BioAg Trial

Crookwell Replicated Pasture Trial

Crookwell, NSW	**2014 - 2018**
Location	Year
BioAg	**Pasture**
Conducted by	Crop
Small plot	
Trial Type	

Aim

To assess and measure pasture dry matter response over time, comparing BioAg treatments (annual and biennial) with annual treatments of single super phosphate (SSP).

Introduction

Phosphorus (P), Sulfur (S) and Calcium (Ca) are all-important nutrients for a quality pasture.

P is essential for plant growth. It plays a role in photosynthesis, respiration, energy storage and transfer, cell division, cell enlargement and many other vital plant functions. Phosphate helps promote early root formation and growth, it is a large contributor to yield and profitability in pastures and crops and it assists in the transportation of nutrients.

S is used by plants to help with nitrogen metabolism, enzyme activity and protein and oil synthesis. It also helps stimulate soil biology, rumen biology and helps maximise wool tensile strength.

Ca is also important in root and shoot stimulation, helps with the mechanical strength of the plant (integrity and selectivity of cell membranes), activates several enzyme systems, helps neutralise organic acids within the plant, is essential for good seed set in subterranean clovers. It can also help stimulate microbial activity and molybdenum availability.

Both Single Super Phosphate (SSP) and *Superb* (BioAg) supply these three main ingredients.

SSP has been the mainstay of pasture production in Australia for a long time, but with changing ideals in agricultural communities, the use of "non-chemical" based fertilisers is rising. *Superb* is a blend of 2 naturally occurring products, being *BioAgPhos* (derived from Reactive Phosphate Rock) and Gypsum.

BioAgPhos® is a unique fertiliser that provides pastures and crops with an immediate and continuing source of plant-available phosphate. It is made by digesting reactive phosphate rock (sourced from Algeria) with our proprietary microbial culture, which is designed to further break down the rock and improve nutrient availability to plants.

> **The difficulty lies not so much in developing new ideas as in escaping from old ones.**
>
> *– John Maynard Keynes*

Method

The trial site selected and soil tested in 2014 and then again in 2018 to look at nutrient run-down.

Treatments were then applied (hand spread) based on district standard treatment (125kg/ha SSP – 11kg phosphorus (P) per hectare per year):

- Nil
- SSP – annual application
- *Superb* – annual application
- *Superb* - biennial application
- *BioAgPhos (BAP)* – annual application
- *BioAgPhos (BAP)* – biennial application

The trial site did offer the opportunity to include 6 other replicated treatments; these were used to research other treatments and had no impact on the aim, purpose or conclusions of the trial.

Plots were mown on a cut and carry basis (i.e. all mown material was removed from plots). No stock grazing was allowed although there was some accidental grazing from lambs in the spring of 2016 – two cuts were lost.

Treatments were re-applied as needed on an annual or biennial basis.

Total of 22 cuts were taken over a 4 year period finishing in the autumn of 2018.

Forage quality tests were also taken in the spring of 2017 – results also available in discussion.

Trial Design

Nil	*BAP* – annual	SSP - annual	Treatment
SSP - annual	Treatment	Treatment	Treatment
BAP – annual	Treatment	Treatment	Nil
BAP - biennial	*Superb* - biennial	Treatment	*Superb* – annual
Treatment	*Superb* - annual	Treatment	Treatment
Superb - annual	SSP - annual	*BAP* - biennial	Treatment
Treatment	*BAP* - biennial	Nil	SSP - annual
Treatment	Treatment	*Superb* - annual	Treatment
Superb - biennial	Nil	Treatment	Treatment
Treatment	Treatment	*Superb* - biennial	*Superb* - biennial
Treatment	Treatment	*BAP* – annual	*Superb* - annual
Treatment	Treatment	Treatment	*BAP* - biennial

