

Tolerance of lucerne to soil acidity

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Overview

- Breeding for specific traits: TA37
- Breeding for adaptation: SARDI 7 Series 2
- Field evaluation
 - Nodulation
 - Persistence
 - Forage Yield
 - Impact of lime
- Summary

Intolerance of lucerne to acidic soils

- **Poor root growth**
 - Tolerance to low pH
 - Aluminium toxicity
 - Mn, availability other nutrients
- **Poor nodulation**
 - **Survival of Rhizobia in soil**
 - **Nodulation potential of plant**



**Selection for
improved root
growth**



Identification of acid
tolerant rhizobia



Selection for
improved plant
nodulation



1. The Screening System



pH 4.5
25-75uMol Aluminum
Low ionic strength McNights
solution (minus N)
2-3 weeks



2. Selecting the longest roots

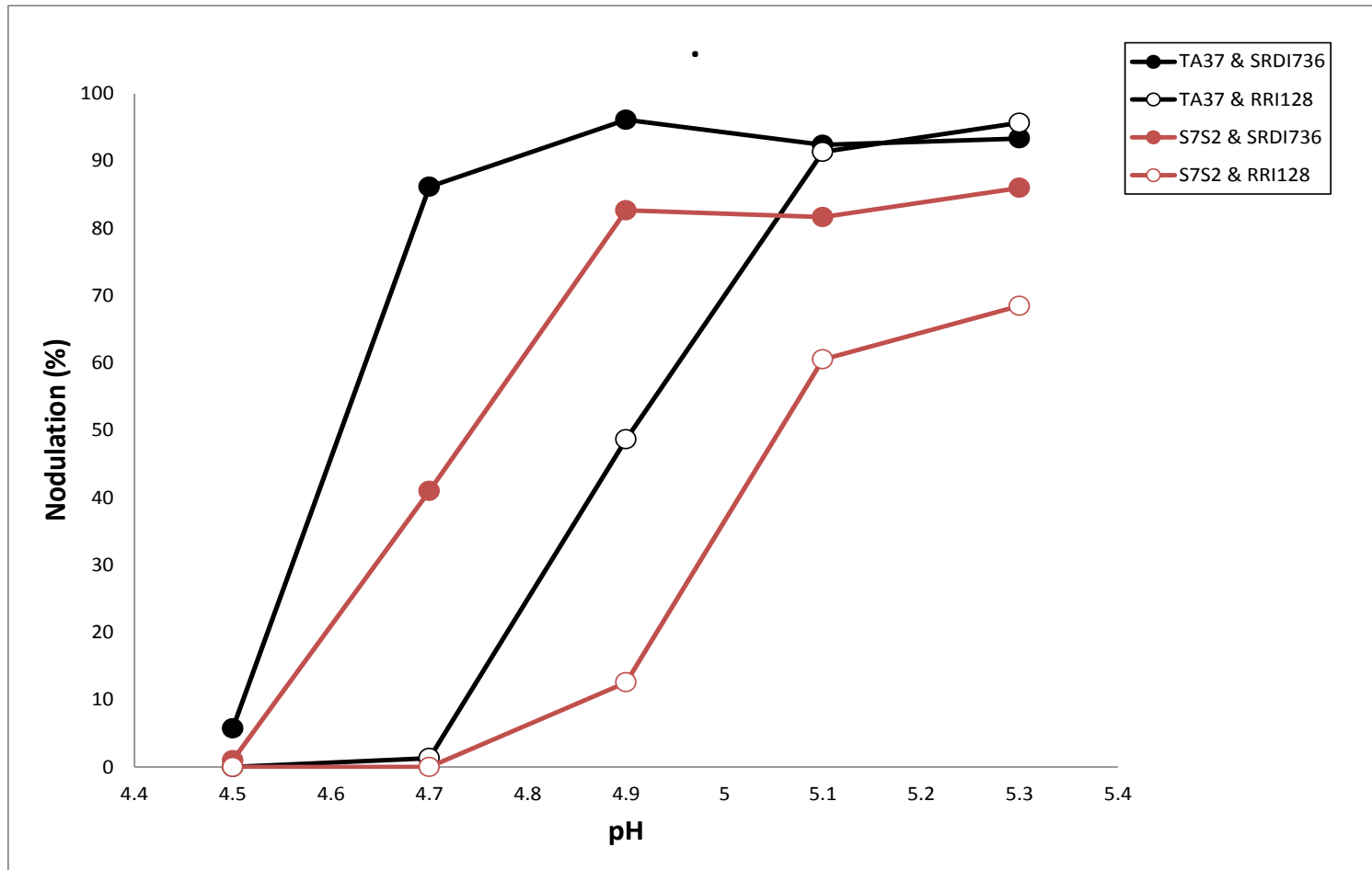


multiple trait selection



Nodulated plants with long roots

Nodulation x pH in solution





SARDI 7

Average <2% nodulation

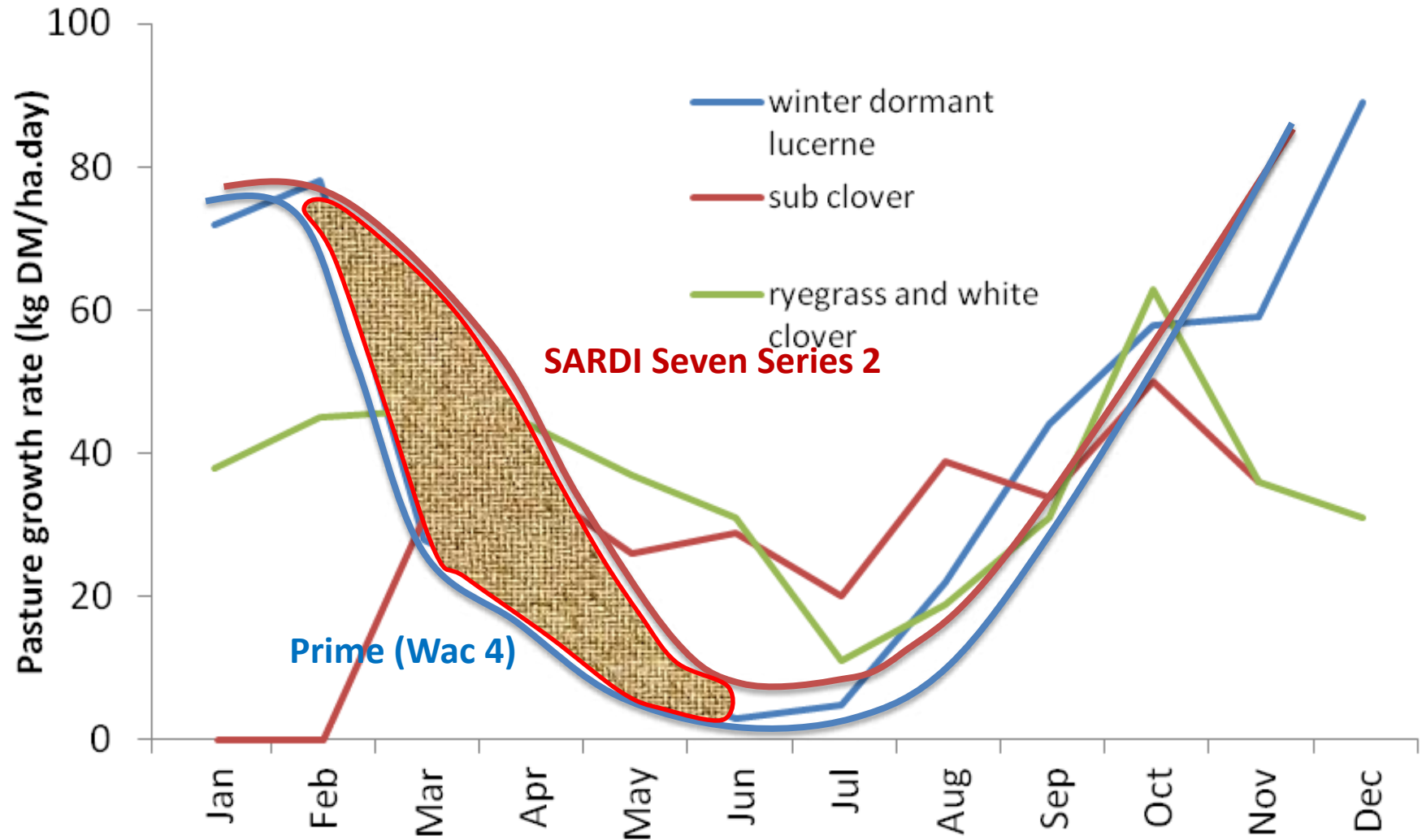
TA33

2 cycles selection for nodulation
~60% nodulation

- Target:
 - Very persistent, especially in the colder, wetter regions with acidic soils. Aim was to replace winter active 3-5's in these environments.
 - Excellent aphid and disease tolerance
- Method:
 - 30 years of recurrent selection for these environments.
 - Evaluation trials sown unfenced and managed by farmers

