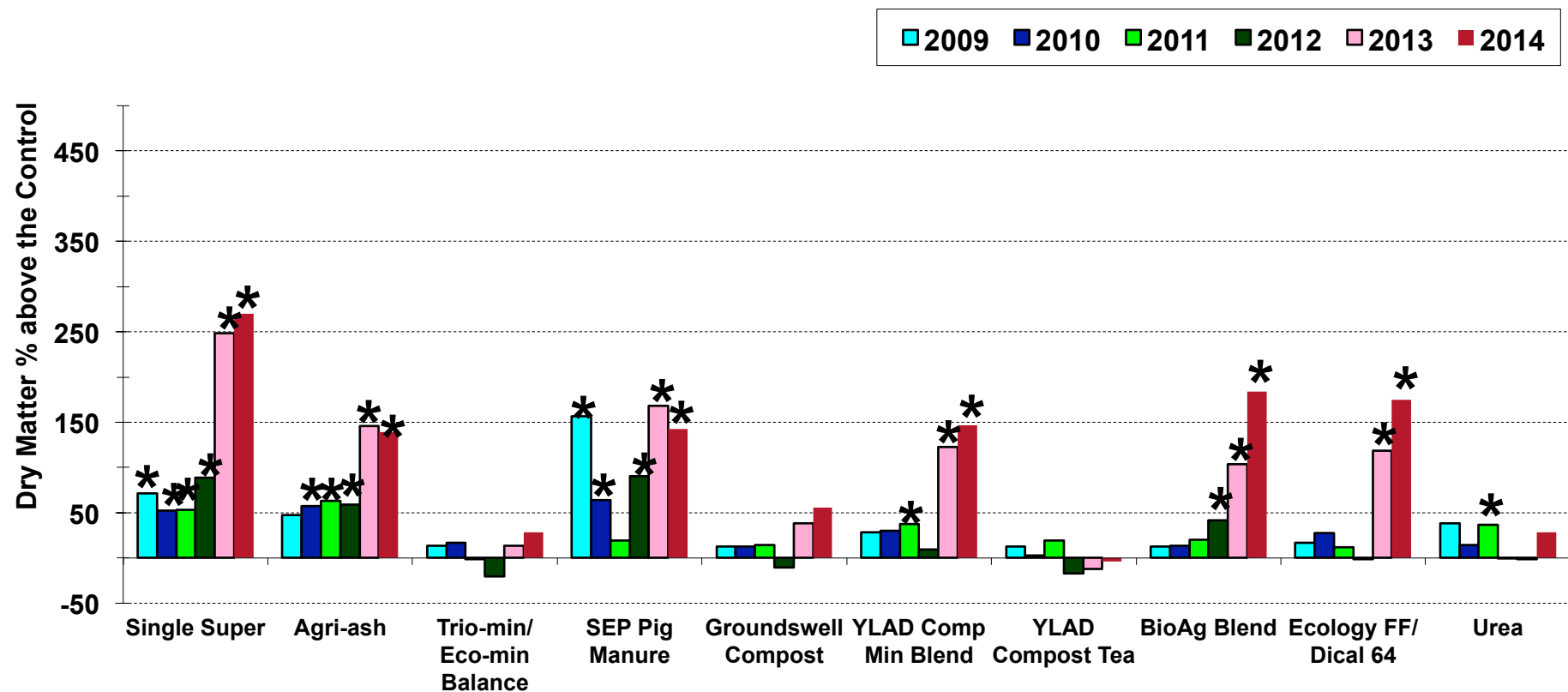


Nov 2010 - Spring Biomass Measurements

Nov 2012 – Annual Chemical & Microbial Soil Testing

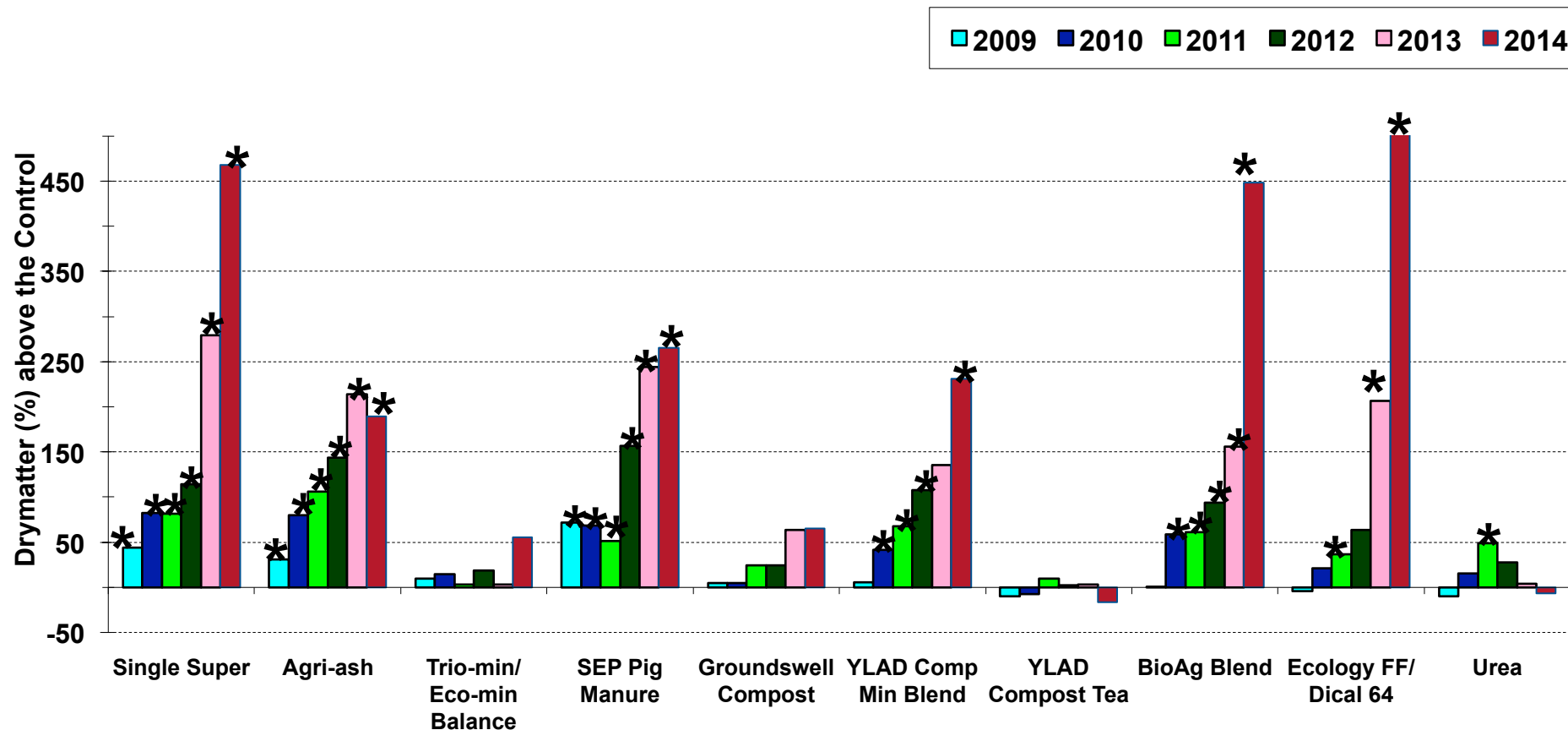


RESULTS for 2009 - 2014: Spring Herbage Mass – GLENROY



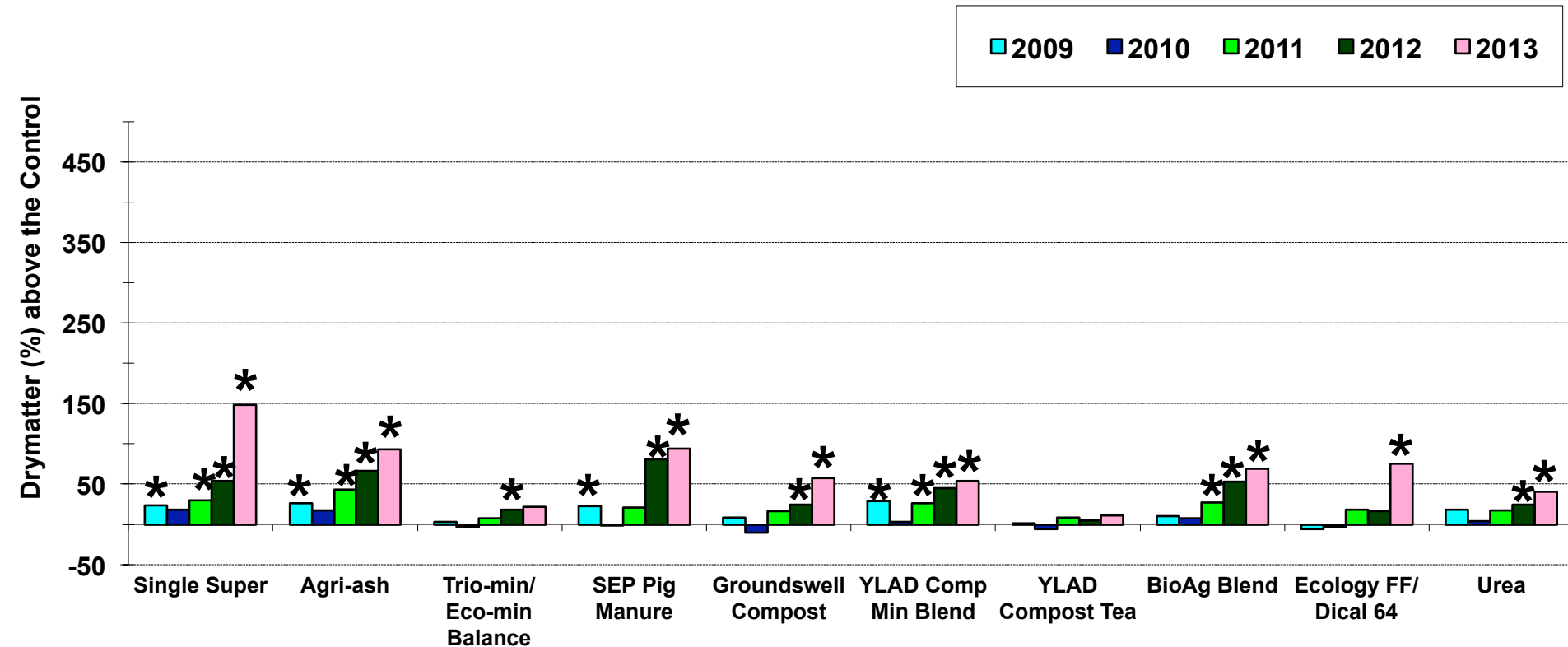
*** indicates significant difference from control in that year
P ≤ 5% (using multiple comparison tests)**

RESULTS for 2009 - 2014: Spring Herbage Mass – KIA-ORA



*** indicates significant difference from control in that year
 $P \leq 5\%$ (using multiple comparison tests)**

RESULTS for 2009 - 2013: Spring Herbage Mass – TE KOOTI



*** indicates significant difference from control in that year
P ≤ 5% (using multiple comparison tests)**

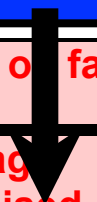
Fertiliser Costs 2014

Freight charges will vary for individuals

Large variation in spreading costs across products

PRODUCT	RATE t/ha	RATE L/ha	COST LANDED YASS \$/t or \$/ 1000 L	PRODUCT COST \$/ha	SPREAD COST \$/ha	TOTAL COST \$/ha	APPLIC'N FREQ.	ANNUALISED COST/ha
Single super	0.125		326	41	6.50	48	1	48
Agriash	2.5		125	313	45	358	6	60
Eco-min Balance	0.3		403	121	16	137	1	137