Results and Discussion

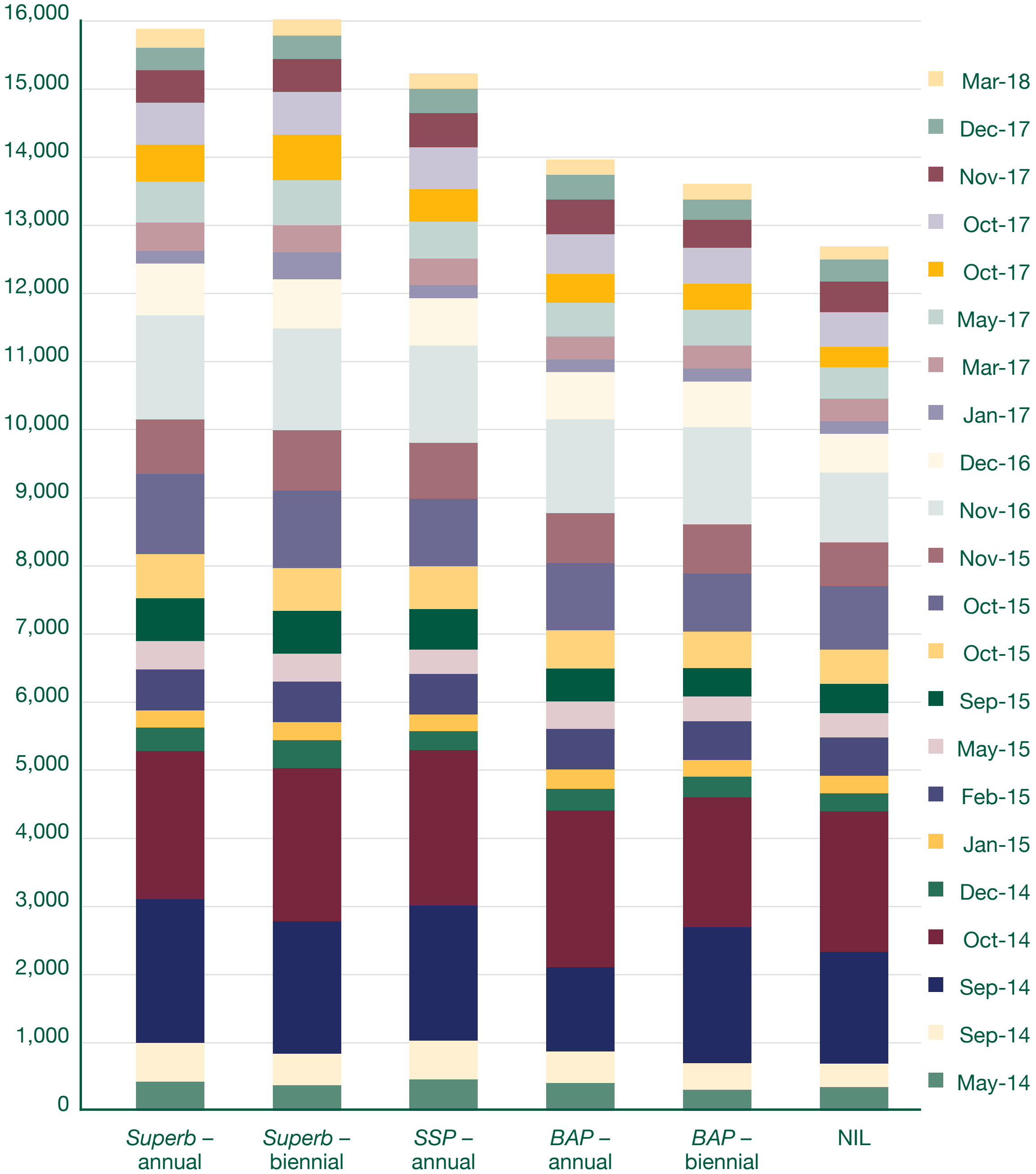
Dry Matter Harvested per Cut – kilograms

Treatment	May 14	Sep 14	Sep 14	Oct 14	Dec 14	Jan 15	Feb 15	May 15	Sep 15	Oct 15	Oct 15	Nov 15
Superb - annual	433	569	2106	2178	341	249	608	413	631	644	1180	799
Superb - biennial	376	460	1943	2249	414	264	594	411	626	628	1139	886
SSP - annual	461	565	1984	2284	276	248	591	359	598	626	992	820
BAP - annual	404	467	1237	2295	329	282	593	410	481	558	989	731
BAP - biennial	309	533	1997	1901	339	248	564	365	421	533	855	718
Nil	346	488	1638	2069	260	220	561	358	427	507	928	644

Treatment	Nov 16	Dec 16	Jan 17	Mar 17	May 17	Oct 17	Oct 17	Nov 17	Dec 17	Mar 18	Total
Superb - annual	1528	760	185	416	603	543	616	473	335	274	15884
Superb - biennial	1492	726	219	395	653	663	631	483	343	239	15834
SSP - annual	1431	691	198	386	545	473	614	508	352	229	15231
BAP - annual	1378	690	188	341	493	426	576	514	363	221	13966
BAP - biennial	1433	665	187	343	524	382	528	410	294	237	13786
Nil	1024	570	180	337	460	296	513	447	323	193	12789

LSD on total Dry Matter (Least significant difference) = 507

Total Dry Matter Cut (kilograms) per Treatment



At the end of the trial the two *Superb*® treatments produced more dry matter than SSP.

SSP produced the third highest amount of dry matter, better than both *BioAgPhos*® treatments while all treatments out-performed the nil treatment.

The treatments containing Sulfur (SSP and the two *Superb*® treatments) were significantly better than the straight phosphate products (*BioAgPhos*®).