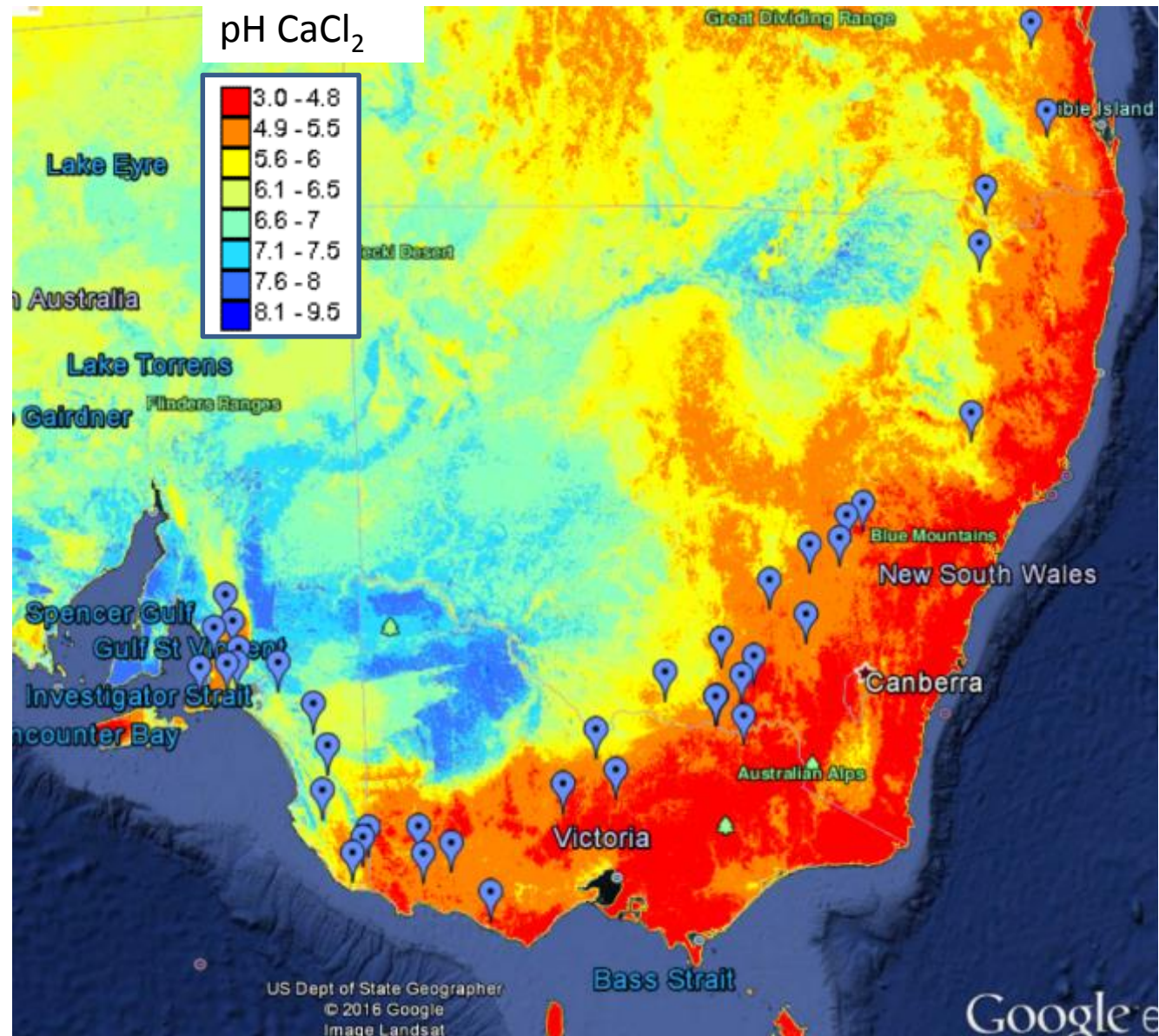
Forage growth rates for irrigated lucerne subterranean clover and ryegrass and white clover

from Kelly *et al.* (2005)