SEP pig manure	4.0		47	188	53	241	3	80
Groundswell compost	3		72	216	45	261	2	131
YLAD compost mineral blend	0.4		161	64	45	109	1	109
YLAD Bio TX 500 compost tea extract		100	295	30	10	40	1	40
BioAg Blend	0.3		332	100	19.5	120	2	60
Ecology FF/Dical 64	0.155		394	61	16	77	1	77
Urea	0.1		570	57	10	67	1	67

2009-14 Average Annualised Cost (\$/ha)

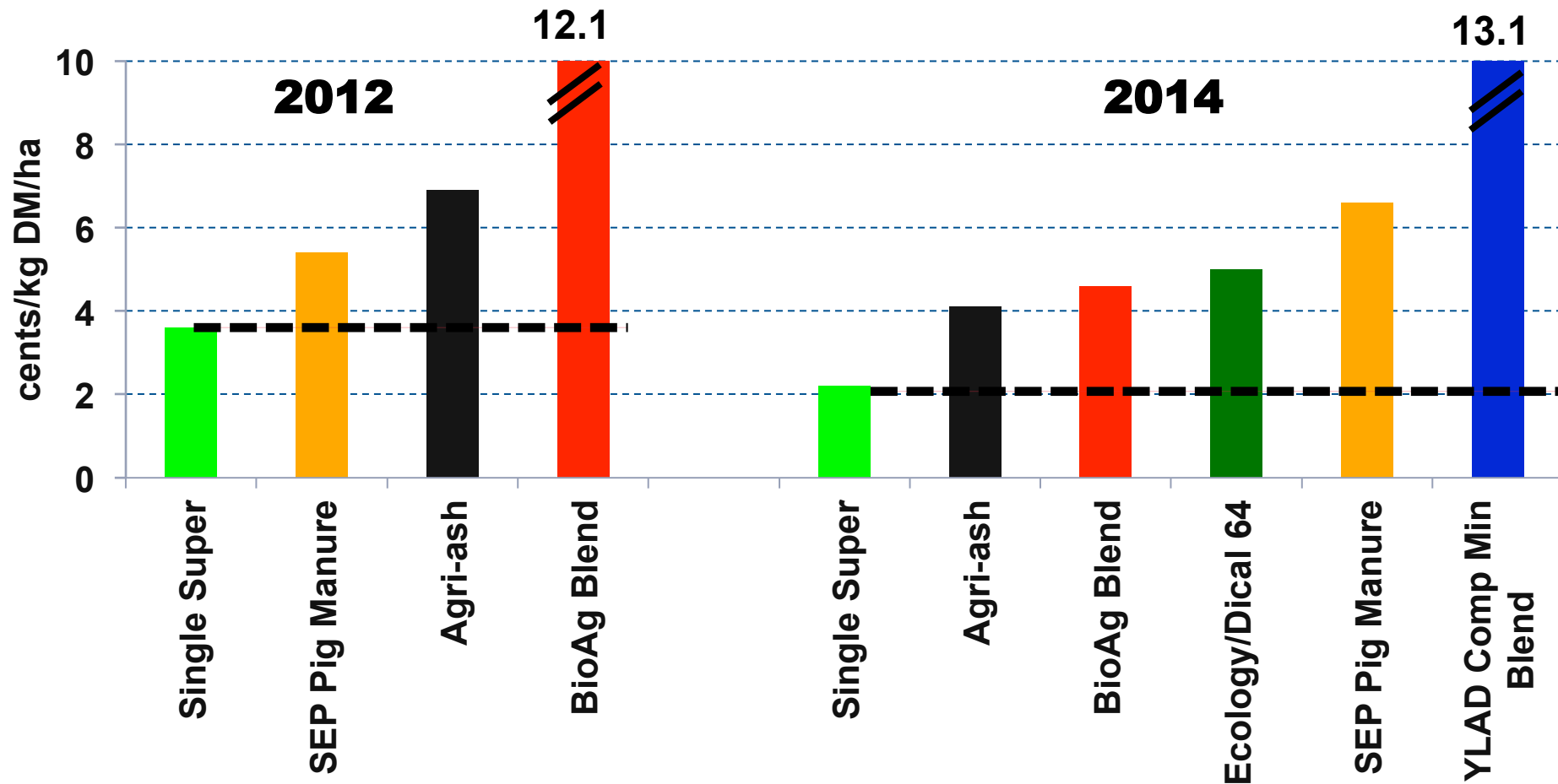


FERTILIZER PRODUCT	Annualised cost of product landed at Yass & spread on farm \$/ha							Application frequency
	2009	2010	2011	2012	2013	2014	Average Annualised Cost (\$/ha)	
Single Super	44.33	43.50	51.63	46.50	49.75	47.25	47.16	Annual
Agri-ash	35.33	35.33	35.33	50.42	53.75	59.58	44.95	6 years
Trio-min/Eco-min 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	3 years
Groundswell Compost	116.00	116.00	116.00	117.50	122.00	130.50	119.67	2 years
YLAD Compost Mineral Blend								
Glenroy	188.80	194.25	195.21	115.84	115.00	101.66	151.79	Annual
Kia-Ora	188.80	194.25	221.32	147.74	115.00	109.37	162.75	Annual
Te Kooti	188.80	194.25	195.21	133.35	115.00	n/a	165.32	Annual
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	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