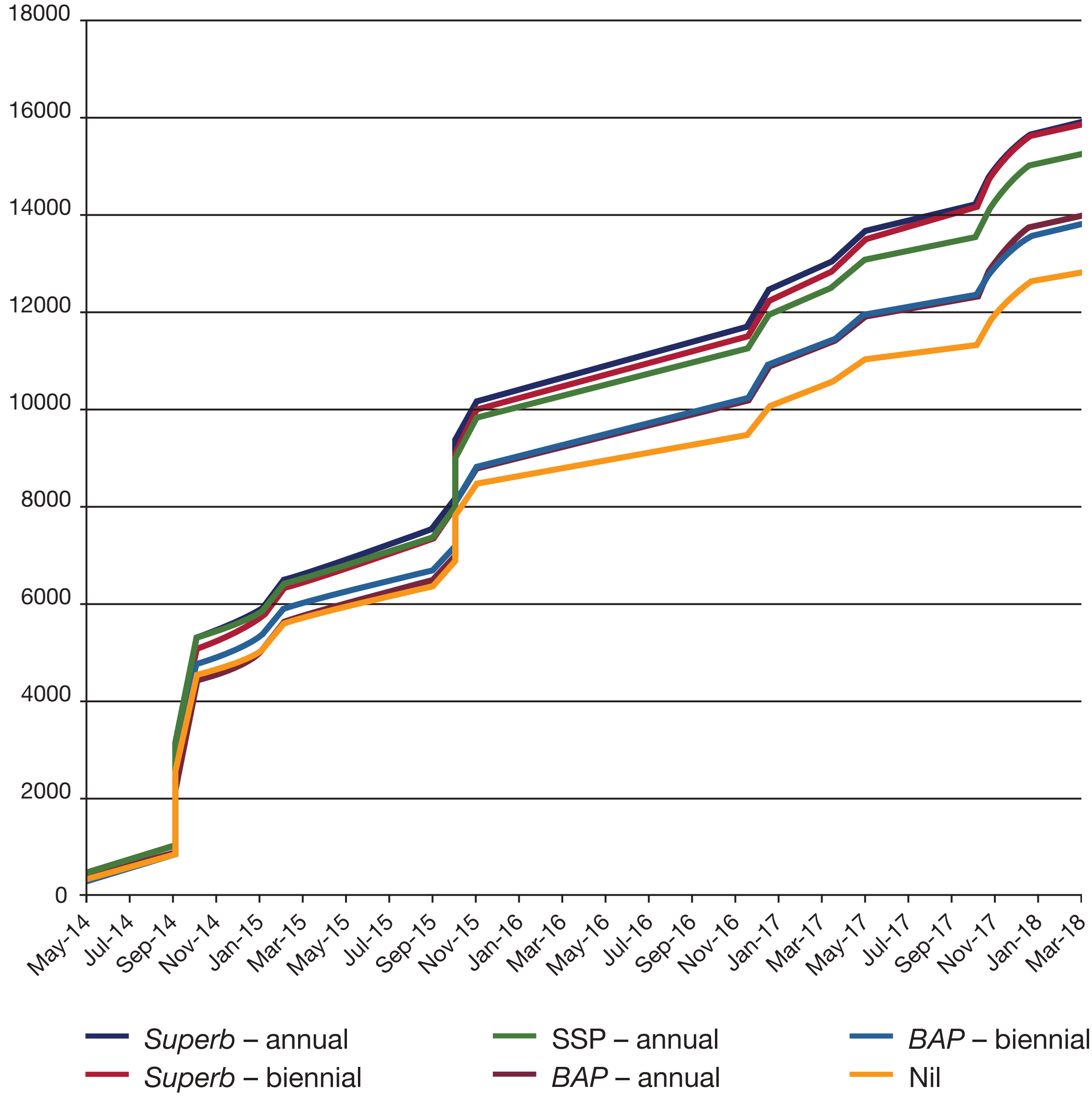
Sulfur is an integral part of every living cell and a constituent of 3 of the 21 amino acids that form proteins.

Sulfur is also a constituent of enzymes and vitamins (thiamin and biotin), it is essential for nitrogen fixation in legumes.

It is also necessary for chlorophyll formation.

This shows the importance of Sulfur in pasture production and how, when combined with Phosphorus, you can increase pasture dry matter production.

Cumulative Dry Matter Cut (kilograms) per Treatment over Time



Although there was no statistical difference between the two *Superb*® treatments with that of SSP, the trend showed that the longer the trial went the better the dry matter responses were to a slow release phosphate fertiliser (cumulative graph).

SSP was the better performer for the first 6-12 months of the trial.

From then on *Superb®* lead dry-matter cuts.

The annual treatment of *Superb®* did slightly out-perform the biennial treatment in the first three years although the biennial treatment provided the best cumulative response in the last year of the trial.