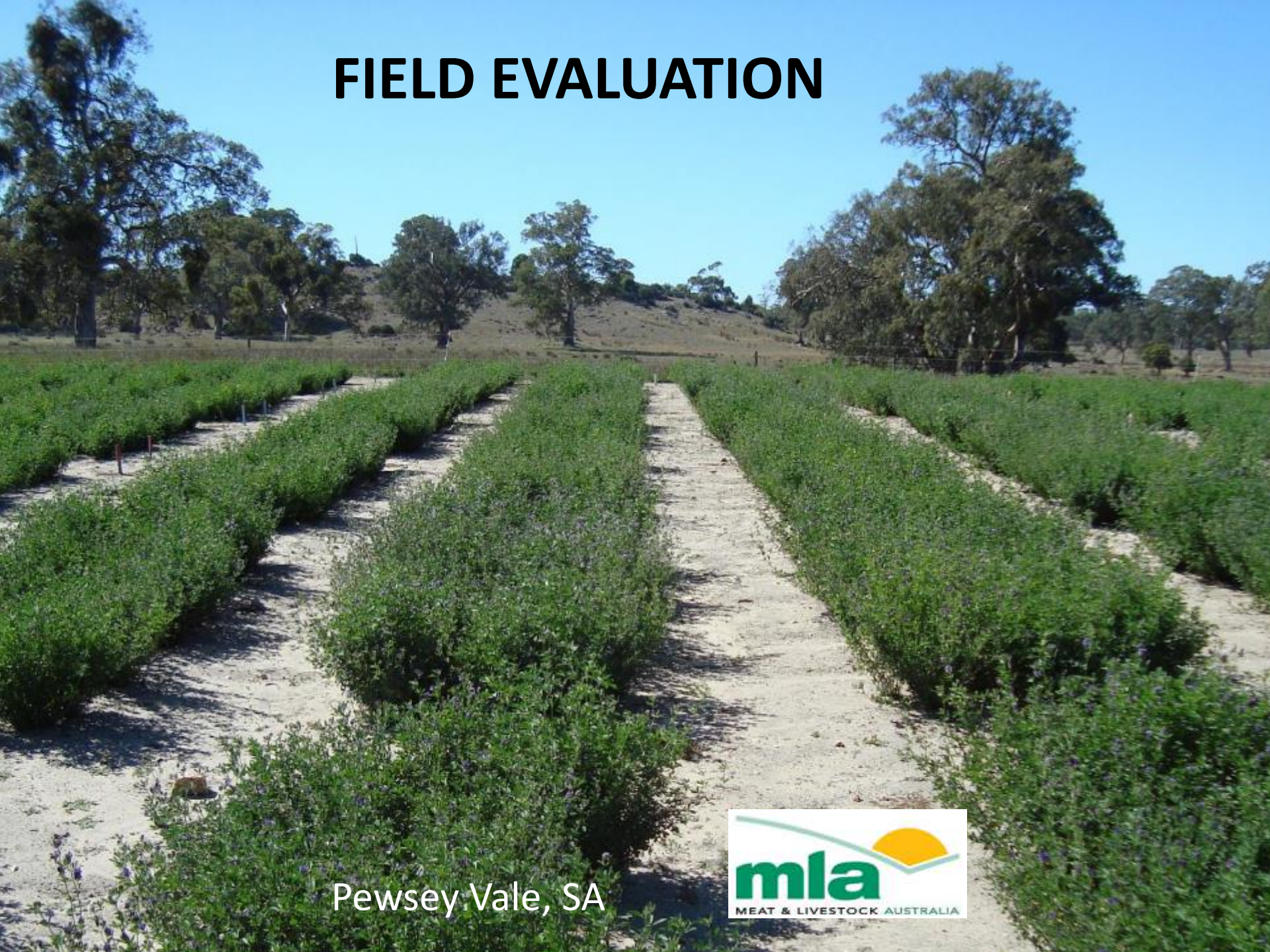


Breeding SARDI Seven Series 2

- >30 years of recurrent 'passive' selection for these environments
- Targeted lines with excellent persistence in wet, acidic soils



FIELD EVALUATION



Pewsey Vale, SA



Experimental Design

- 4 sites: Pewsey Vale, Tooperang (SA), Holbrook (NSW) and Boralma (Vic)
- Variety x Rhizobia experiments
 - TA37, S7S2 x RRI128, SRDI736, nil . 5 replications
- Lime x (var.rhiz) experiments, with 3 lime rates
 - S7S2.RRI128, S7S2.SRDI736, S7S2.nil, TA37.SRDI736
 - 3 lime rates (700,1400,2800)
 - 4 replications

Soil Chemistry

Site	Depth	NO ₃	P Colwell	K Colwell	S	pH (CaCl ₂)	DTPA Mn	Exc. Al	Exc. Ca	CEC total	Al CEC