COST EFFECTIVENESS - Glenroy

2012 & 2014

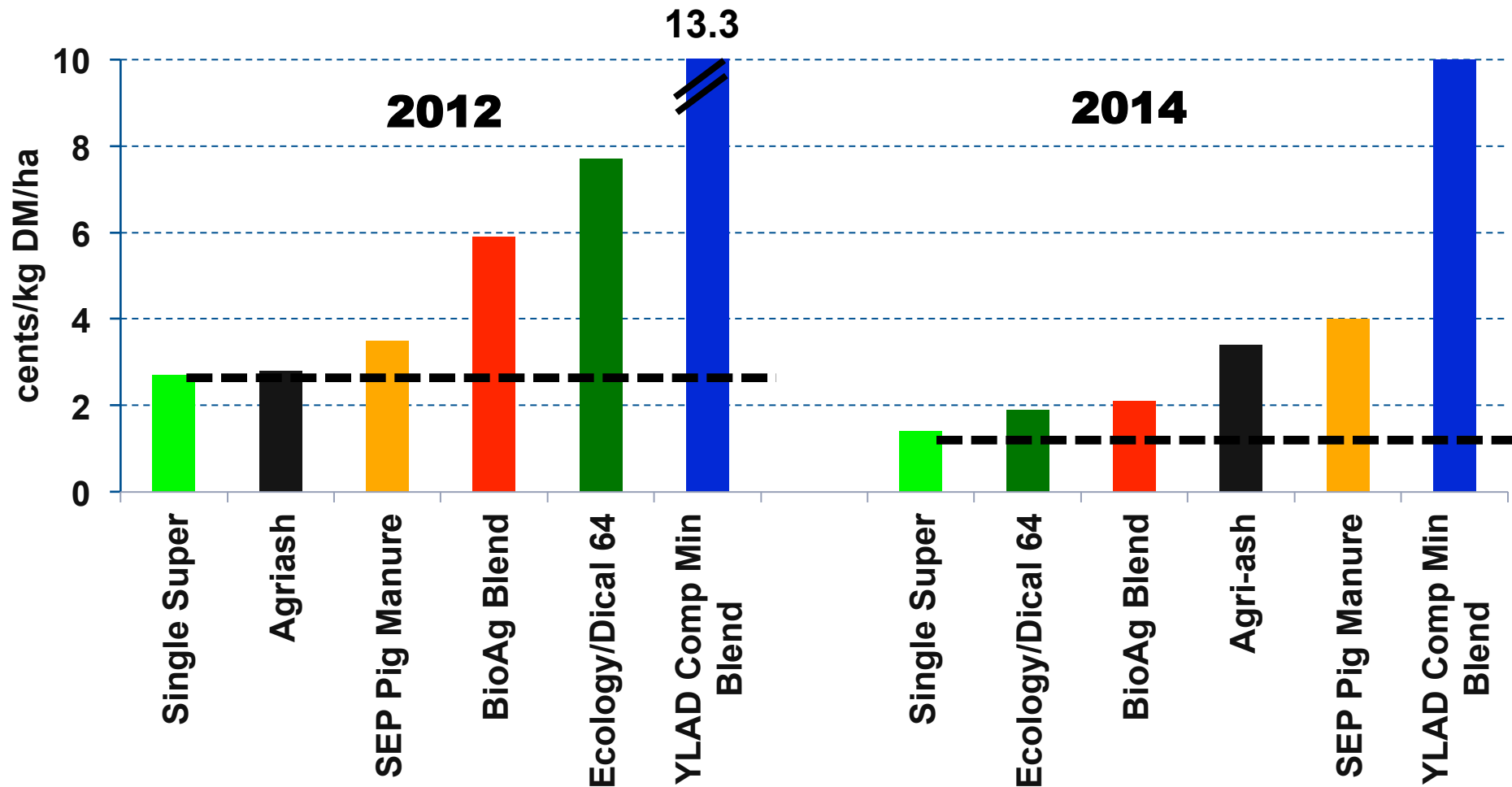
Cost of additional pasture grown above the Control



COST EFFECTIVENESS – Kia-Ora

2012 & 2014

Cost of additional pasture grown above the Control



PHOSPHORUS

- **Phosphorus is present in fertiliser in different forms:**
 - ***Water soluble P*** (plant available now)
 - ***Citrate soluble P*** (available to plants in weeks to months)
 - ***Citrate insoluble P*** (available to plants over years – a very slow release form of P)
 - ***Organic P*** (varying levels of solubility)

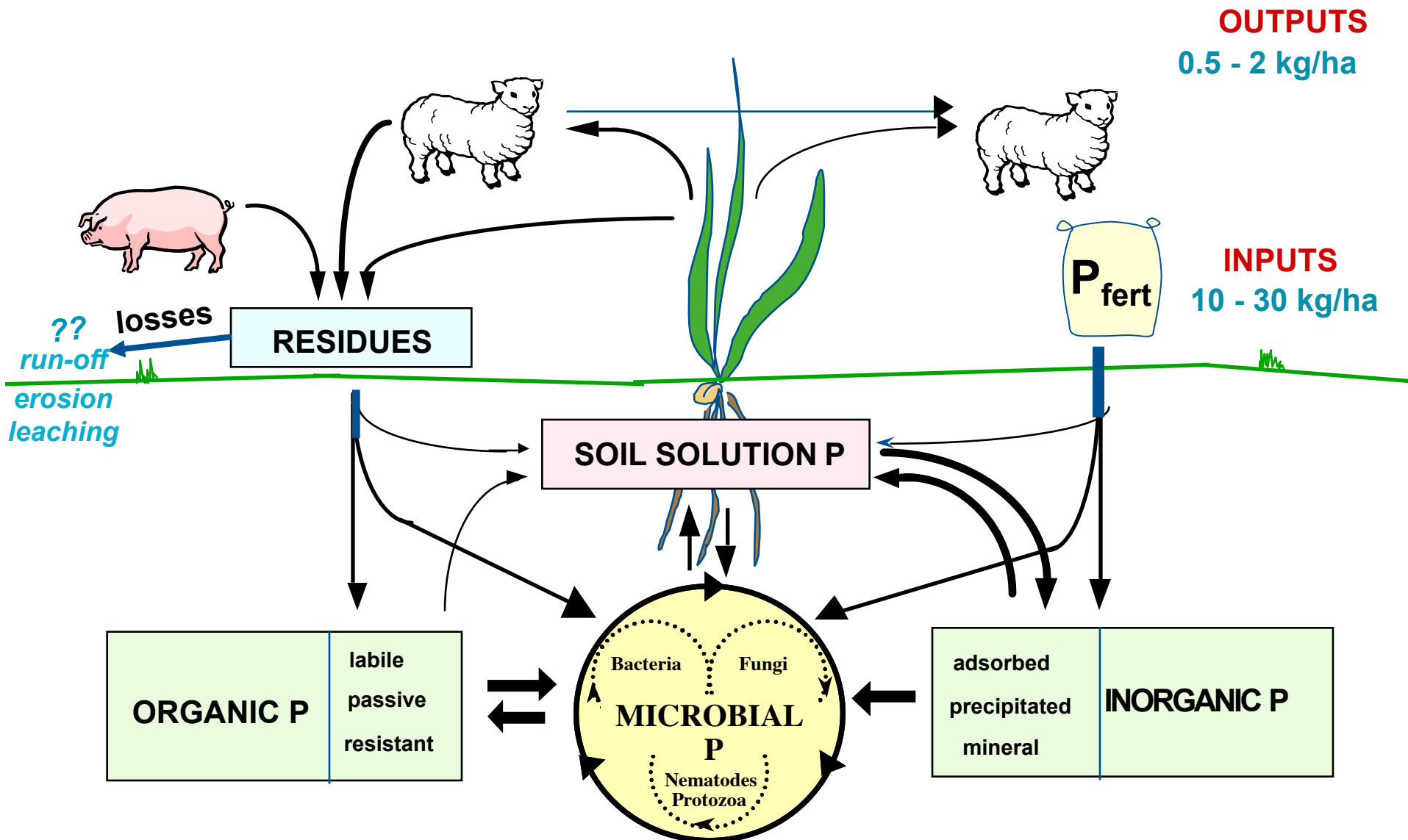
Total P & S applied after 6 years

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	No laboratory analysis undertaken on fertilizer applied				
- Glenroy					
- 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