The use of a slow release fertiliser based on “reactive phosphate rock” as used in *BioAgPhos®* and *Superb®* does have an accumulative effect over time, continual applications either annually or biennially work to improve pasture dry matter production.

The trial showed that Superb® produced more dry matter than conventional P and S fertilisers, though on a statistical basis they would be considered equal.

It is clear that Superb® performed as well as traditional fertiliser in a modest rainfall pasture system.

Economics

Based on the dry matter production over 4 years the cheapest option is to spread *Superb* on a biennial basis (both on a per hectare price and on a cost of extra dry matter produced).

The trial indicates their is an opportunity to reduce the cost of production for extra dry matter by 20% while, in the longer term, producing more dry matter.

	Superb (annual)	SSP (annual)	*Superb* (biennial)	Nil
Ex Port Fertiliser Cost (avg for 4 years)	$284/T	$303/T	$284/T	$0/T
Freight to Farm	$70/T	$40/T	$70/T	$0/T
Delivered Price to Farm	$354/T	$343/T	$354/T	$0/T
Application Rate	125kg/ha	125kg/ha	250kg/ha	0kg/ha
Fertiliser Cost per Ha	$44.25/ha	$42.88/ha	$88.50/ha	$0.00/ha
Spreading Cost	$9.38/ha	$6.88/ha	$9.38/ha #	$0.00/ha
SSP = $55/T				
Superb = $75/T				
Applied Cost of Fertiliser	$53.62/ha	$49.75/ha	$97.88/ha	$0.00/ha
			every 2nd year	
Annual Cost of Fertiliser	$53.62/ha	$49.75/ha	$48.94/ha	$0.00/ha
Cost of Dry Matter based on Crookwell Trial Data				
Total Dry Matter	15884kg/ha	15231kg/ha	15834kg/ha	12789kg/ha
Extra Dry Matter over Nil	3095kg/ha	2442kg/ha	3045kg/ha	0kg/ha
Extra Dry matter / Ha (average per annum)	6.93c/kg	8.15c/kg	6.43c/kg	0.00c/kg

Cost of application every 2nd year, halved to represent an annual cost.

Also evident from the table is that with hay at a cost of anywhere between $150 and $300 per tonne of dry matter, i.e. 15-30c/kg DM – it is much cheaper to grow your own forage.

Conclusion

Dry matter production on the plots receiving a biennial (every second year) application of *Superb* was the highest, however not statistically different than for annual applications of either *Superb* or SSP.

The trials aims were achieved, and showed that both annual and biennial applications were as effective as SSP in the production of dry matter.

The trial also highlighted the benefit of fertiliser in growing additional feed, and that the use of fertiliser was more economical than the buying of feed. The cost of feed production was lowest with biennial applications of *Superb*.

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Appendix

Climate – average temperature and rainfall figures (BOM)

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Mean maximum temperature (°C)	26.5	25.9	23.6	18.4	13.9	10.3	9.5	11.0	14.7	18.3	21.4	25.0	18.2
Mean minimum temperature (°C)	10.7	10.7	8.8	5.0	2.3	0.6	-0.4	0.3	2.1	4.6	6.7	9.0	5.0
Rainfall													
Mean rainfall (mm)	69.7	54.7	57.9	57.9	65.9	89.3	84.5	89.3	75.2	76.6	65.5	66.7	860.5
Decile 5 (median) rainfall (mm)	56.6	48.0	43.2	47.2	54.6	79.6	78.6	84.7	72.1	70.5	58.8	55.3	868.7
Mean number of days of rain ≥ 1 mm	5.6	4.8	5.2	5.6	7.3	9.4	9.6	9.4	8.4	7.7	6.4	5.8	85.2

Nutrient Removal

The pasture was made up of primarily sub clover and improved grasses (phalaris and ryegrass).

The plots were all cut and the clippings weighed and exported off the site (there was no animal grazing and thus no effluent (urine or faeces) recycled back on to the plots).

A large amount of nutrient was therefore exported off the plots. In general for every 1 tonne of dry matter removed per hectare (as hay).

Nutrient Removal in kg per ton of Product									
Enterprise	N	P	K	S	Ca	Mg	Cu	Zn	Mn
Hay-50/50 Clover/Grass	26	3	22	2.5	9	4	0.008	0.02	0.015

Source: Australian Soil Fertility Manual (JS Glendinning) Revised Edition FIFA

Over the length of the trial, based on the two *Superb*® treatments and the SSP treatment, the average dry matter removed was 15,649kg.

This represents a nutrient removal over the length of the trial of about 407kg nitrogen, 47kg phosphorus, 344kg potassium, 39kg sulfur, 149kg calcium and 63kg magnesium.