		mg/kg	mg/kg	mg/kg	mg/kg	pH	mg/kg	meq/ 100g	meq/ 100g	meq/ 100g	%
Tooperang	0-10	5	89.4	91	6	4.2	10.7	0.4	2.5	3.5	11
	10-20	1	13	29	4	4.5	3.8	0.3	0.3	0.7	41
	20-30	3	3	146	12	4.5	2.2	0.9	3.5	6.7	14
Pewsey Vale	0-10	61	88	116	9	4.1	10.7	0.8	1.9	3.3	24
	10-20	12	51	94	4	4.3	3.8	0.6	0.9	2	33
	20-30	11	33	86	4	4.4	2.2	0.6	0.8	1.7	32
Holbrook	0-10	42	48	323	16	4.3	140	0.8	4.4	7	12
	10-20	14	11	216	12	4.6	101	0.3	4.5	6.6	5
	20-30	20	6	177	11	5.1	45	0.1	5.4	8.1	1
Boralma	0-10	46	15	319	8	4.3	100	0.8	2.1	4.3	16
	10-20	6	6	189	4	4.7	60	0.6	2.8	4.5	18
	20-30	4	4	151	2	5	24	0.3	3.7	6.4	5

Soil Chemistry

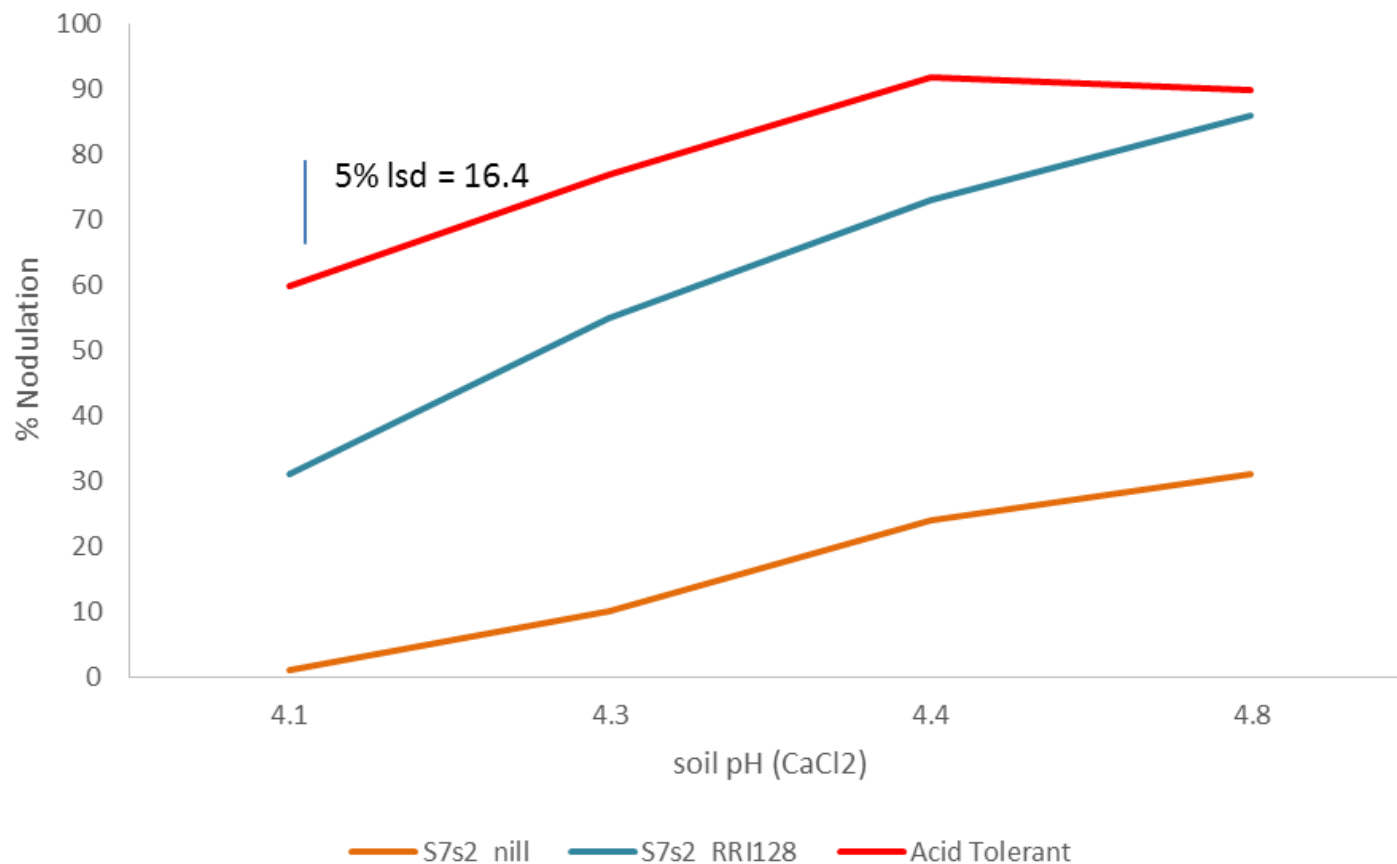
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Impact of pH on nodulation

