GECKO CLaN

Growing Soil Carbon

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Landcare Victoria Inc.

Australian Government

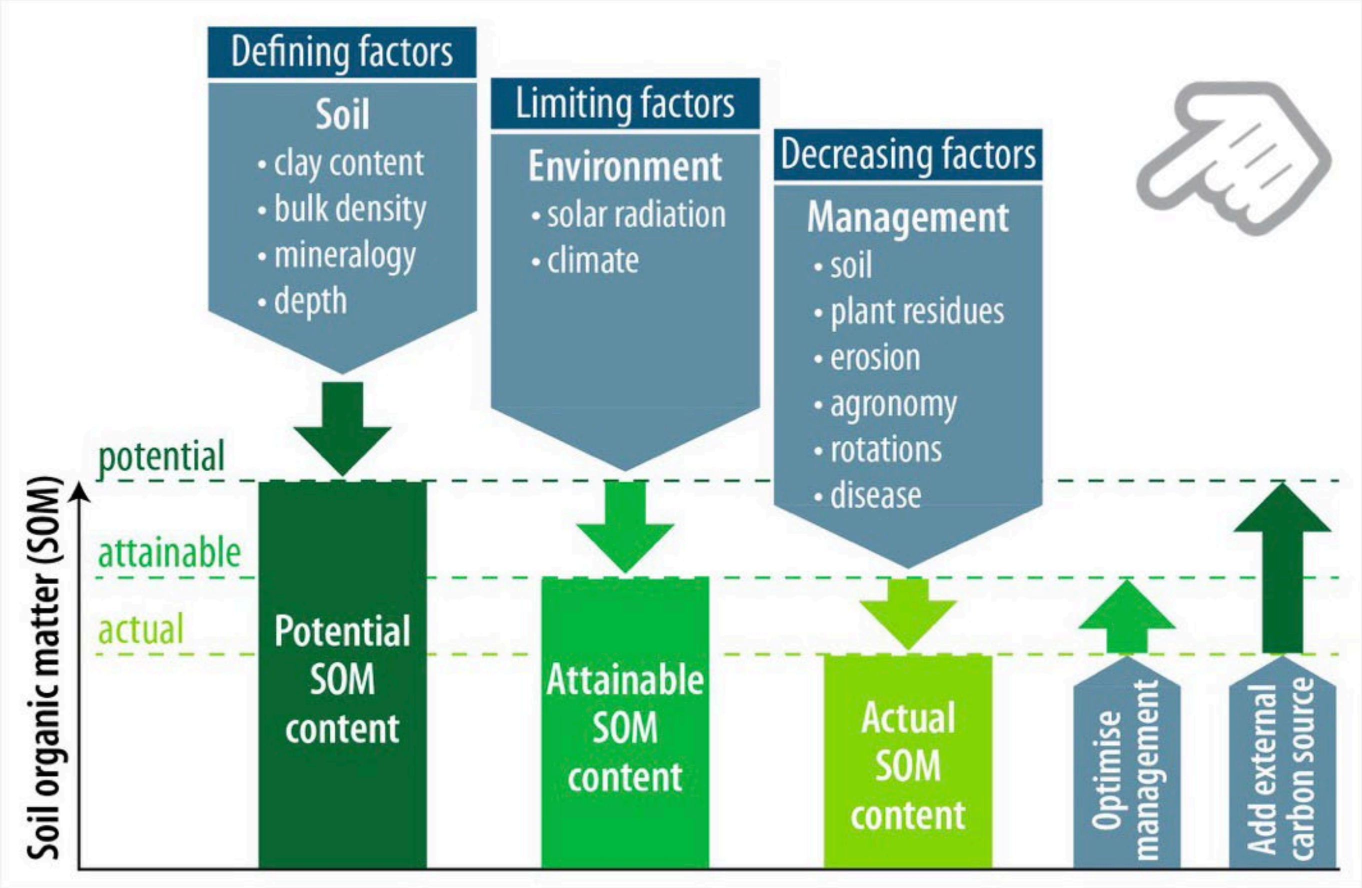
National Landcare Program

Soil Carbon

- **Ross Garnaut**: "Australia can make an exceptional contribution to climate action by creating natural systems to store more carbon in soils"

- **Low Emissions Technology Statement** suggests that increasing soil carbon could reduce Australian emissions by between 4-16 percent.

How realistic is it to increase soil C ?



The capacity of a soil to retain organic matter is typically defined by texture (soil type), climate and, to a lesser extent, management.

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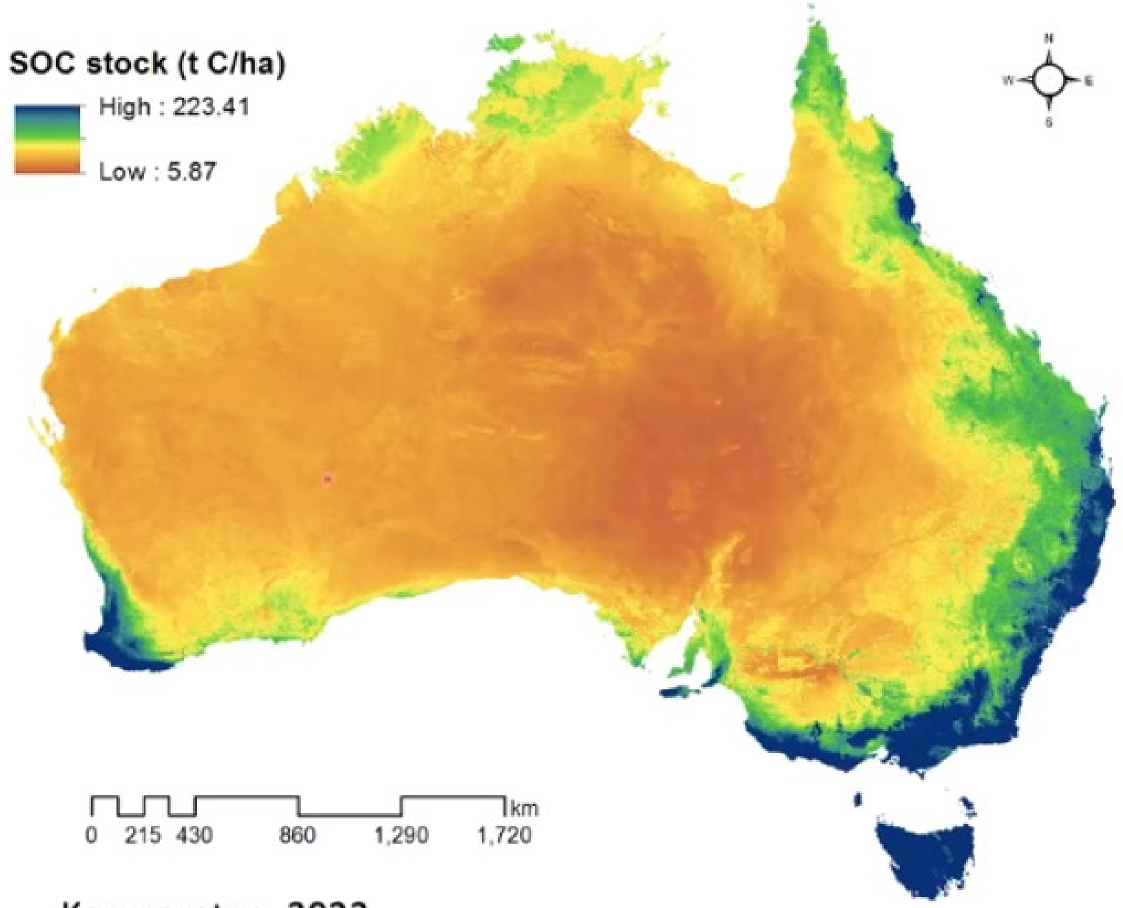
Requirements to increase soil C