 Products containing significant amounts of P & S (kg/ha)

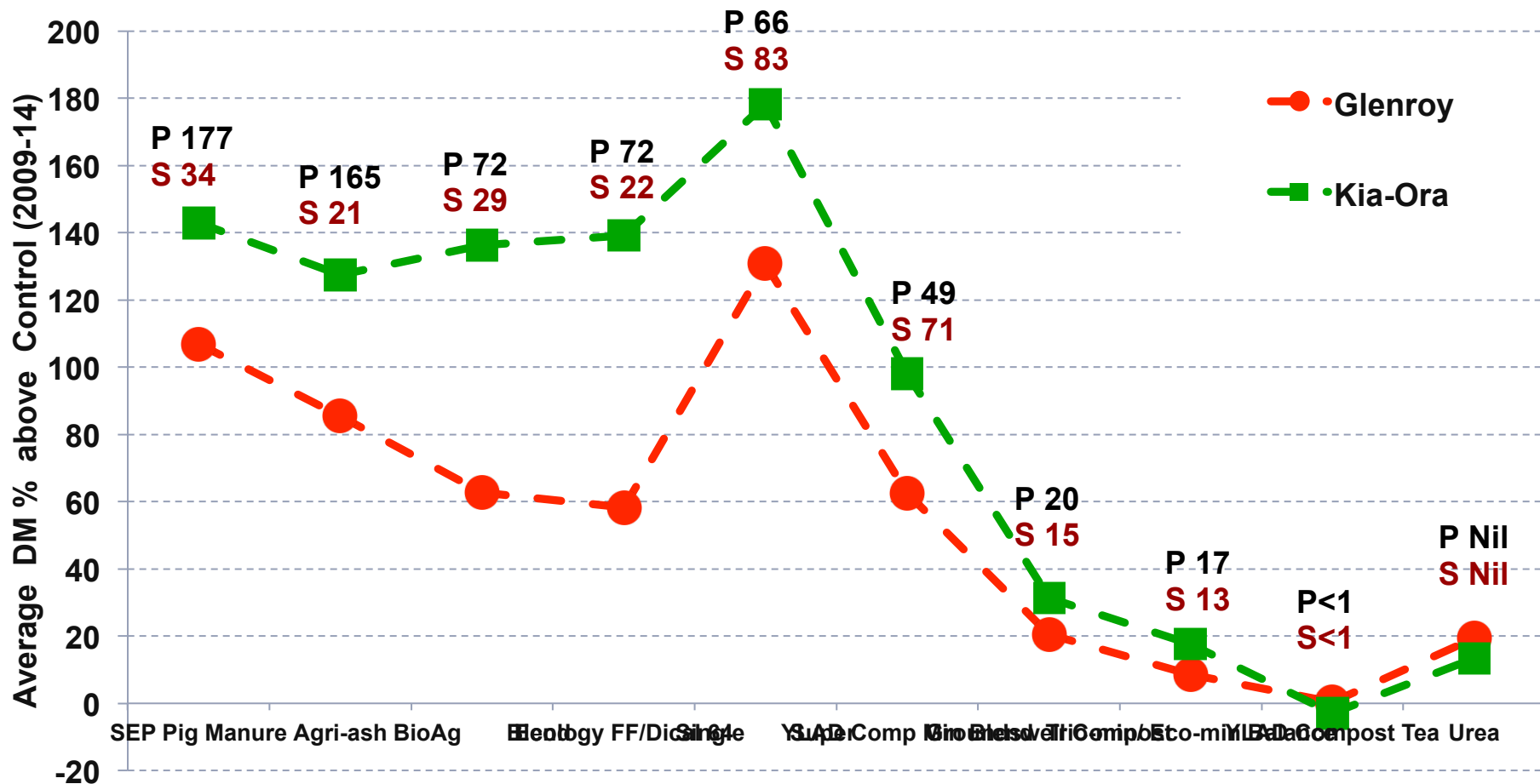
 Dominant form(s) of P in product (kg/ha)