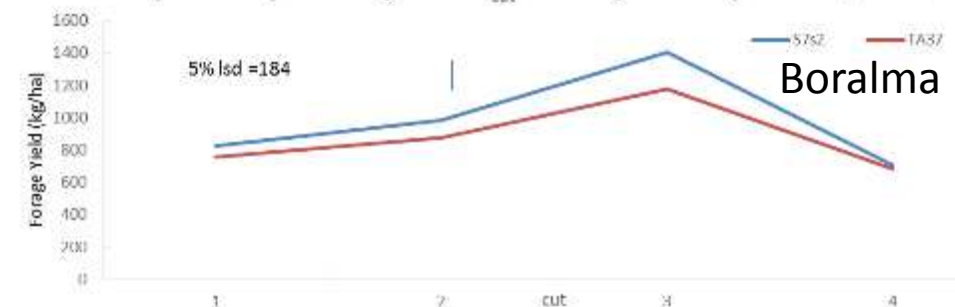
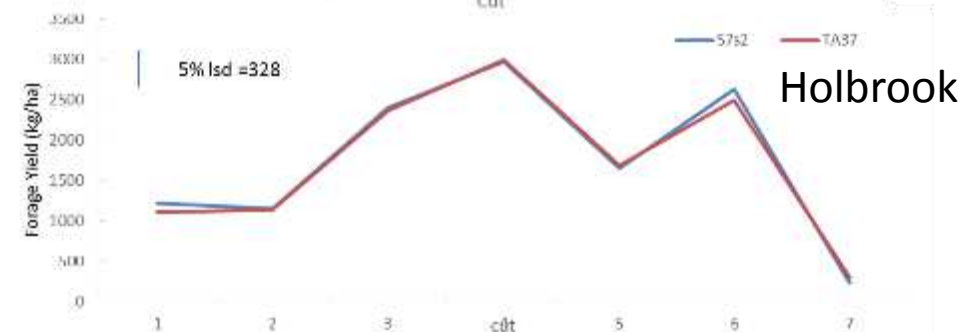
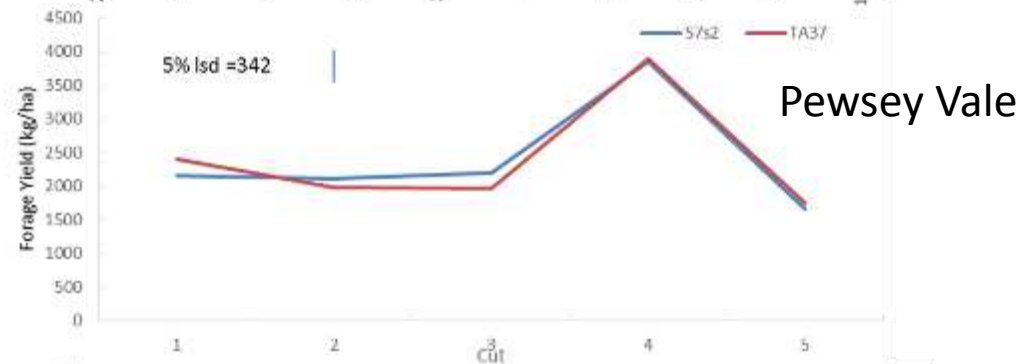
(Holbrook, Boralma, Pewsey Vale, Tooperang)



*(Combined results from no-lime and limed experiments to achieve pH gradient.