Karunaratne, 2022

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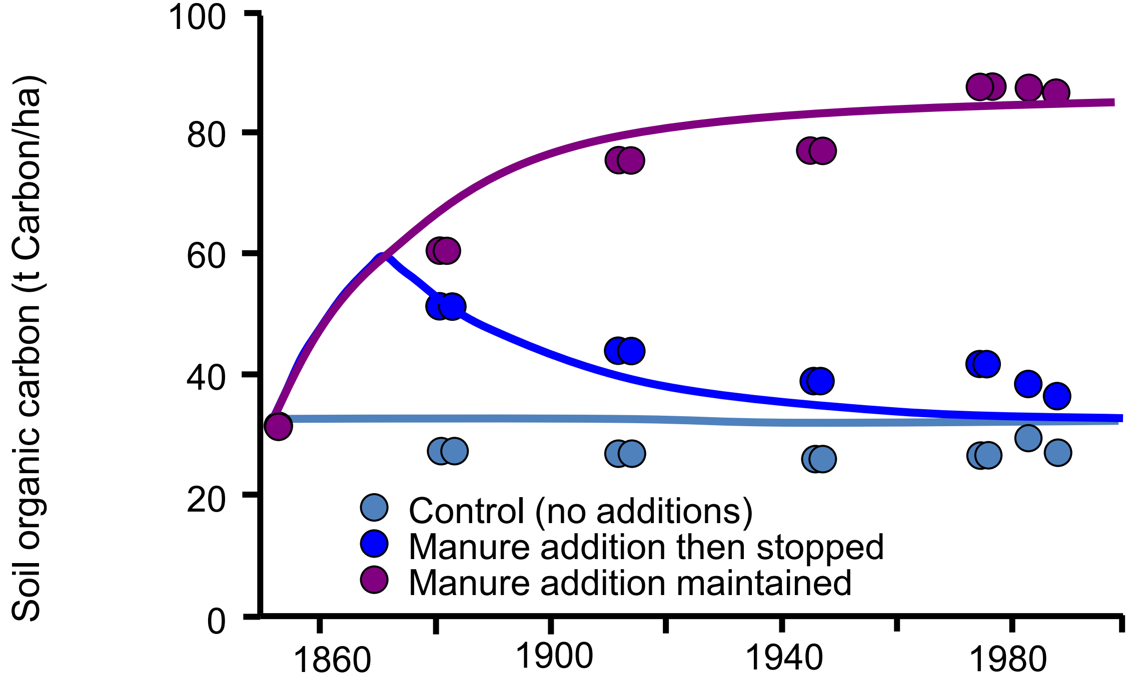
Soil carbon: saturation and permanence



From Petersen et al 2005

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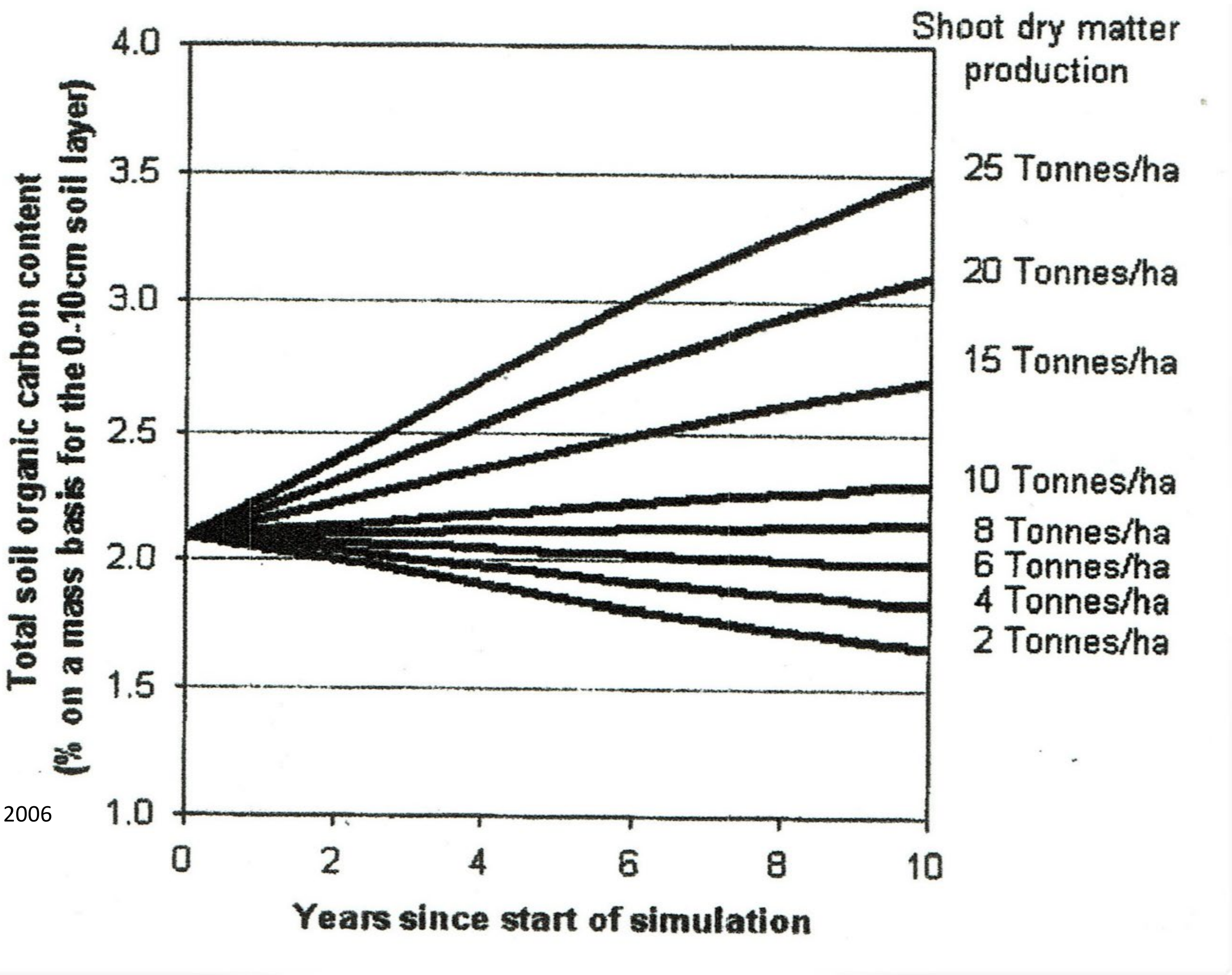
DM Production required for Soil Carbon Increase
(Yass)



Baldock 2006

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Carbon Accumulation

Pasture System	Soil Carbon Sequestration	Difference
Native	42.8	Not Significant
Introduced	40.4	
Annual	43.7	Not Significant
Perennial	39.7	
Continually Grazed	38.5	Not Significant
Rotationally Grazed	39.5	
Control	41.7	Not Significant
Pasture Cropping	41.9	
Unimproved	36.1	**Significant**
Fertilized	46.0	

Chan et al. 2010

Hamilton Long-Term Phosphate Experiment

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Building Soil Carbon – a Slow Burn

Hamilton Long Term Pasture Trial

– After 25 years – a trend but no statistically differences in soil carbon between fertility treatments.