We were applying 11kg P per annum (equivalent) with fertiliser, i.e. 44kg P per plot was applied over the length of the trial, just under what we took off as dry matter, but there was quite a decline in the soil P levels based on Colwell P measures (refer to soil test results).

What happened?

Given the reduction in P levels for all treatments it would appear we applied less than the required maintenance levels, in practice annual or biennial soil tests would pick this up and nutrient application adjusted accordingly.

A significant decline was seen in potassium levels due to the total removal of dry matter. Again this would be identified with regular soil testing and rectified with applications of fertiliser containing either Muriate or Sulphate of Potash.

The nature of the trial meant that nutrients were removed with each cut. If pasture is grazed a portion of nutrients would be cycled via animal manure and composting of plant matter.

Soil Tests (Environmental Analysis Lab - Lismore)

Method	Nutrient		Units	2014 Crookwell Trial	2018 Nil	2018 SSP	2018 *Superb* (B)	2018 *BAP* (A)	2018 *Superb* (A)	*Desirable Level Loam*
Morgan 1	Calcium	Ca	mg/kg	999	1376	901	1044	905	1066	*375*
	Magnesium	Mg	mg/kg	75	76	71	87	79	77	*60*
	Potassium	K	mg/kg	201	108	114	119	98	90	*60*
	Phosphorus	P	mg/kg	3.6	1.7	1.6	1.9	1.8	1.6	*10*
Bray 1	Phosphorus	P	mg/kg	4.7	3.9	4.6	3.8	3.9	4.1	*24*
Colwell	Phosphorus	P	mg/kg	17	9.2	9.2	10	10	10	*45*
Bray 2	Phosphorus	P	mg/kg	13	8.3	10	11	7.9	11	*48*
KCl	Nitrate Nitrogen	N	mg/kg	24.2	18	30	20	14	17	*10*
	Ammonium Nitrogen	N	mg/kg	21.0	4.3	17	6.4	2.2	2.7	*15*
	Sulfur	S	mg/kg	0.9	5.8	7.4	5.0	3.5	4.2	*25*
1:5 Water	pH		units	5.80	6.25	5.52	5.75	5.61	5.79	*6.3*
	Conductivity		dS/m	0.095	0.079	0.090	0.074	0.061	0.067	*120*
Calculation	Organic Matter		%OM	6.5	6.2	6.5	7.3	6.4	6.6	*3.5*

continued overleaf

Soil Tests (Environmental Analysis Lab - Lismore) – *continued*

Method	Nutrient		Units	2014 Crookwell Trial	2018 Nil	2018 SSP	2018 *Superb* (B)	2018 *BAP* (A)	2018 *Superb* (A)	*Desirable Level Loam*
Ammonium Acetate + Calculations	Calcium	Ca	cmol$^+$/Kg	9.06	10.50	7.12	8.66	7.49	8.3	*5*
		Ca	kg/ha	4067	4713	3195	3887	3363	3728	*2000*
		Ca	mg/kg	1816	2104	1426	1735	1501	1664	*1000*
	Magnesium	Mg	cmol$^+$/Kg	0.95	0.80	0.77	0.96	0.89	0.82	*1.2*
		Mg	kg/ha	257	218	210	261	242	223	*290*
		Mg	mg/kg	115	98	94	117	108	99	*145*
	Potassium	K	cmol$^+$/Kg	0.97	0.51	0.56	0.58	0.50	0.46	*0.4*
		K	kg/ha	845	450	489	511	436	402	*300*
		K	mg/kg	377	201	218	228	195	180	*150*
	Sodium	Na	cmol$^+$/Kg	0.07	0.05	0.03	0.05	0.05	0.05	*0.22*
		Na	kg/ha	35	27	16	25	26	25	*101*
		Na	mg/kg	16	12	7	11	12	11	*51*
KCl	Aluminium	Al	cmol$^+$/Kg	0.04	0.01	0.10	0.04	0.06	0.03	*0.5*
		Al	kg/ha	9	3	21	7	12	7	*81*
		Al	mg/kg	4	1	9	3	5	3	*41*
Acidity Titration	Hydrogen	H^+	cmol$^+$/Kg	0.08	0.11	0.13	0.08	0.11	0.07	*0.5*
		H^+	kg/ha	2	3	3	2	2	2	*9*
		H^+	mg/kg	1	1	1	1	1	1	*5*