Zero lime trial Seasonal Production

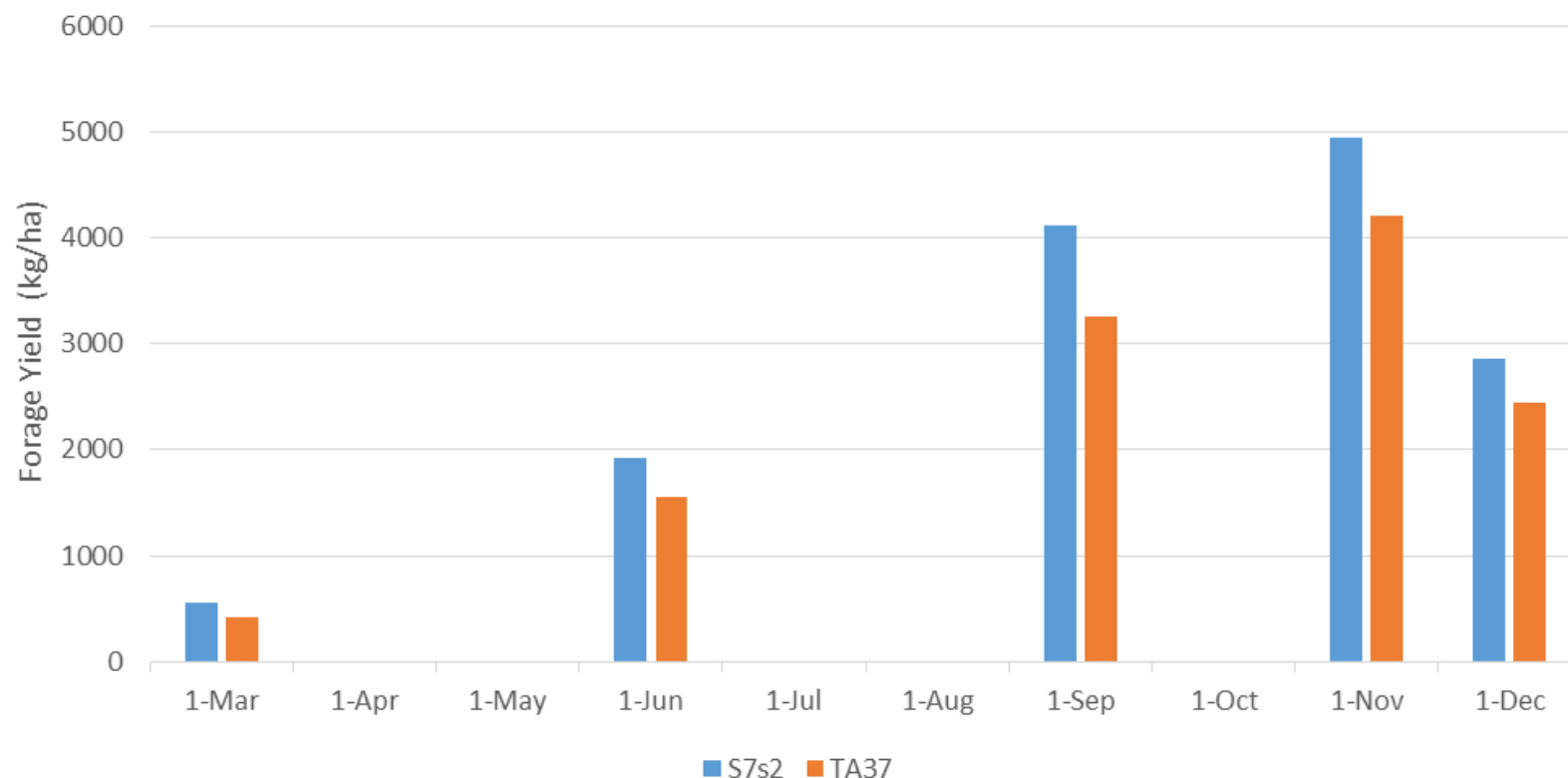
- Total production:
Tooperang: 14.4t/ha
Pewsey Vale: 12t/ha
Holbrook: 11t/ha
Boralma: 2t/ha



Lucerne still extends the growing season and gives summer feed on acid soils .

Decile 1-2 spring inducing a soil water deficit from mid-September at Tooperang in 2015.