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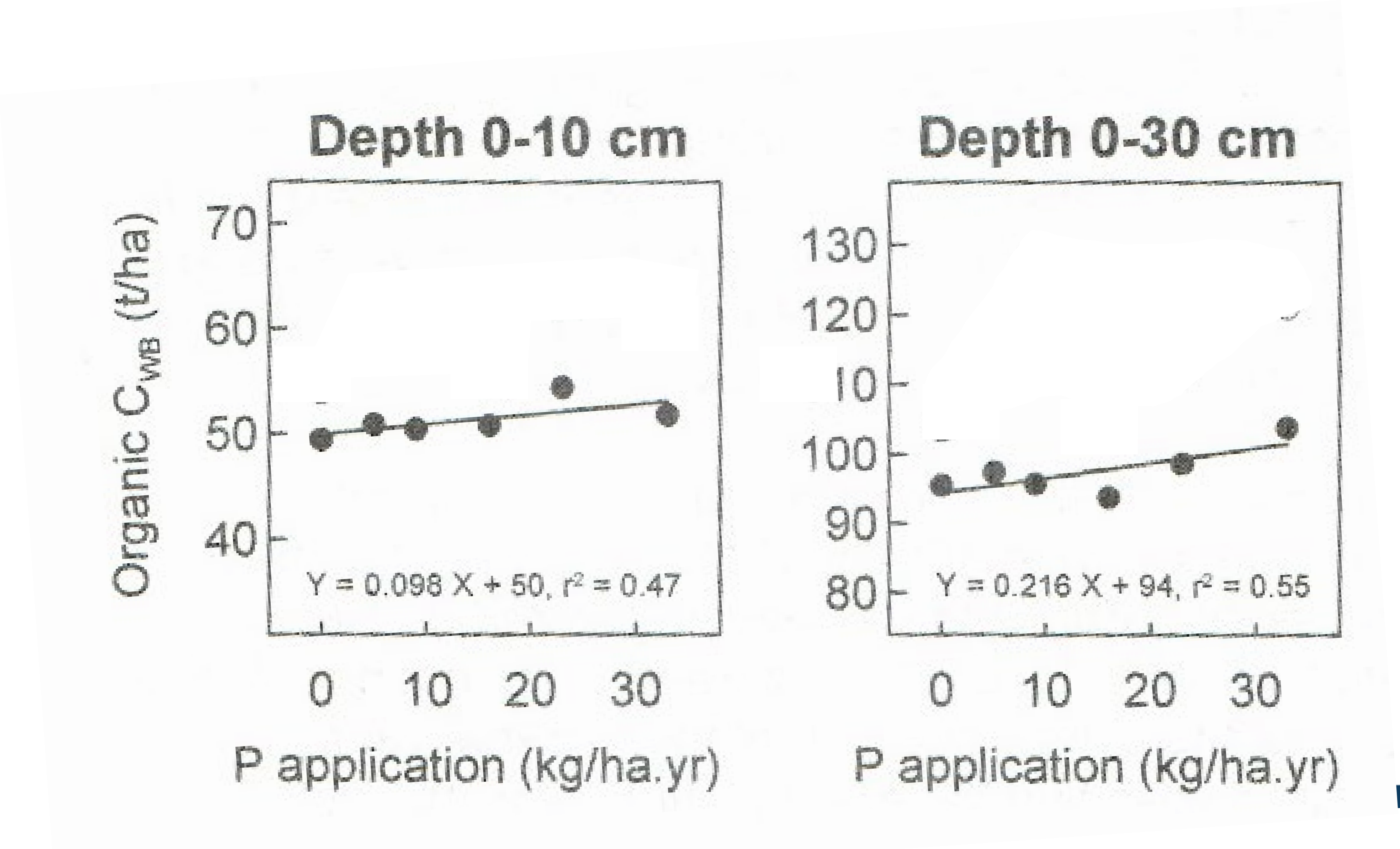
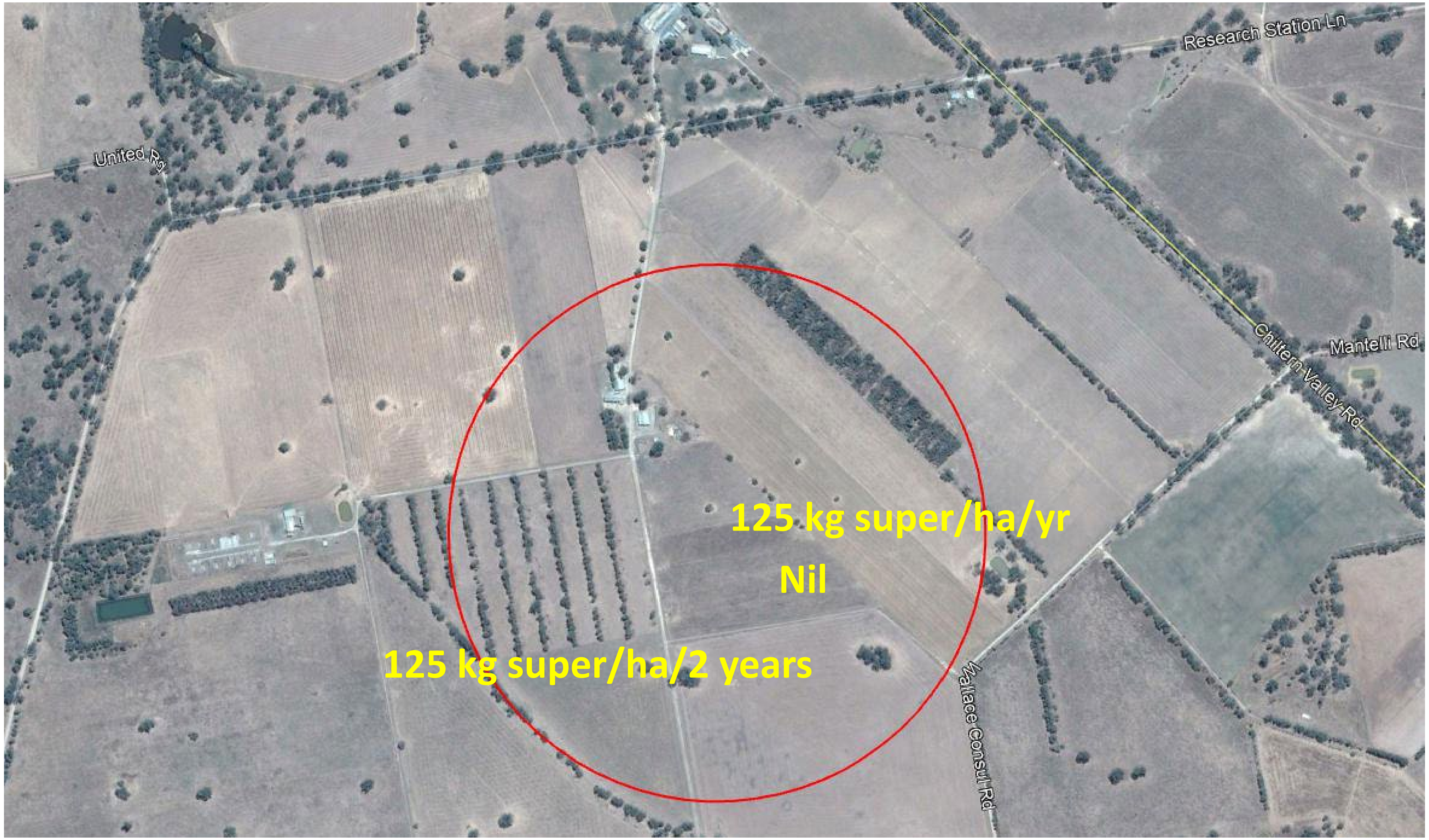
Hamilton Long Term Pasture Trial



Pasture Topdressing Demonstration – Rutherglen Research Institute



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Rutherglen PTD

- Treatments analysed after 100 years

- Annual increase in soil C over that period

  0.01% per year

  1% over 100 years

Because of the technical uncertainty in measuring small soil C changes and the higher cost of stabilising any gain in soil C compared with the C credit earned, carbon sequestration in Australian agricultural soils as a means of offsetting a significant part of the national GHG emissions is technically limited and economically nonviable at the present time.