P cycle in grazing systems



Source: Richardson, AR et.al. 2009, *Crop and Pasture Science* 60:124-143

Average Spring herbage yield (2009-2014) v's Phosphorus & Sulphur applied



High P



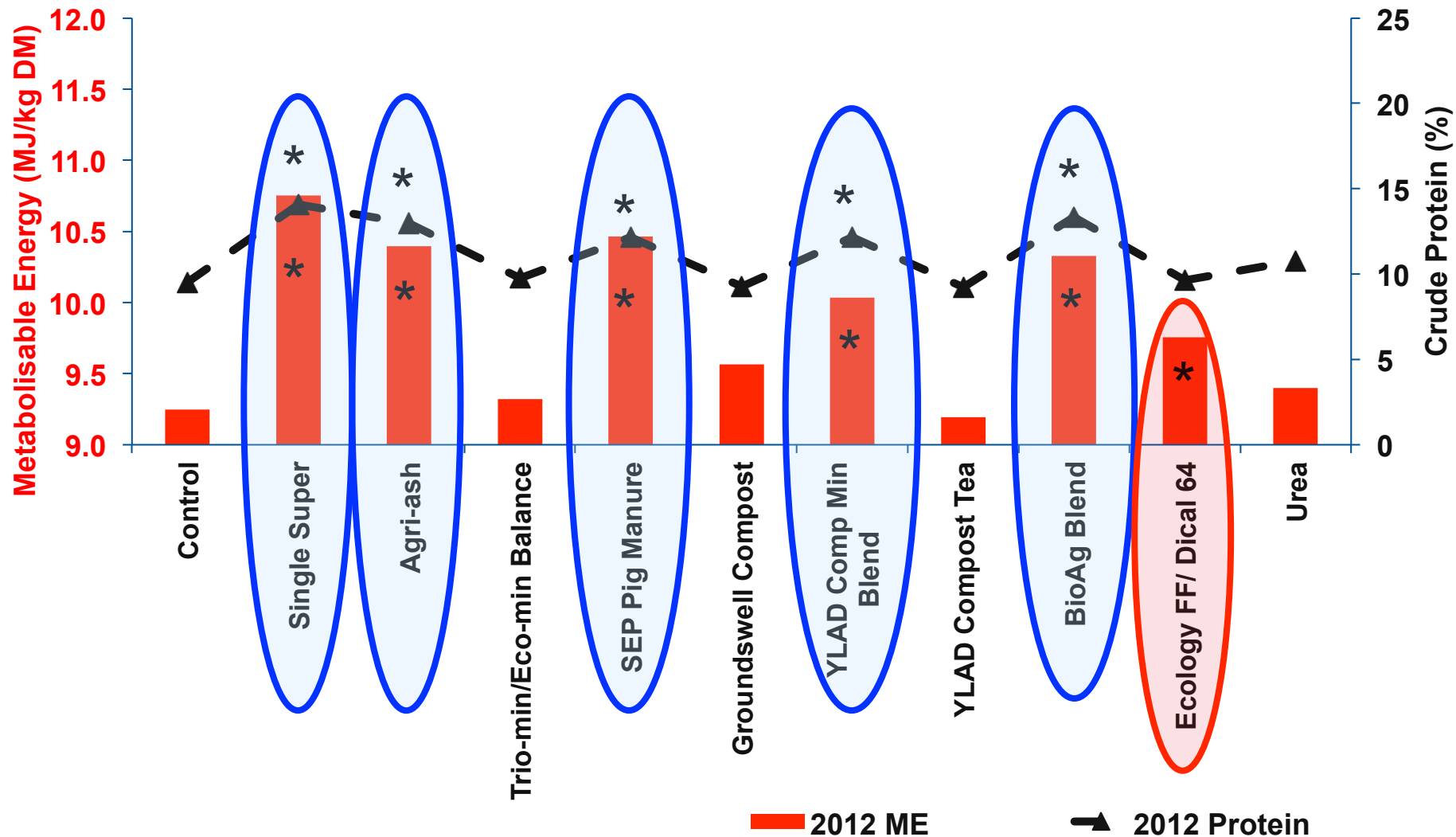
Low P

Sep 2014 – Pasture Quality scoring & sampling Glenroy



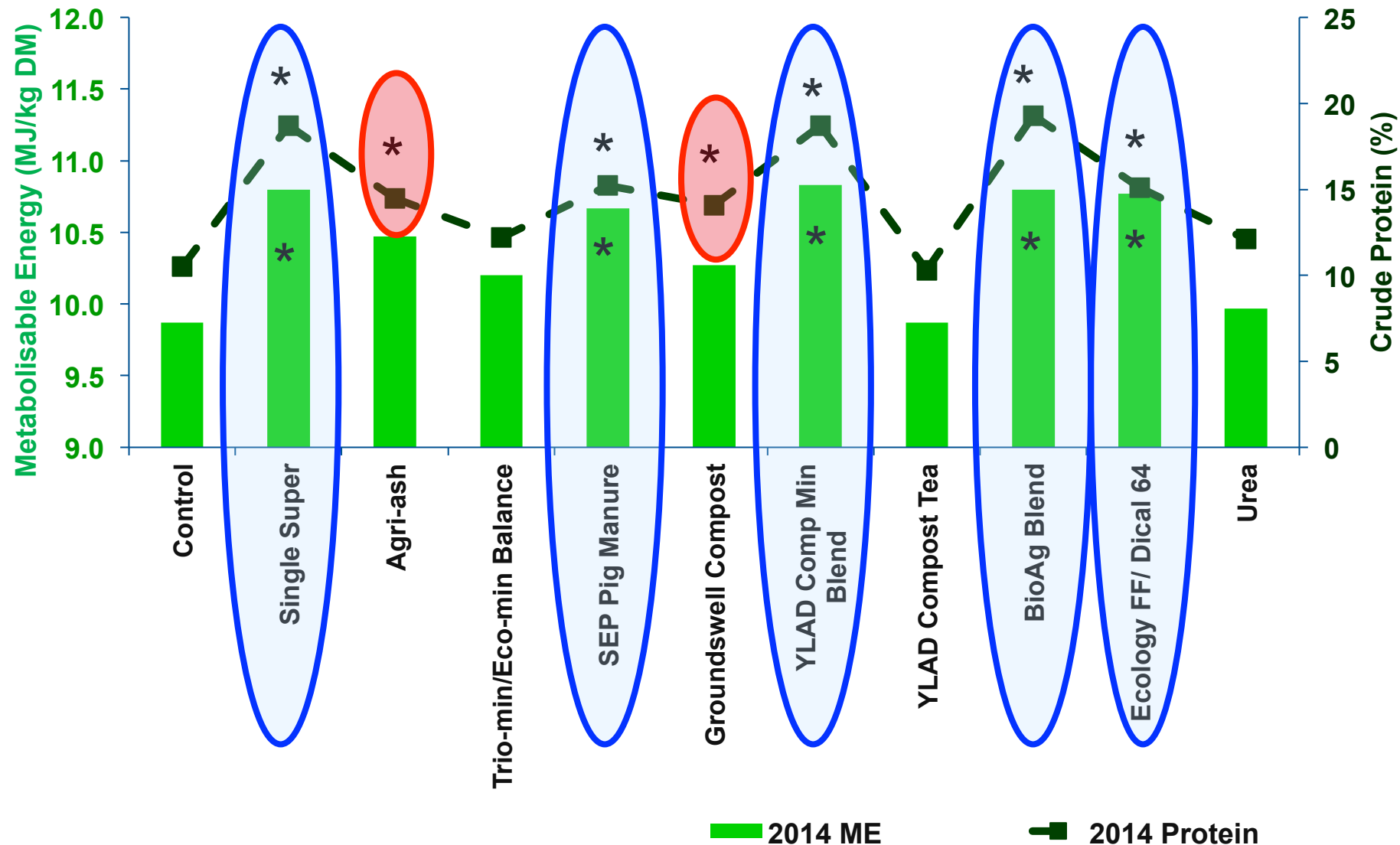
PASTURE QUALITY – GLENROY

Spring Sampling Period - 2012