58% of production from Nov, Dec and Mar cuts



Lime Experiments

Tooperang Acid Trial soil profile

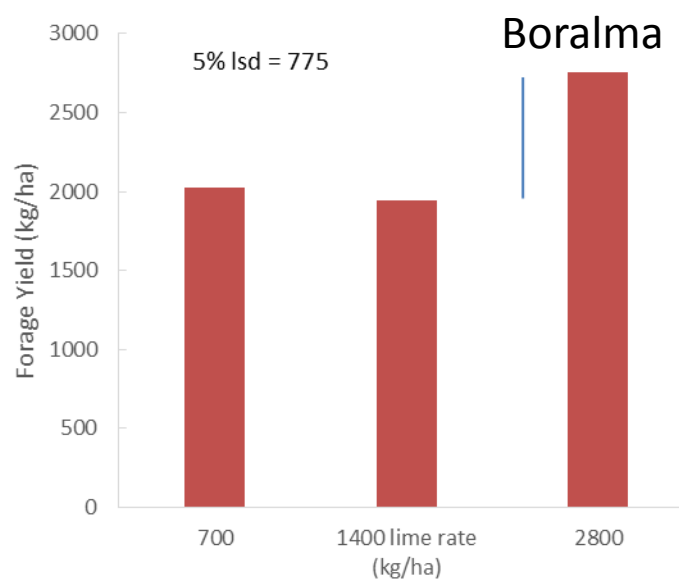
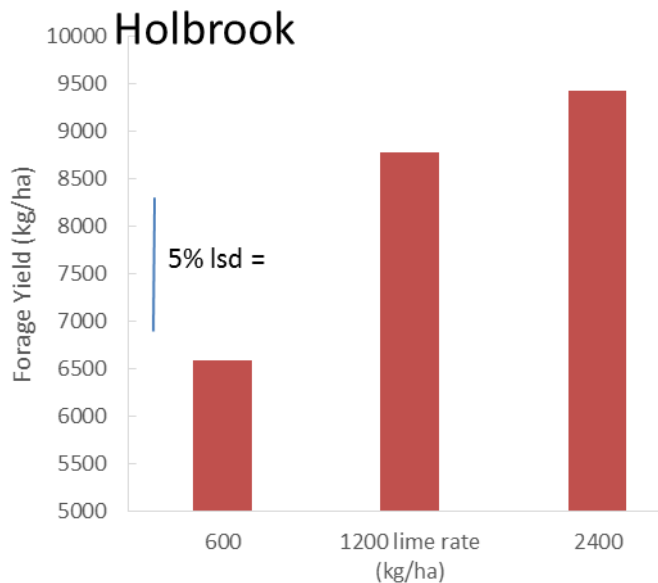
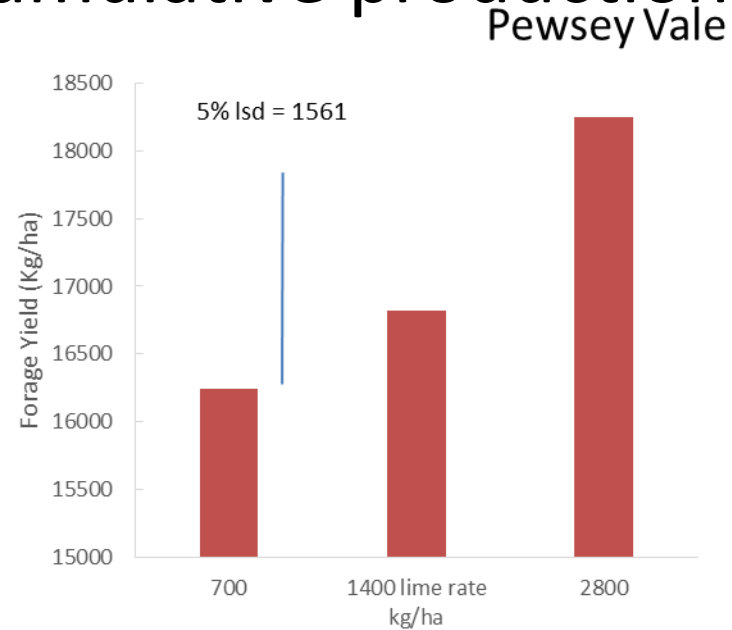
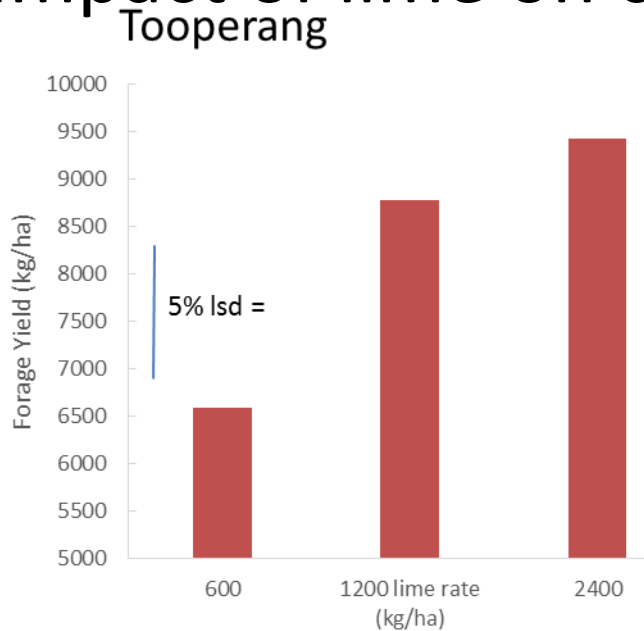
With 2.4t/ha lime incorporated with rotary hoe to 10cm

Depth	pH _{Ca}	Exc. Al	CEC Total	Al% CEC
0 to 10	4.2 5.1	0.4	3.5	11 2.7
>10 to 20	4.4 4.5	0.3	0.7	41 20.1
>20 to 30	4.5 4.5	0.9	6.7	14 27 to 5



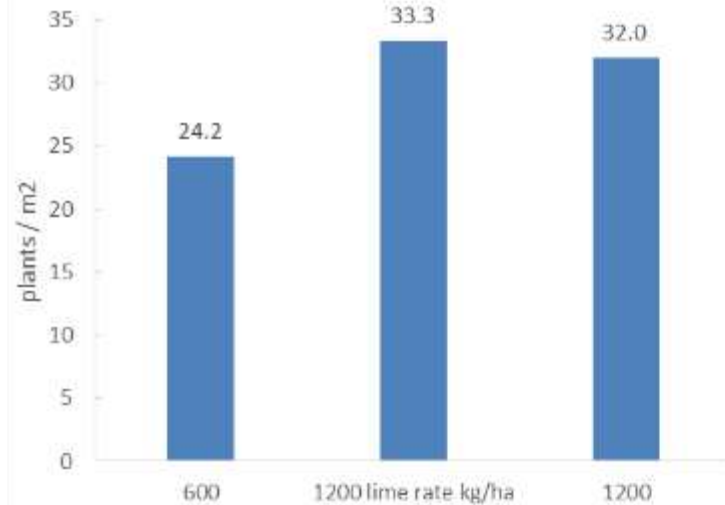
Nitrate = 5ppm, K: 90 (0-10) 29 (10-20) 146 (20-30), S 6ppm, P_{Colwell} 89 (0-10)