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Review of Straw Retention Trials

- Total Soil Organic Carbon
  - Small increase in soil organic carbon (SOC) – significant in 6 out of 25
- Microbial biomass
  - Changes in response to straw return/removal proportionally much greater than total SOC
- Soil Physical Properties
  - Larger impacts – greater aggregate stability
    - Even when no measurable change in total SOC

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- Decomposed soil organic matter has fixed ratios of carbon to other nutrients:
  - Carbon:Nitrogen = 10:1
  - Carbon:Sulphur = 54:1
  - Carbon:Phosphorus =155:1

Relative Importance for Profitability

Stocking Rate/Stock Numbers	8
Herd/Flock Fertility	4
Animal Growth Rate	2
Carcase Characteristics	1

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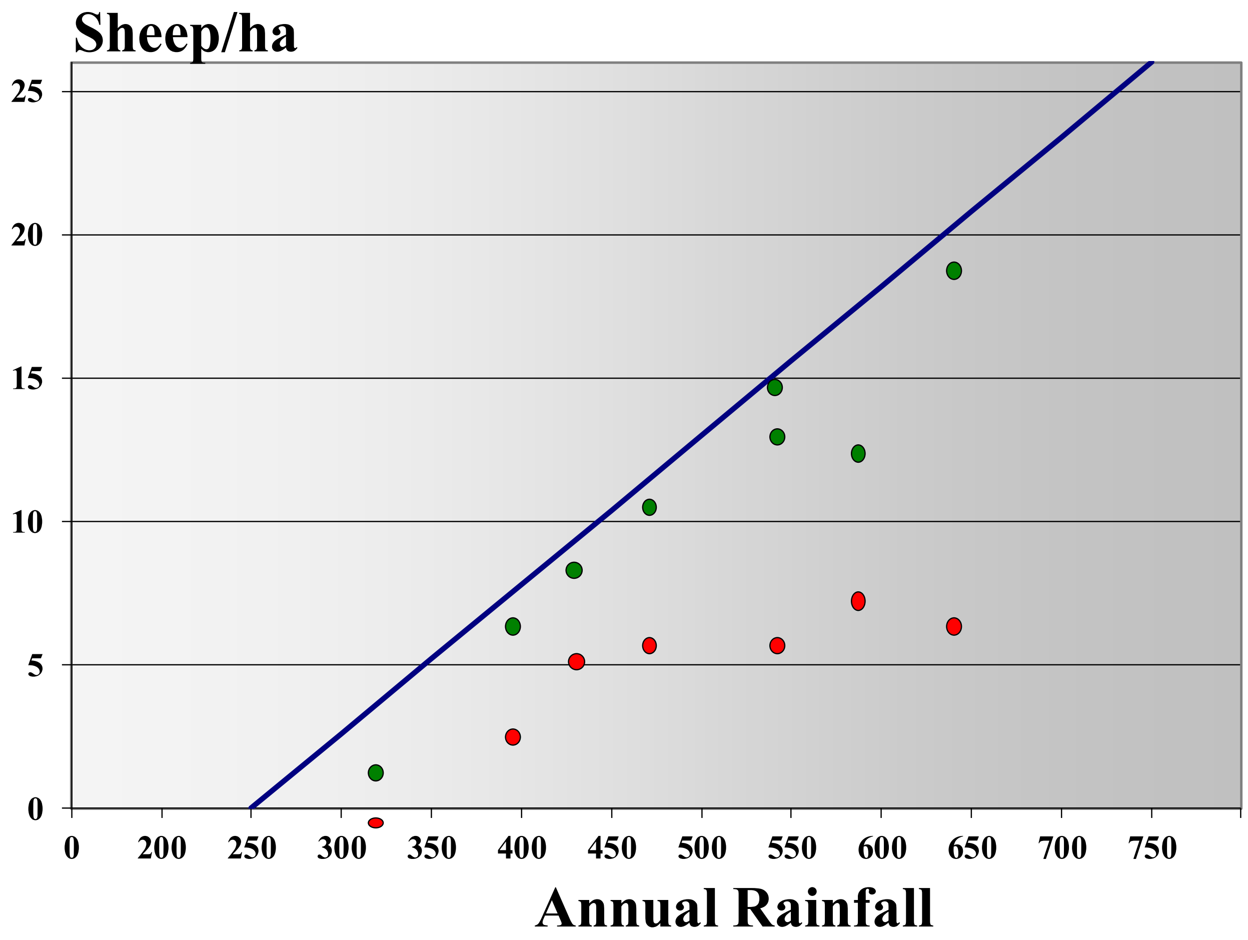
Carrying Capacity v Annual Rainfall - S Aust