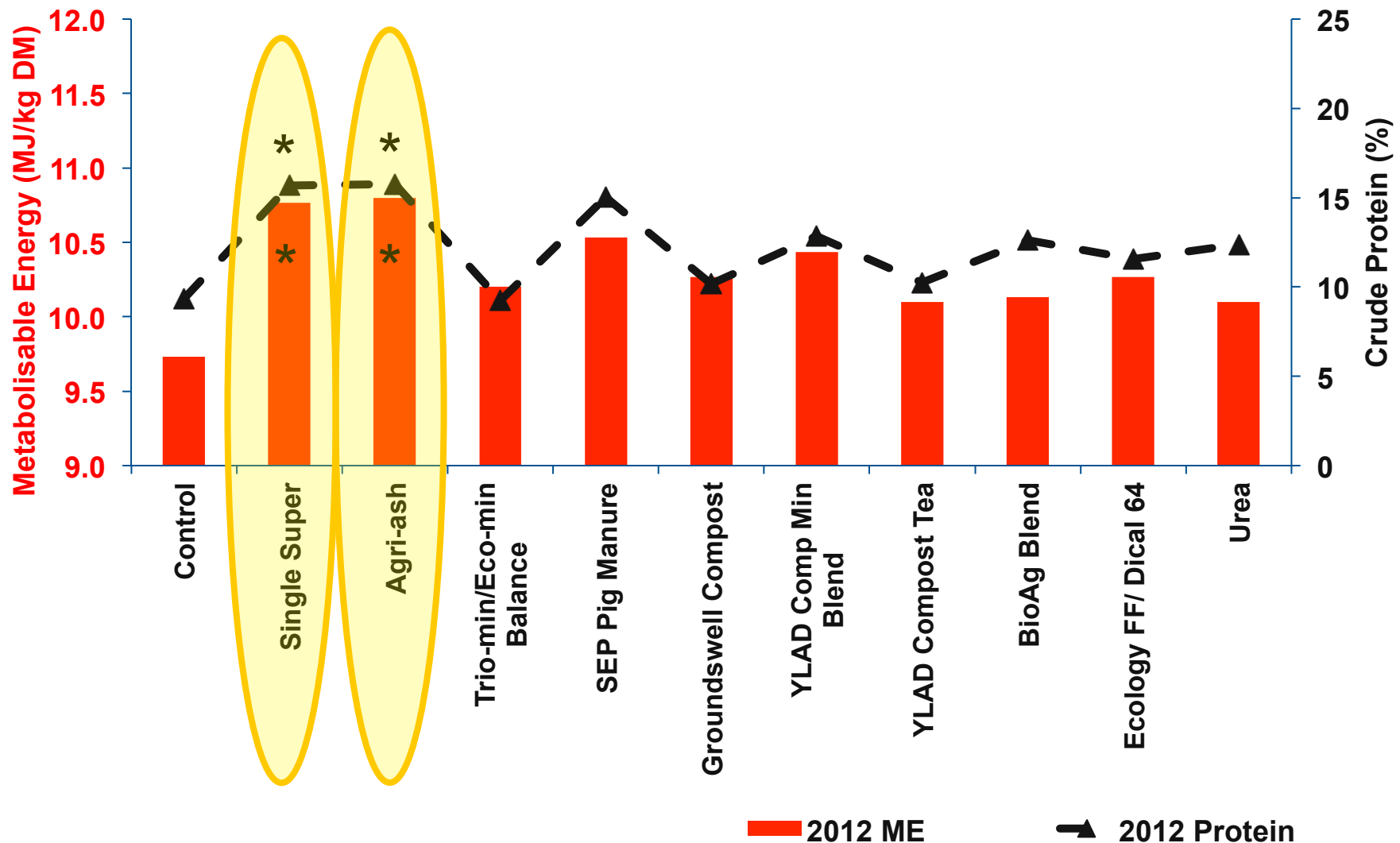
PASTURE QUALITY – GLENROY

Winter+Spring Sampling Period – 2014



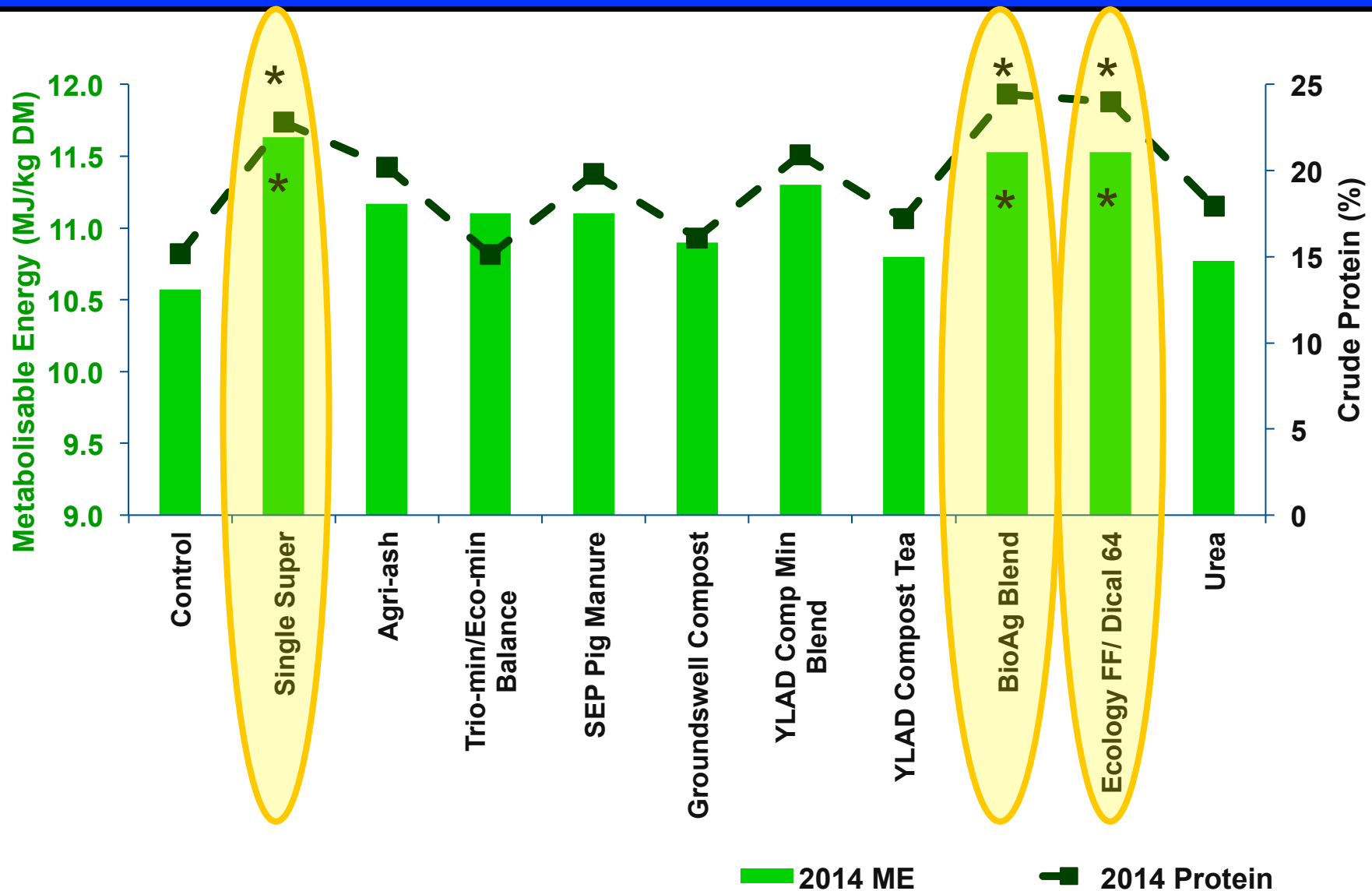
PASTURE QUALITY – KIA-ORA

Spring Sampling Period - 2012



PASTURE QUALITY – KIA-ORA

Winter+Spring Sampling Period - 2014

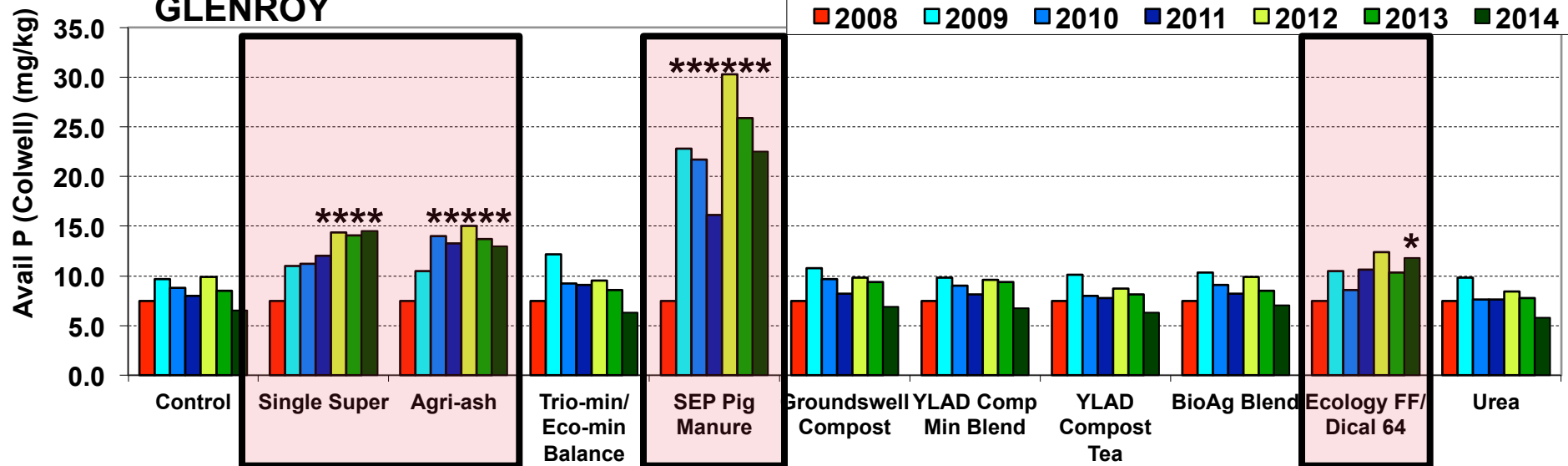


\$/ha ranking based on livestock performance for 2 selected years.