continued overleaf

Soil Tests (Environmental Analysis Lab - Lismore) – *continued*

Method	Nutrient		Units	2014 Crookwell Trial	2018 Nil	2018 SSP	2018 *Superb* (B)	2018 *BAP* (A)	2018 *Superb* (A)	*Desirable Level Loam*
Calculation	Effective Cation Exchange Capacity		$cmol^+/Kg$	11.16	11.99	8.71	10.37	9.10	9.74	*7*
Base Saturation Calculations	Calcium	Ca	%	81.2	87.5	81.7	83.5	82.4	85.3	*69*
	Magnesium	Mg	%	8.5	6.7	8.9	9.2	9.8	8.4	*16*
	Potassium	K	%	8.6	4.3	6.4	5.6	5.5	4.7	*5*
	Sodium - ESP	Na	%	0.6	0.4	0.4	0.5	0.6	0.5	*3*
	Aluminium	Al	%	0.4	0.1	1.2	0.4	0.6	0.3	*7.0*
	Hydrogen	H^+	%	0.7	0.9	1.5	0.8	1.2	0.8	
Calculation	Calcium/Magnesium Ratio		ratio	9.6	13.1	9.2	9.0	8.4	10.2	*4.31*
DTPA	Zinc	Zn	mg/kg	1.1	0.6	0.9	1.0	0.9	0.8	*4*
	Manganese	Mn	mg/kg	34	19	33	31	34	29	*18*
	Iron	Fe	mg/kg	273	95	297	225	258	202	*18*
	Copper	Cu	mg/kg	0.9	0.8	1.0	1.0	1.0	1.0	*1.6*
$CaCl_2$	Boron	B	mg/kg	0.49	0.54	0.58	0.66	0.44	0.51	*1.4*
	Silicon	Si	mg/kg	39	39	51	54	59	50	*40*
LECO IR Analyser	Total Carbon	C	%	3.70	3.52	3.70	4.19	3.66	3.79	*2*
	Total Nitrogen	N	%	0.27	0.27	0.28	0.31	0.29	0.28	*0.2*
Calculation	Carbon/Nitrogen Ratio		ratio	13.7	13.2	13.4	13.4	12.8	13.5	*10 to 12*
	Basic Texture	t		Loam	Loam	Loam	Loam	Loam	Loam	–
	Basic Colour	c		Red	Brownish	Brownish	Brownish	Brownish	Brownish	–

Crookwell Trial – Feed Quality Results (October 2017 – Forage Lab Australia)

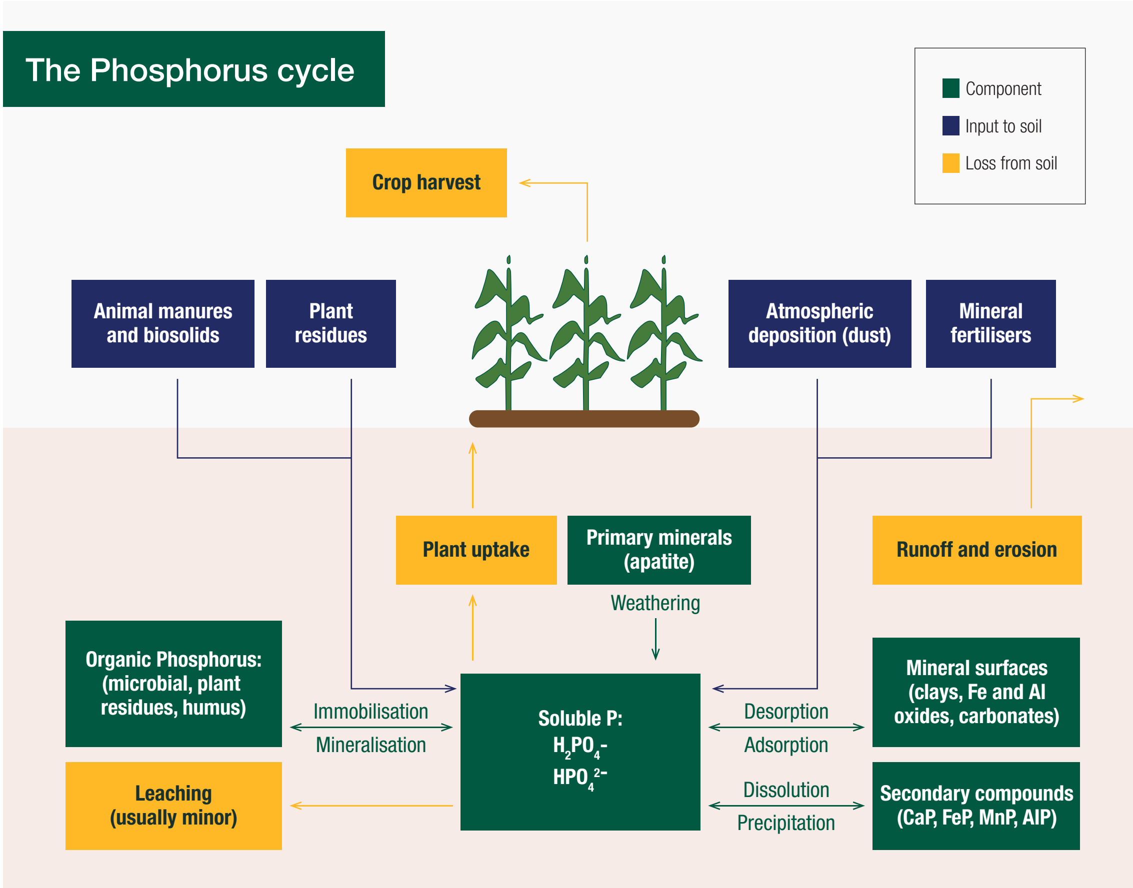
Measure	Nil	*Superb* (annual)	SSP (annual)	*BAP* (annual)
Moisture	66	68.5	68.5	65.9
Dry Matter	34	31.5	31.5	34.1
Crude Protein (%DM)	20.6	23.9	21.8	23.1
ADF (%DM)	30.9	31.8	31.7	29.3
aNDF (%DM)	58.4	50.5	54.8	52.9
Ca (%DM)	0.53	0.85	0.63	0.62
P (%DM)	0.36	0.35	0.36	0.39
Mg (%DM)	0.19	0.25	0.21	0.22
K (%DM)	2.81	3.23	3.27	3.63
S (%DM)	0.27	0.29	0.29	0.32
ME (mj/kg DM)	10.5	10.4	10.3	10.3
Relative Feed Value (RFY)	103	118	109	116