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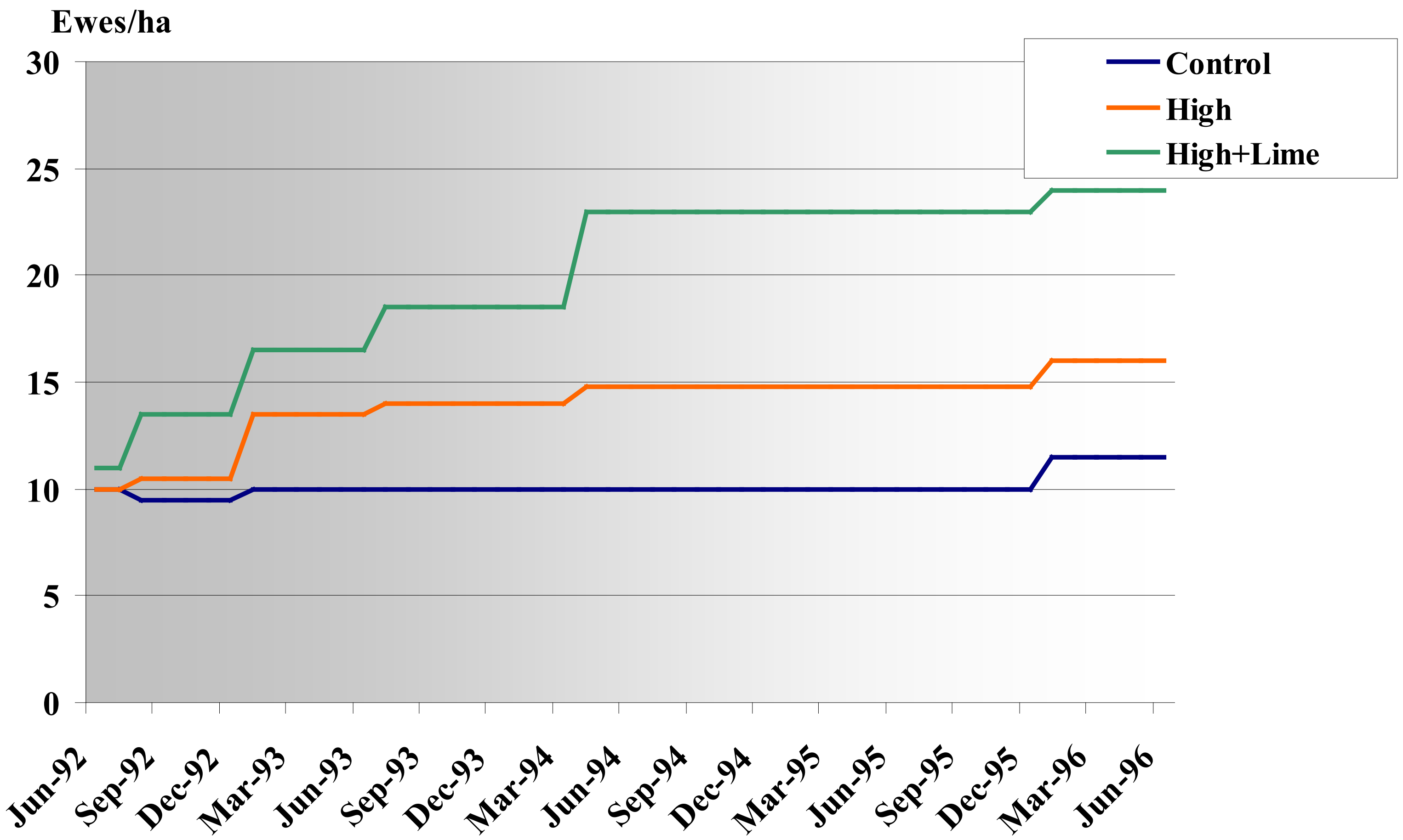
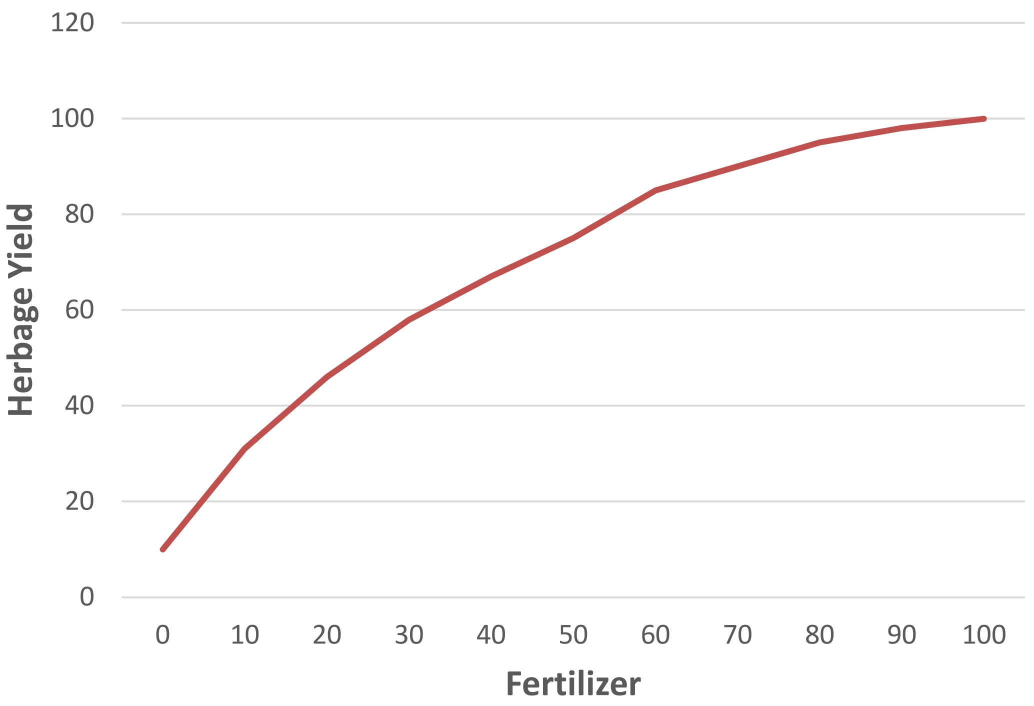
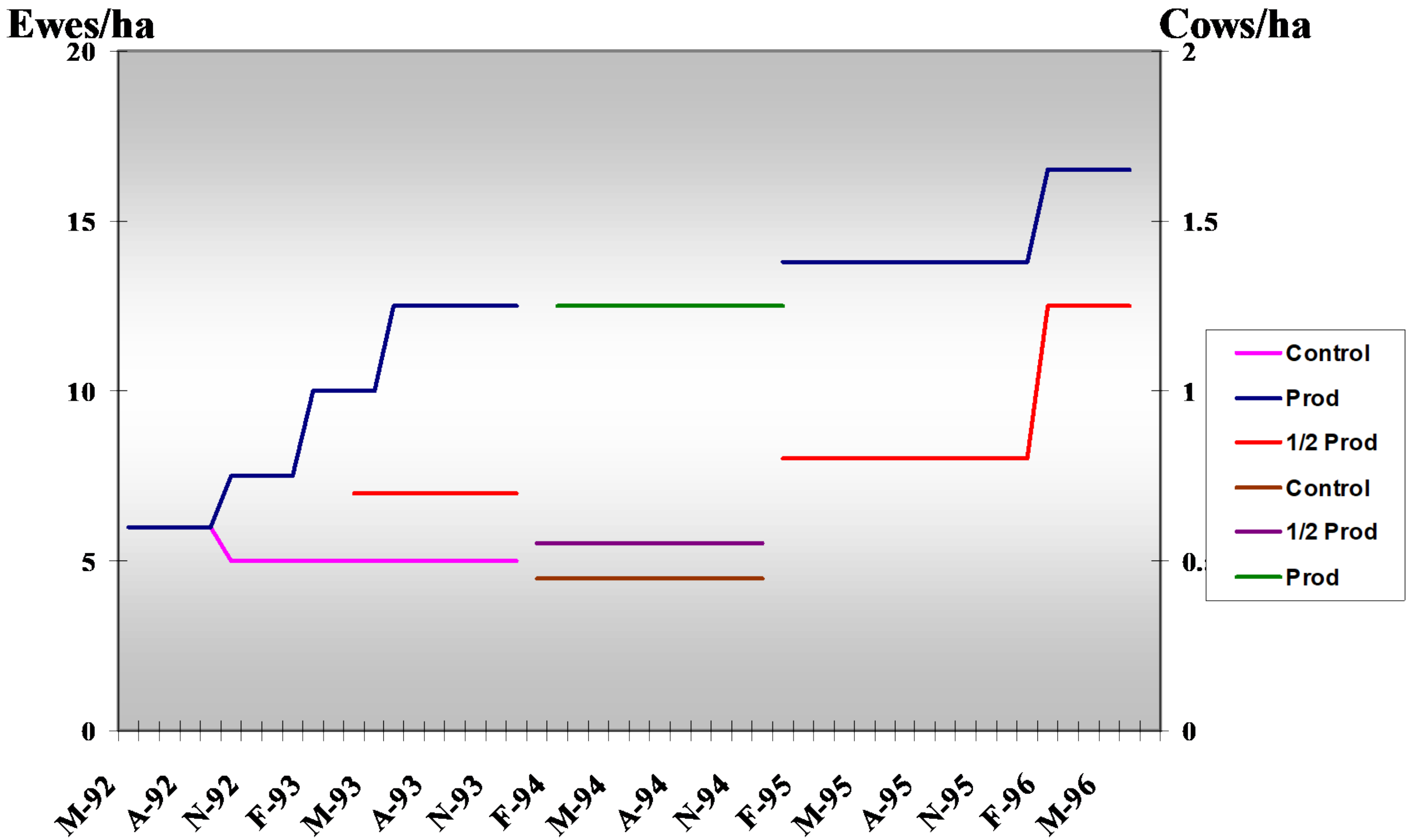
Changes in Stocking Rate, Yea, VIC



Stylised pasture response in cutting trials



Changes in Stocking Rate, Longwood VIC



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Molybdenum Response

Potential Stocking Rate (DSE/ha)

	Growing Season (Months)					
		5	**6**	**7**	**8**	**9**
Paddock size	Greater than 20 ha	8	11	14.5	18	21
	Less than 20 ha	11	14	17.5	21	24

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Pasture Resilience, Longwood VIC

Trace Elements (ex Moly)

PADDOCK	Boron	Copper	Zinc	Manganese
	mg/kg	mg/kg	mg/kg	mg/kg
A	0.34	0.57	1.3	50
B	0.37	0.72	1.1	92
C 1	0.26	0.7	0.67	99
C 2	0.18	0.36	0.59	37
D	0.34	0.81	1.8	120
E	0.27	0.69	0.62	74
F	0.25	0.64	0.79	91
G	0.22	0.45	1.3	29

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Effect of Lime and Boron on Herbage and Seed yields of Sub Clover – Pot Trials

Treatment		Total Herbage	Seed	HWS B
No Lime	No Boron	56.6	3.5	0.17
No Lime	Boron	56.1	21.5	0.29
Lime	No Boron	20.8	0.5	0.10
Lime	Boron	56.2	28.1	0.37

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Boron – response to foliar application

Dandelion Problem

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Fertility Solution

Fertility Solution

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Calcium Magnesium Ratios

- **Effect of Ca:Mg Ratio on Lucerne Yield** (Uni Wisconsin)