Impact of lime on cumulative production

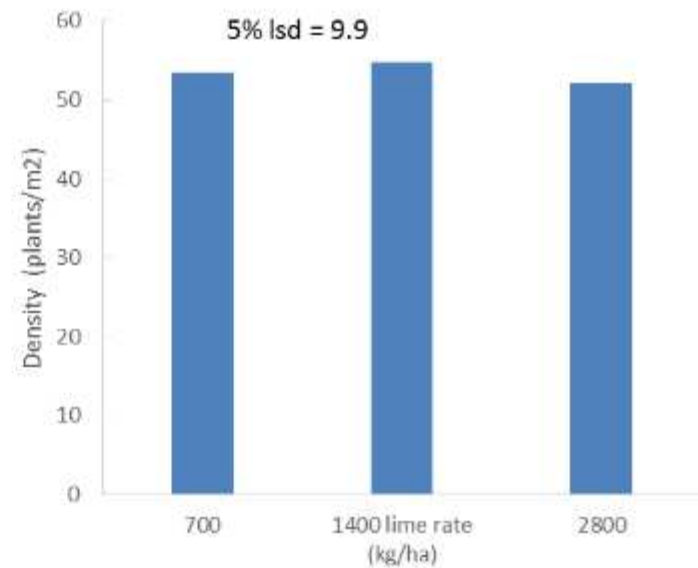


Final Plant Density at 3 lime rates

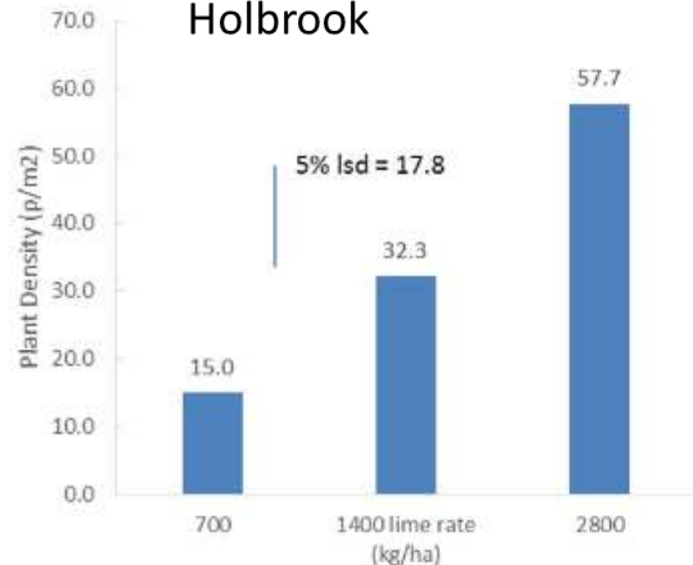
Tooperang



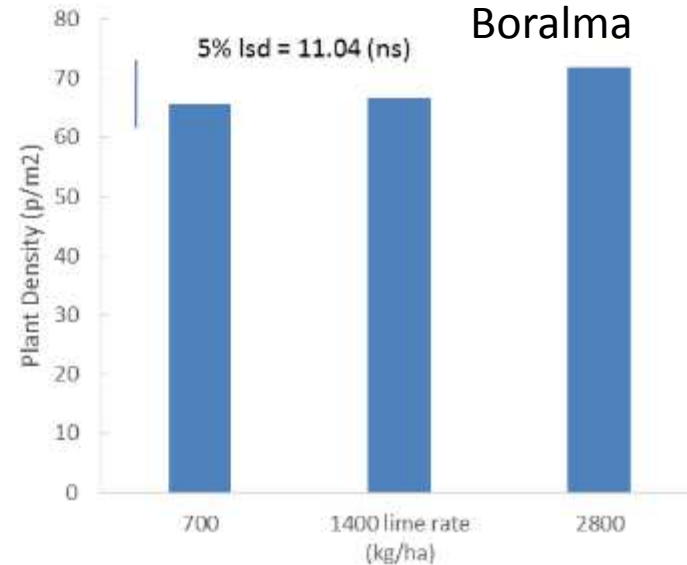
Pewsey Vale



Holbrook



Boralma



Summary

- Performance of lucerne overall much better than expected on highly acidic soils
 - ❖ Longterm breeding for adaptation on acidic soils with S7S2 successful
 - ❖ High forage yield and nutritive value
 - ❖ Boralma exception (waterlogged pale clay soil, poor structure)
 - ❖ Sites still young, will continue to be monitored in the future
- Performance further improved with lime
 - Return on investment in first 18 months
 - Likely to improve resilience (Combined stresses of drought x grazing x competition x WLT)
- Recommendations for sowing SARDI 7 Series 2 and TA37 above pH_{Ca} 4.5 with new strain (to be available from next year) in combination with lime