The results indicate an improvement in crude protein when using sustained release fertilisers (*Superb*® and *BioAgPhos*®); which in turn delivered a higher Relative Feed Value.

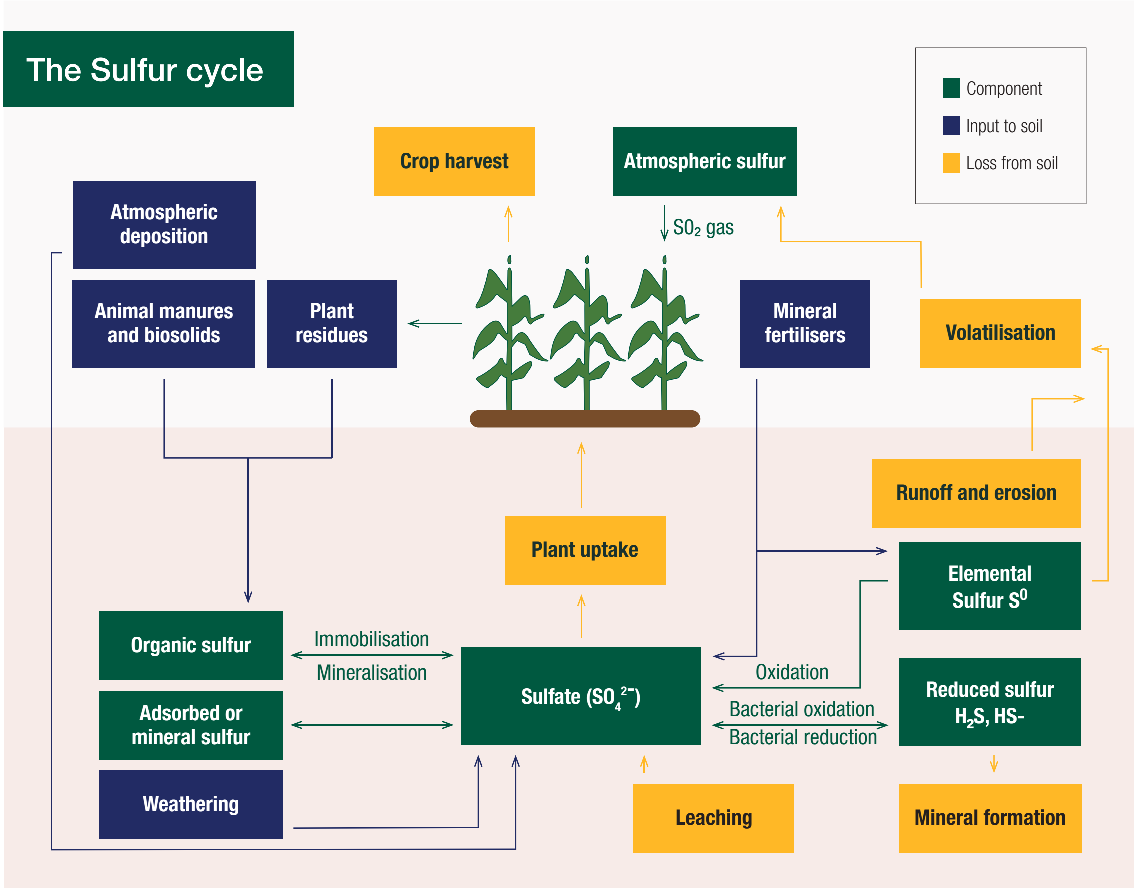
In addition there was an increase in the feeds calcium content when using *Superb*®.