	Kia Ora		Glenroy	
	2012	2014	2012	2014
Agri-ash	269	175	81	96
BioAg Blend	100	459	8	126
Control	0	0	0	0
Groundswell Compost	-70	-51	-116	-112
Ecology/Dical 64	61	534	-65	114
Trio-min/Eco-min	-105	-77	-138	-69
SEP Pig Manure	226	211	98	69
Single Super	210	505	170	235
Urea	-66	-63	-60	-39
YLA`D Compost Mineral Blend	36	52	-153	12
YLAD Compost Tea	-40	-39	-39	-39

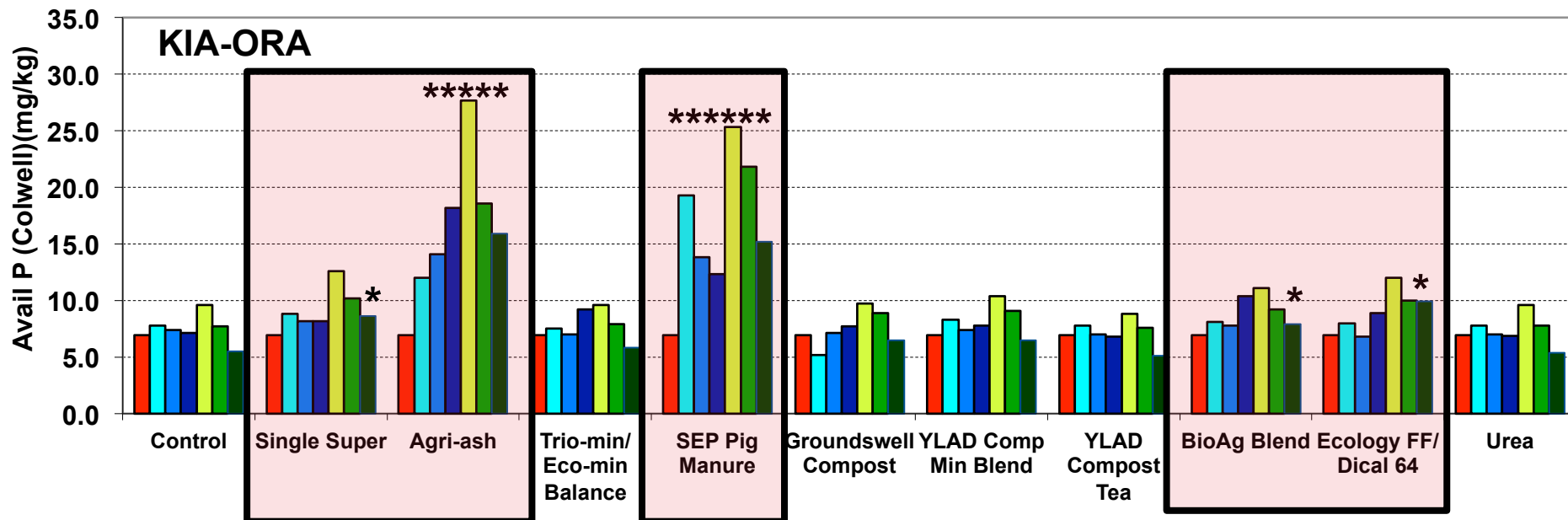
Available Soil Phosphorus (Colwell) Results 2008 – 2014

GLENROY

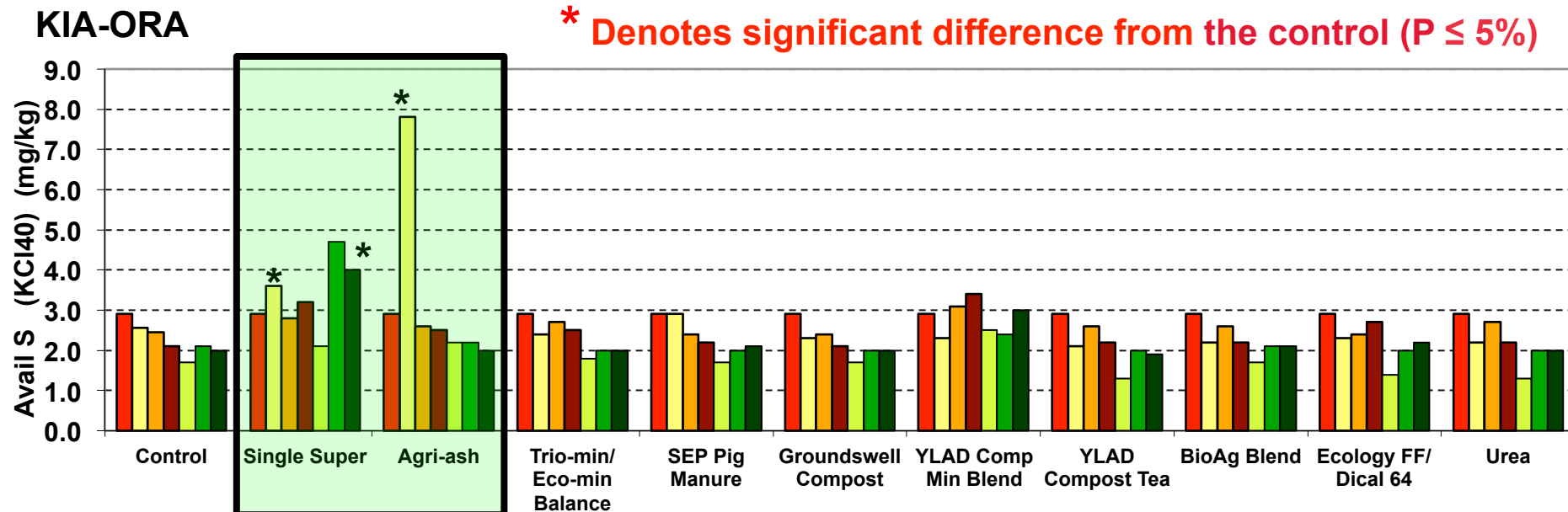
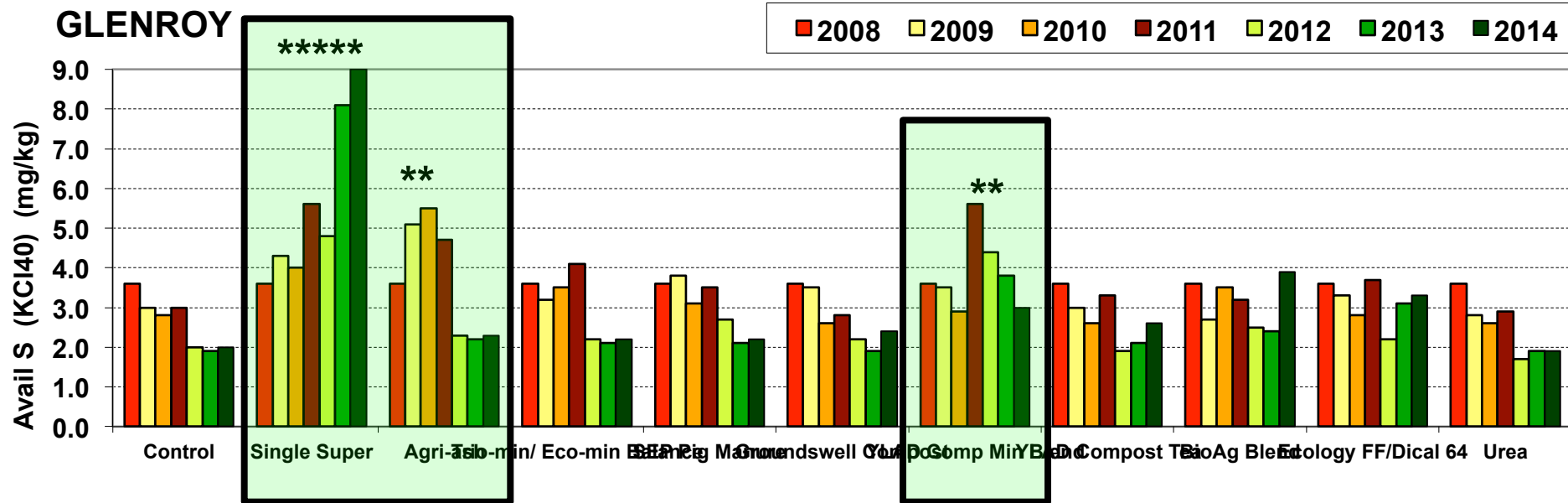


* Denotes significant difference from the control ($P \leq 5\%$)

KIA-ORA



Available Soil Sulphur (KCl₄₀) Results 2008 – 2014



SUMMARY -

- When starting from a low soil fertility status can you afford to wait for a pasture growth response when using products that consist mostly of insoluble P??
 - Answer based on a business decision and/or a personal philosophical decision
- Sulphur is particularly holding back pasture growth in many products & likely that if additional S is applied growth would improve.
 - Recognise this would result in a higher cost


Soil pH_(CaCl) & Aluminium (Al) %

- Initial soil pH levels 4.0 - 4.2 ; initial soil Al % levels 15 - 33%
- Products significantly raising pH_(CaCl) higher than Control & significantly lowering Al % below Control :**
(statistical analysis based on multiple pair-wise comparison tests $P \leq 5\%$)

PRODUCT	Glenroy						Kia-Ora					
	2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014
Agri-ash												
YLAD Compost Min Blend												
BioAg Blend												
Trio-min/Ecomin Balance												
SEP Pig Manure												

KEY


pH & Al %


Al % only

- No other products changed soil pH / Al % and certainly none of them made it worse**

Soil Microbial Results

- 6 years of monitoring using:
 - FDA Microbial Activity Test and
 - Biomass Carbon Test
- No product has consistently resulted in higher or lower soil microbial status compared to the Control to date

Where is the project going ...