Ca:Mg Ratio	Lucerne t/ha
2.3	3.7
3.4	3.7
4.1	3.8
4.8	3.8
5.3	3.9
8.4	3.6

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Calcium Magnesium Ratios

Ca:Mg Ratios of Highest & Lowest Yielding Sites (Corn) (Ohio State Uni)

Yield Level	Ca:Mg Ratios	
	1975	1976
5 Highest Yielding Sites	5.7 – 26.8	5.7 – 26.8
5 Lowest Yielding Sites	5.8 – 21.5	5.0 – 16.0

Variation Between Paddocks (% paddocks)

Farm # (pdks)	Nil	P Only	K Only	Lime Only	P & K	P & Lime	K & Lime	P K & Lime
1 (47)	32	19	11	0	11	5	5	16
2 (37)	24	27	8	3	35	3	0	0
3 (54)	3	11	29	3	34	0	9	11

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Within Paddock Variation

ANALYSIS					TOPSOIL AVERAGE
pH	(CaCl2)				4.3
Phosphorus	(Olsen)				18
Potassium	(Colwell)				146
Sulphur	(KCL40)				11
Aluminium % of cations					17%

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Within Paddock Variation

ANALYSIS		UPPER THIRD			TOPSOIL AVERAGE
pH	(CaCl2)	4.4			4.3
Phosphorus	(Olsen)	20			18
Potassium	(Colwell)	177			146
Sulphur	(KCL40)	10			11
Aluminium % of cations		11%			17%

Within Paddock Variation

ANALYSIS		UPPER THIRD	MIDDLE THIRD		TOPSOIL AVERAGE
pH	(CaCl2)	4.4	4.3		4.3
Phosphorus	(Olsen)	20	20		18
Potassium	(Colwell)	177	174		146
Sulphur	(KCL40)	10	13		11
Aluminium % of cations		11%	15%		17%

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Within Paddock Variation

ANALYSIS		UPPER THIRD	MIDDLE THIRD	BOTTOM THIRD	TOPSOIL AVERAGE
pH	(CaCl2)	4.4	4.3	4.2	4.3
Phosphorus	(Olsen)	20	20	15	18
Potassium	(Colwell)	177	174	89	146
Sulphur	(KCL40)	10	13	9	11
Aluminium % of cations		11%	15%	24%	17%

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Paddock Sample vs Ave of Precision Samples

Site	pH		Colwell Phosphorus		Potassium	
	Bulk	Precision	Bulk	Precision	Bulk	Precision
BUNGEET	4.8	4.7	19	22	270	281
BENALLA	4.6	4.6	41	64	160	180
EARLSTON	5.0	4.9	130	102	120	141
LONGWOOD	5.0	5.0	82	45	160	140

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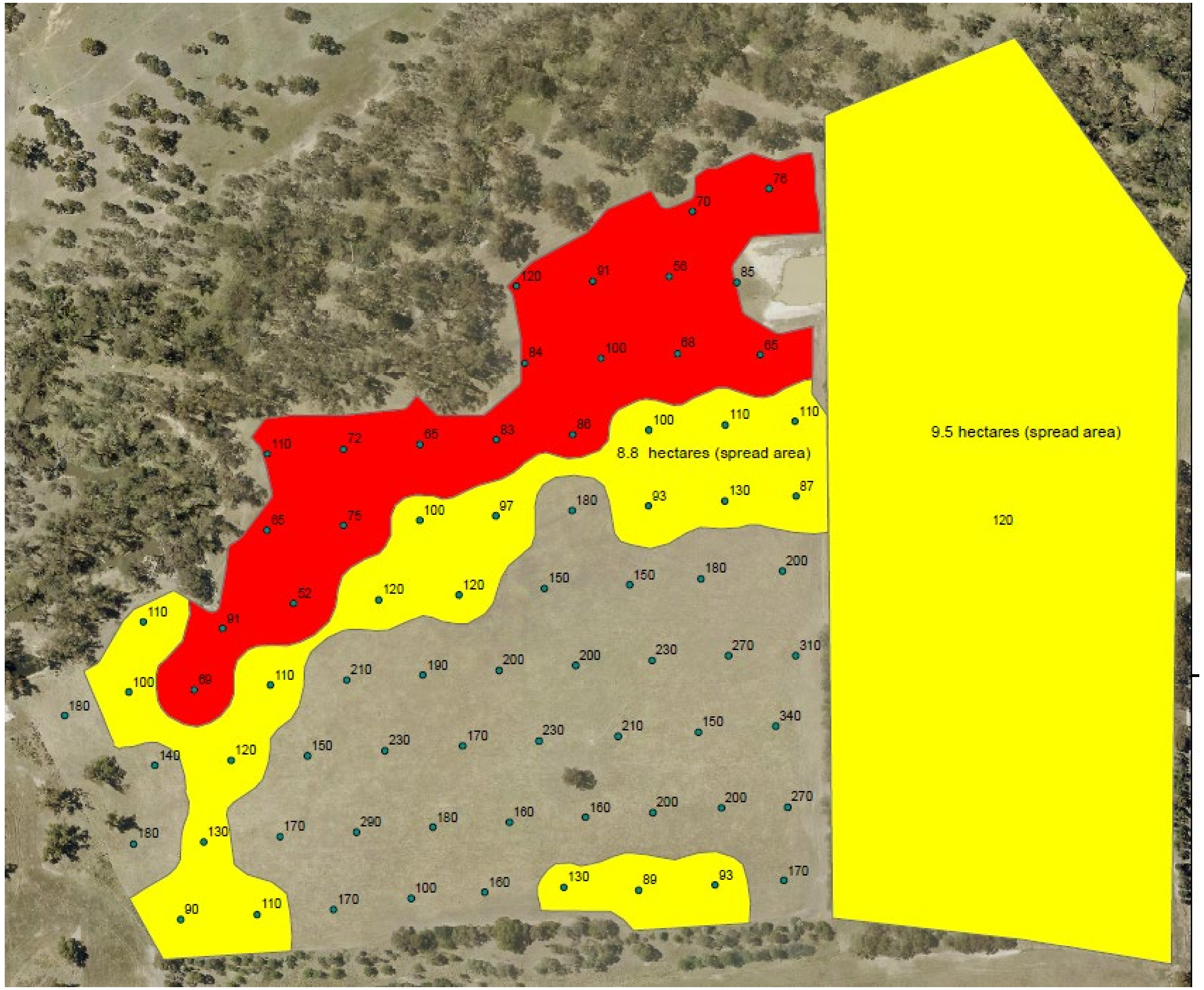
Potassium variation - Earlston