These aspects will be evaluated further in future trials.

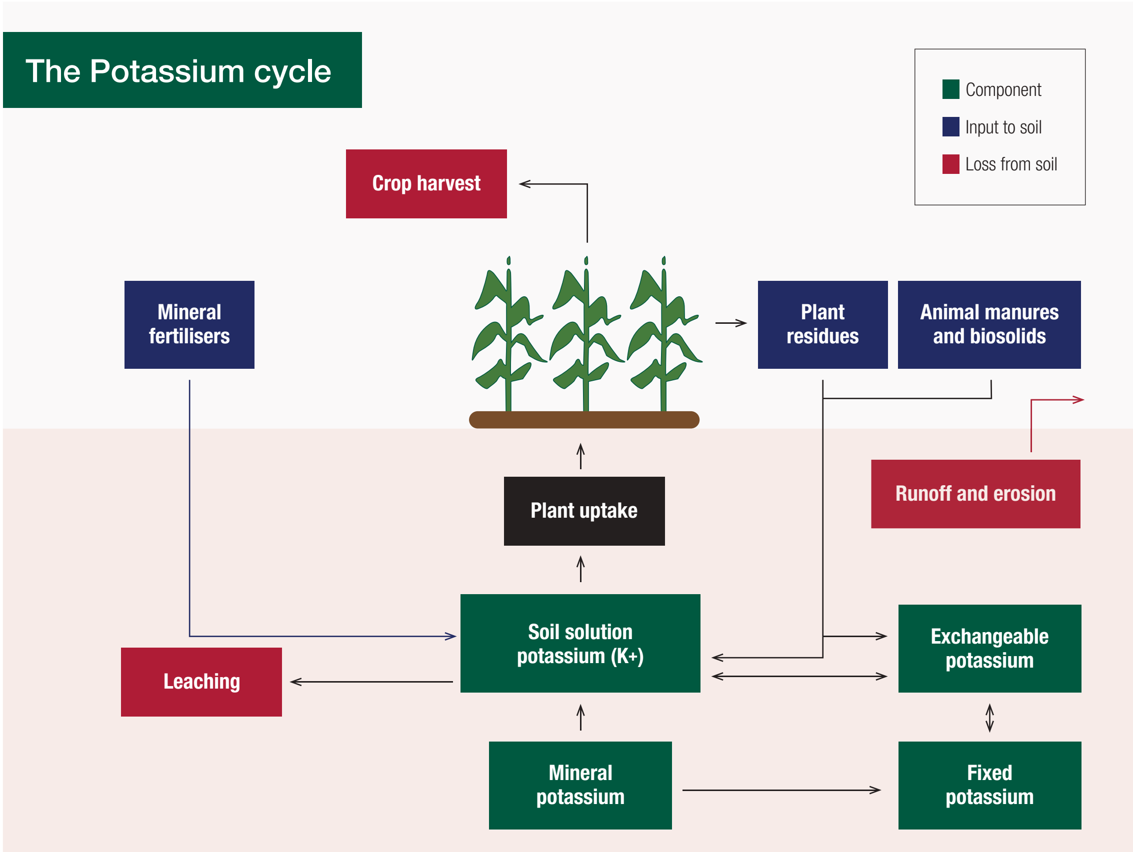
Phosphate (P) Cycle



Sulfur (S) Cycle



Potassium (K) Cycle



Further Reading/Information

1. The Role of Reactive Phosphate Rock Fertilisers for Pastures in Australia: Australian Journal of Experimental Agriculture, Volume 37, Number 8, 1997, 845-1098 *www.iaea.org/inis/collection/NCLCollectionStore/_Public/33/019/33019248.pdf*
2. Australian Soil Fertility Manual (JS Glendinning) Revised Edition FIFA
3. Australian Bureau of Meteorology *www.bom.gov.au/climate/averages/tables/cw_070025.shtml*
4. Hamilton Long Term Phosphate Trial *www.evergraze.com.au/library-content/long-term-phosphate-trial/* *www.grassland.org.nz/publications/nzgrassland_publication_219.pdf*
5. Forage Lab Australia *www.foragelabaustralia.com.au*
6. Use of Phosphate Rocks for Sustainable Agriculture: FAO FERTILIZER AND PLANT NUTRITION BULLETIN No.13
7. Effectiveness of Reactive Phosphate Rock for P Fertility Management in Broad-Acre Organic Cropping: RIRDC Publication No. 10/213

Acknowledgements

BioAg would like to acknowledge the help of McGeechan Farm Supplies (Crookwell) and its staff for its help throughout the trial and to Mick McGeechan for hosting BioAg and allowing the trial to go forward.

More Information

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