- No product applied after 2014.
- Spring herbage mass & soil nutrient status measured in 2015 & 2016 as fertilizers run down.
- **ADDITIONAL SOIL MICROBIAL MEASUREMENTS :**

Soil microbial diversity has been determined based on soil DNA taken from plots in 6th year of trial (Spring 2014 from 2 trial sites).

Data currently being analysed for presentation.

Funding Received - \$216K



Primary
Industries



Local Land
Services
South East



Local Land
Services
Riverina



Office of
Environment
& Heritage



Australian Government

National
Landcare
Programme



Catchment Management
Authority
Murrumbidgee

the fresh food people
Woolworths



sheep
connect
new south wales

Special thanks to our trial co-operators:

***Bruce & Noelene Hazell, Gary & Hansie Armour
and Geoff & Fiona Henderson***

YOUTUBE CLIPS available for ...

**‘Alternative Fertilizer & Pasture Productivity’
Seminar held at Bookham Hall on
1st September 2015**

Web address:

<http://southeast.ils.nsw.gov.au/our-region/key-projects/alternative-fertilizers-field-research-project>

Additional Elements of Interest

- **Total Carbon - no significant differences**
- **Sodium % (compared to Control)**
 - Glenroy (2013) Pig & EFF/Dical 64 higher
 - Kia-Ora (2012) YLAD Comp Min Blend sig lower
- **Ca:Mg ratio (compared to Control (2-3G; 1-2 K))**
 - Glenroy - higher in Agriash all years (5-9)
 - higher in BioAg 2010 -14 (5-6)
 - higher In YLAD Comp Min Blend 2010 -14 (7-9)
 - Kia-Ora - higher in Agriash 2009-10, 2012-13 (2-4)
 - higher in YLAD Comp Min Blend 2012-14 (2-3)

■ **Electrical Conductivity (compared to Control)**

- Glenroy - higher in Agriash 2010
 - higher in Pig Manure 2010 & 2012
 - higher in Single Super 2012 -14
- Kia-Ora - higher in Agriash 2014
 - higher in Single Super 2013 -14
 - higher in YLAD Comp Min Blend 2014

■ **Calcium (cmol) (compared to Control)**

- Glenroy - higher in Agriash all years
 - higher in BioAg 2009-11
 - higher in YLAD Comp Min Blend all years
- Kia-Ora - higher in Agriash all years
 - higher in YLAD Comp Min Blend 2010-14

- **Potassium (cmol) (compared to Control)**

- Glenroy - lower in Single Super 2014
- Kia-Ora - lower in Agriash 2013-14
 - lower in Ecology FF/Dical 64 2014
 - higher in YLAD Comp Min Blend 2014

- **Magnesium (cmol) (compared to Control)**

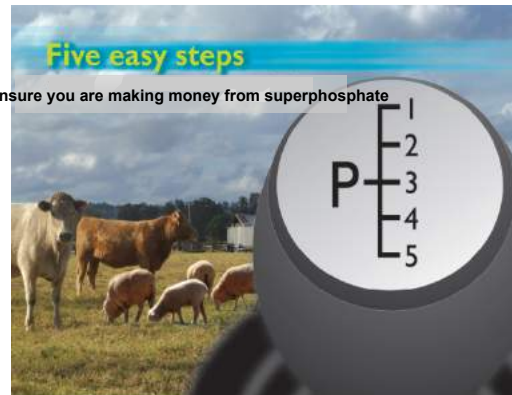
- Glenroy - higher in Pig Manure in 2010,2012-14
- Kia-Ora – no significant differences

- **FDA (compared to Control)**
 - Glenroy – no significant differences
 - Kia-Ora - higher in BioAg 2009

- **Biomass Carbon (compared to Control)**
 - Glenroy - no significant differences
 - Kia-Ora - higher in Agriash 2010

How do I choose an appropriate fertilizer for my pasture-grazing situation?

1. Decide your objective for pasture growth & soil fertility.
2. Determine soil nutrient deficiencies/toxicities from soil test & paddock history.



STEP 1

How to take soil tests properly

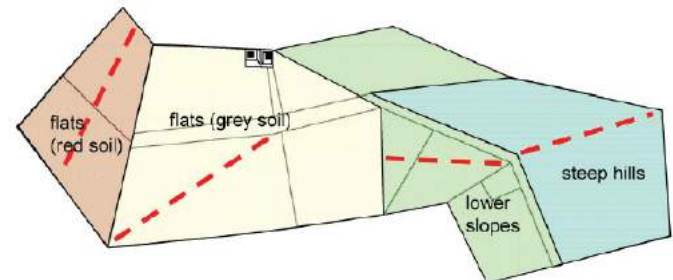
It is important to collect soil samples correctly to ensure a meaningful test result:

- Representative samples** – Establish monitor areas or transects that represent each of the major classes of land (land management units) across the farm. The objective is to adequately represent the differing areas of the farm that are to be fertilised whilst ensuring a reasonable soil testing load and expense. Using a soil corer, sample in the monitor area or along the transect in a systematic way and record the sampling interval and pattern used so that the sampling pattern can be replicated at later times. To ensure samples reflect the paddock as a whole, avoid stock camps, fence lines, water troughs, fertiliser dumps, burnt timber rows, wet gullies, gateways, tracks or dung patches and sample from different soil types separately.
- Mark the site** – Keep a record of the monitor area or transect for future testing. You may do this by noting where you started and finished and the route taken, by taking a series of GPS readings, etc.
- Depth** – Extractable P is measured in topsoil samples using a soil sample depth of 10cm. P is typically more concentrated in the top few centimetres of soil so it is very important to obtain the full volume of soil to 10 cm depth to avoid biasing the concentration of P in the soil sample.
- Sample number and handling** – Take a minimum of 30 soil cores along the transect or monitor area and combine to give a sample that is representative of the paddock. Send the sample to the testing laboratory promptly. Use an ASPAC-accredited laboratory to take advantage of the quality control that this accreditation represents.
- Timing** – Always sample at the same time every year. It is potentially feasible to take annual samples at any time of the year, but soil samples are most commonly taken in late spring. At this time soil is usually moist, but not wet, allowing soil cores to be taken quickly

and easily. Moist soil holds together in the corer and this helps to ensure the sample is the full 10 cm depth. Never sample within the first few months after fertiliser application.



Soil testing: establish monitor paddocks or transects (•••••) that represent the major classes of land, or land management units of the farm. The objective is to adequately represent the differing areas of the farm that are to be fertilised whilst ensuring a reasonable soil testing load. Retest the monitor areas annually. Over time you will be able to make decisions on the basis of the soil fertility trends that the data will reveal.



How do I choose an appropriate fertilizer for my pasture-grazing situation?

3. IDENTIFY suitable fertilizers based on nutrient analysis.

4. ASK suppliers for evidence of product performance.

→ TEST STRIPS are a useful way to compare:
new product vs nil control vs standard practice.

→ Always exclude from grazing for 6-8wks in spring to see differences

5. COST fertilizers also accounting for freight and spreading.

6. CHOOSE product based on steps 1 -5.

How do I choose an appropriate fertilizer for my pasture-grazing situation?

7. RATES of fertilizer application can be determined with help of:



<http://www.mla.com.au/Extension-and-training/Tools-and-calculators/Phosphorus-tool>

8. MONITOR soil fertility ANNUALLY in key paddock(s) to determine nutrient changes. Always align with grazing records.