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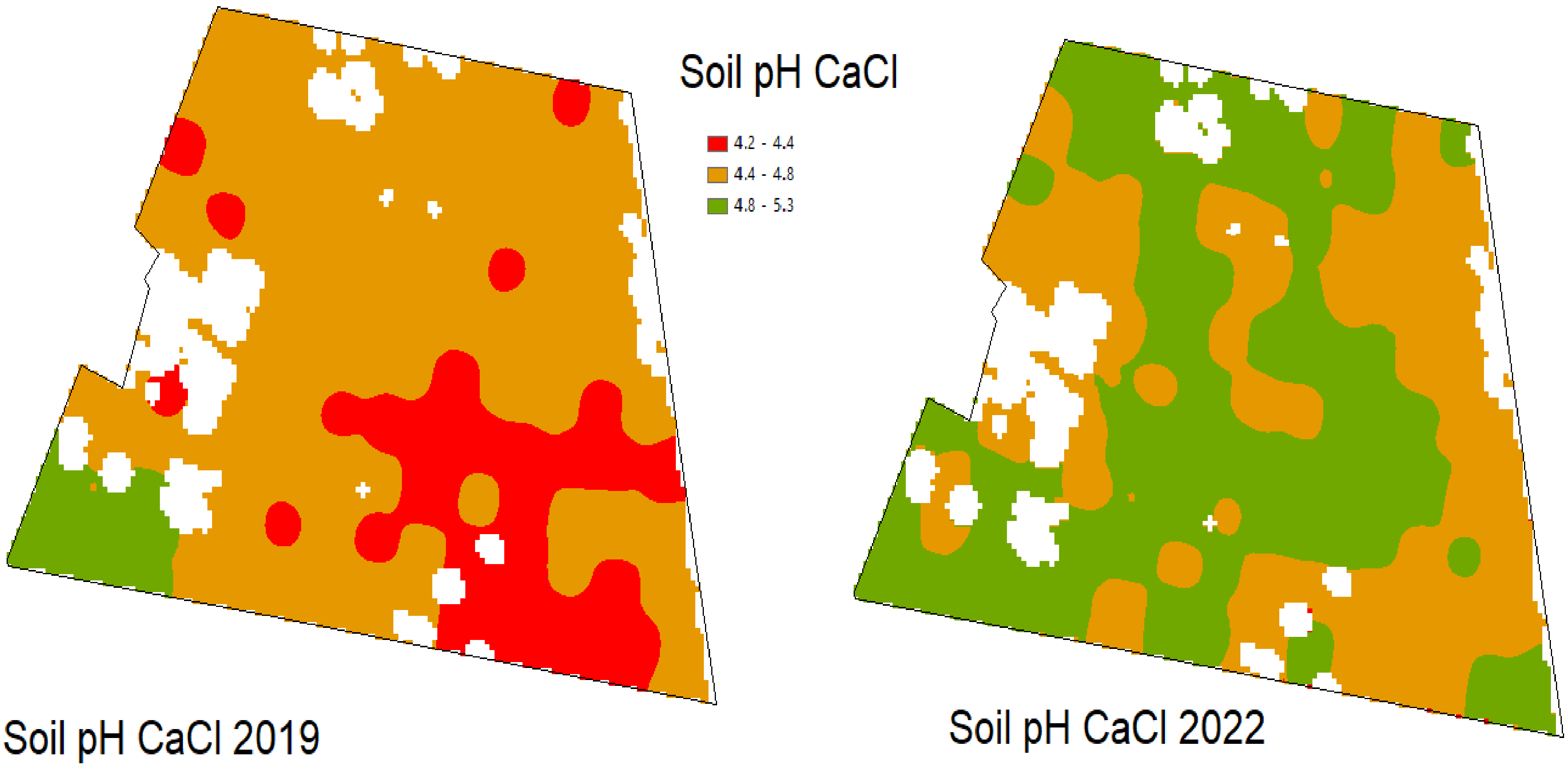
Change in soil pH ($CaCl_2$) at Benalla trial site.



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Sampling

Testing

- Soil Test for pH and major nutrients
  - Phosphorus, Potassium, Sulphur.
  - Some indication for trace elements

- Plant Test (Clover) for trace elements

- Blood Test for animal deficiencies
  - Follow up with mixed herbage samples if need clarification for the causes of some animal deficiencies.

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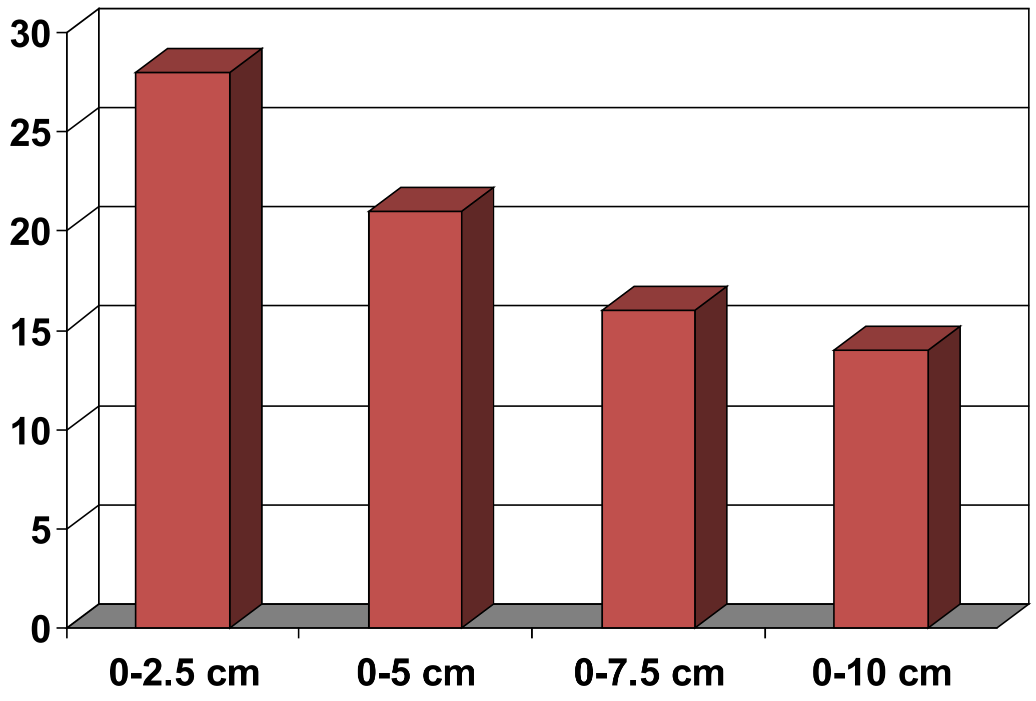
Sampling

- Number of Samples
- Sample Depth
- Time of Sampling
- Sample pattern

Effect of Depth of Sampling on P Value



Signs of Potassium Deficiency

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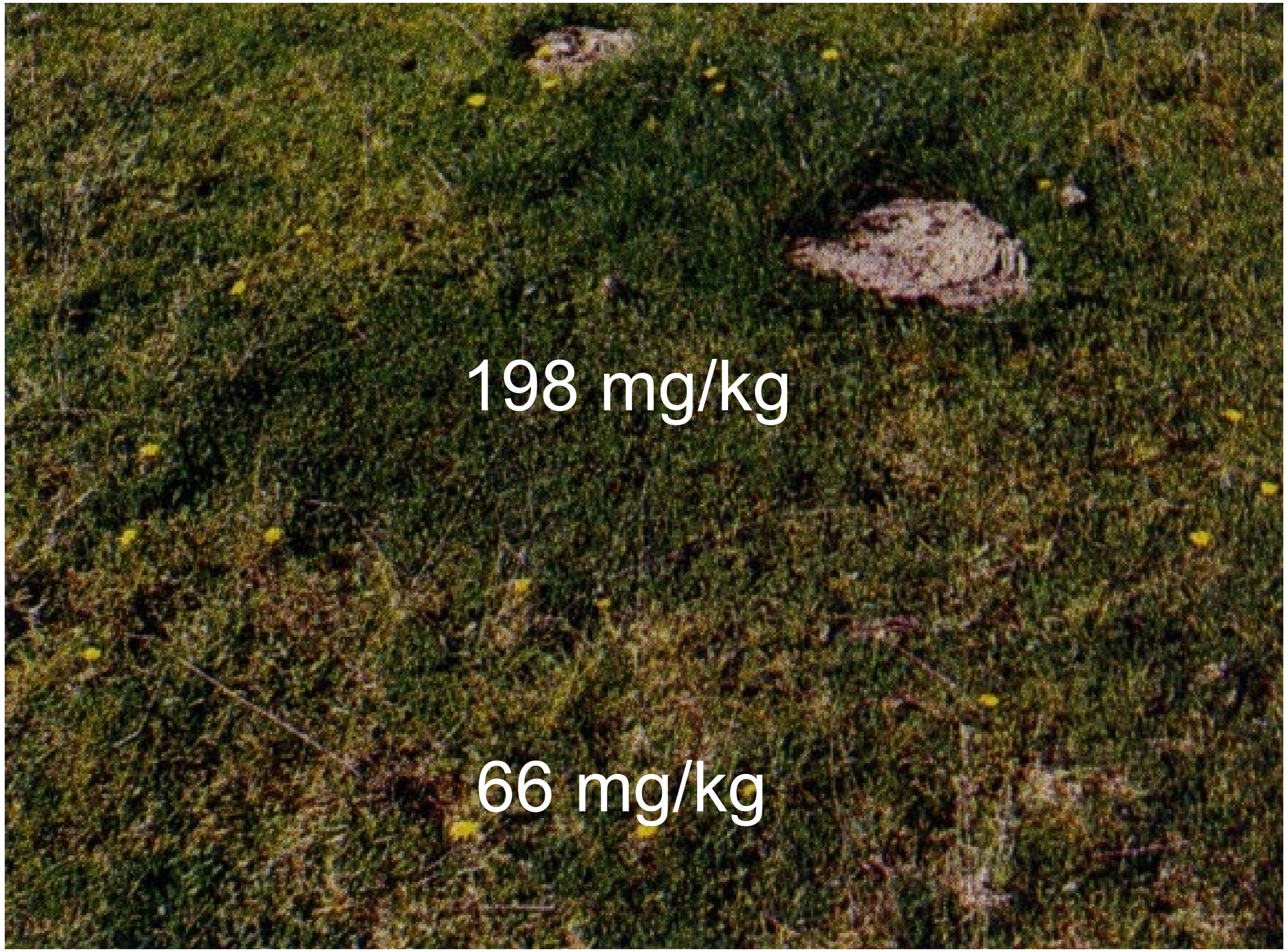
Signs of Potassium Deficiency



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Which Paddocks to Fertilize

pH	Al%	Phosphorus	Potassium
5.6	0.1	8	256
4.8	0.60%	5.3	220
4.7	3.30%	11	160
4.7	2.40%	17	100
4.7	2.40%	1.3	224
4.6	4.40%	13	203
4.6	2.20%	2.6	98
4.3	24%	18	185
4.3	20%	24	110
4.2	25%	4.8	88

Each paddock is 10ha – fertilizer budget is $5000

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Which Paddocks to Fertilize - Lime

pH	Al%	Lime	Cost/ha @$75/t	Cost/paddock
5.6	0.1			
4.8	0.60%			
4.7	3.30%			
4.7	2.40%			
4.7	2.40%			
4.6	4.40%			
4.6	2.20%			
4.3	24%	2.5t/ha	$187.5	$1875
4.3	20%	2.5t/ha	$187.5	$1875
4.2	25%	3 t/ha	$225	$2250

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Which Paddocks to Fertilize -Phosphorus

Phosphorus	Capital P	Annual P/ha	Cost/ha @$6.1/kg	Cost/paddock
8	63	21	$128	$1280
5.3	83	27	$165	$1650
11	35	9	$55	$550
17	0		0	
1.3	118	39	$238	$2380
13	17		0	
2.6	105	35	$214	$2140
18	0		0	
24	0		0	
4.8	87	29	$177	$1770

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Which Paddocks to Fertilize -Potassium

Potassium	kg K/ha	Cost/ha @	Cost/paddock
256	0		
220	0		
160	0		
100	50	$130	$1300
224	0		
203	0		
98	50	$130	$1300
185	0		
110	50	$130	$1300
88	50	$130	$1300

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Total Paddock Cost

Lime	Phosphorus	Potash	Total
0	$1280		$1280
0	$1650		$1650
0	$550		$550
0		$1300	$1300
0	$2380		$2380
0			
0	$2140	$1300	$3440
$1875			$1875
$1875		$1300	$3175
$2250	$1770	$1300	$5320

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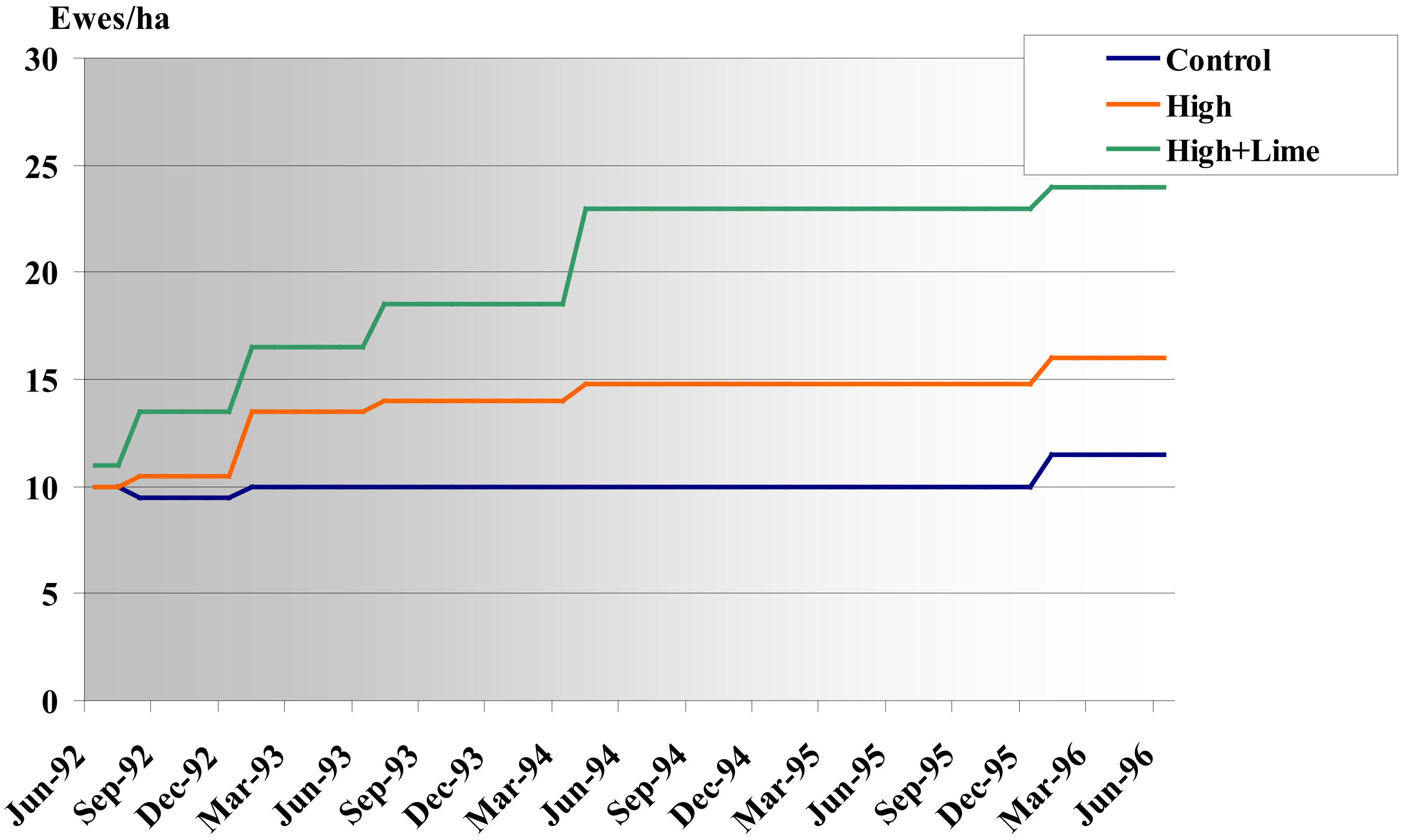
Developing a Fertilizer Strategy

- Prioritise paddocks
  - Soil test,
  - Fix everything
  - Treat single deficiencies first
- Apply capital dressings to correct deficiencies over 2 -3 years -(or maintenance dressings)
  - Select least cost fertilizer
- Allocate enough resources for extra stock

Grow more Grass, Increase SR, Increase Soil Carbon



Fertility & Worms

Site	Treatment	No worms per square metre
Yea	Low Fertilizer	193
	High Fertilizer	331
Mansfield	Nil Fertilizer	28
	High Fertilizer	75

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