

Lees Valley Farmer Group

FIELD DAY

Pasture and forage options for SI hill and high country

1 NOVEMBER 2011

Mt Pember Farm Ltd, Wharfedale Station



PROGRAMME

1.00 pm	Introduction	D. Moot / C. Gates
1.15 pm	Direct drilling results	D. Lucas
1.45 pm	Grass persistence	D. Moot
2.15 pm	Grass response to nitrogen – WUE	A. Mills
2.45 pm	Perennial clovers	A. Black / D. Lucas
3.15 pm	Soil pH / aluminium	J. Moir / S. Berenji
3.45 pm	Annual clovers	D. Lucas / H. Nori
4.15 pm	Lucerne and deer	D. Moot / C. Gates
5.00 pm	BBQ	



Table of Contents

Lees Valley Farmer's Group.....	2
Lees Valley weather summary	3
Pasture yields around Lees Valley	5
Comparison of \pm cultivation, two drill types and three rates of lime when sowing permanent pasture into undeveloped, depleted grassland	6
Perennial Grasses	11
Yield and botanical composition of perennial grasses.....	15
Nitrogen effects on perennial grass yield	18
Legume and Herbs	22
Lime / Lucerne trial.....	27
Lucerne and Caucasian clover in the Lees Valley soil, a pot trial.....	36
Annual Clover Options.....	39
Practical Lucerne Grazing Management.....	44
Cocksfoot Grazing Experiment.....	51

Lees Valley Farmer's Group

The Lees Valley Farmer's Group (LVFG) was formed in January 2005 to discuss agronomic issues related to the intensification of Lees Valley and similar farm types throughout the South Island. At this point scientists from Lincoln University were invited to discuss potential ideas for development. Together the LVFG and Lincoln University sourced funding from the MAF Sustainable Farming Fund (SFF) to establish a demonstration site in the Lees Valley. The aim of the 10 ha research and extension site is for public discussion and debate on pasture options for intensifying hill and high country areas led by agronomists from Lincoln University.

Farmers within the LVFG identified the following topics:

- Pasture species combinations
- Nitrogen on pasture
- Fertilizers and brassicas
- Caucasian clover establishment
- Annual clover establishment and management
- Sowing rates of pastures
- Species persistence

This final public field day exposes a wider audience to the range of issues tackled and provides data for discussion.

A full time technician has been employed to monitor pasture growth and plot management. Senior students from Lincoln University are involved in research projects based around the plots and an army of overseas visitors has assisted with harvests and data collection. The weather station allows site specific rainfall, temperature, wind and solar radiation data to be collected and this assists in interpreting pasture growth.

The LVFG has maintained the site until June 2012 through MAF SFF for pasture persistence. The focus of today's programme is pasture persistence.

Lees Valley weather summary

Table 1 Weather data are summarized below and compared with data from Darfield and the ECAN rain records from near Island Hill across the valley (due North from trial site, on the Ashley River). **Yellow** is data estimated from nearby stations. **Green** is data averaged from 2 rain gauges.

Year	Month	Air temp. (°C)		Soil temp. (°C) (at 10 cm)		Rainfall (mm)	
		Lees Valley	Darfield	Lees Valley	Lees Valley	Lees Valley (ECAN)	Darfield
Year 3	Jul-08	3.5	6.6	3.6	128.5	206	148.4
	Aug-08	4	6.8	5	80.8	130	126.4
	Sep-08	9	11.1	8.6	46.3	75	54.8
	Oct-08	9.6	12.1	10.7	41.2	54	24.4
	Nov-08	13.5	14.8	15.1	16	22	12.6
	Dec-08	14.4	15.5	17.1	68	117	75.2
	Jan-09	17.3	19.3	19.4	30	53	21.2
	Feb-09	14	15.5	17.5	73.3	105	91.8
	Mar-09	12.5	14.9	14.8	11.4	19	14.4
	Apr-09	9.8	12.6	11.5	65.1	108.5	62
	May-09	4.3	7.1	6.5	87.3	145.5	121
	Jun-09	1.3	5.6	3.4	27	45	6
Year 4	Jul-09	2.7	5.6	3	63.6	106	52
	Aug-09	7.6	9.7	5.6	42	70	65.2
	Sep-09	7.7	10.5	7.3	39.6	66	31.4
	Oct-09	7.1	9.5	8.6	72	120	88.6
	Nov-09	11.6	13.1	11.9	14.7	24.5	14
	Dec-09	13.7	15.1	14.5	29.4	49	38
	Jan-10	14.4	16.1	16	41.1	68.5	84
	Feb-10	15.7	17.5	17.4	14.7	24.5	28.6
	Mar-10	13.5	15.8	14.8	33.3	55.5	23.2
	Apr-10	11.3	14.3	11.6	15.9	26.5	19
	May-10	7	9.8	8.8	121.5	202.5	189.8
	Jun-10	3.2	6.6	4.6	55.5	92.5	84.2
Year 5	Jul-10	2.1	6.1	3.2	62.6	88.5	53.6
	Aug-10	5.7	8	5.6	109.6	138.5	86.8
	Sep-10	8.4	10.7	7.6	56.4	97	67.4
	Oct-10	9.6	11.4	10.1	25.2	45.5	37.2
	Nov-10	13.8	15.1	13.7	52.6	65.5	45.4
	Dec-10	15.9	17.6	16.8	45.2	74	50.8
	Jan-11	15.3	16.8	17.6	56.8	82	57
	Feb-11	15.6	17.3	17.1	58.7	65.5	57.1
	Mar-11	13.1	15.7	14.5	43.9	57	58.4
	Apr-11	8.9	12.2	10.5	64.4	70.5	73.2
	May-11	8.9	11.6	8.8	93.2	102	61.9
	Jun-11	5.3	8.1	6.1	44	45.5	42.1
Year 6	Jul-11	3.8	6.0	3.8	68.6	98.0	27.4
	Aug-11	3.9	7.3	3.2	38.5	44.5	44.2
	Sep-11	7.3	8.7	6.3	33.1	44.0	29.4

Table 2 Annual temperature means and rainfall totals for July 2007-June 2011 (4 years).

	Air temp. (°C)		Soil temp. (°C)	Rainfall (mm)		
	Lees Valley	Darfield	Lees Valley	Lees Valley	Lees Valley (ECAN)	Darfield
Temp.	9.8	12.1	10.5			
Rain				612.9	943.6	691.2

Darfield data are courtesy of NIWA Cliflo and ECAN rainfall data are from Environment Canterbury. Rainfall updates from the ECAN network are available by phone or their web page @ <http://ecan.govt.nz/services/online-services/monitoring/rainfall/pages/default.aspx>.

Pasture yields around Lees Valley

The annual dry matter production of various pastures at several different locations around Lees Valley has been monitored by harvesting the pasture grown from within enclosure cages at approximately monthly intervals (see Figure 1).

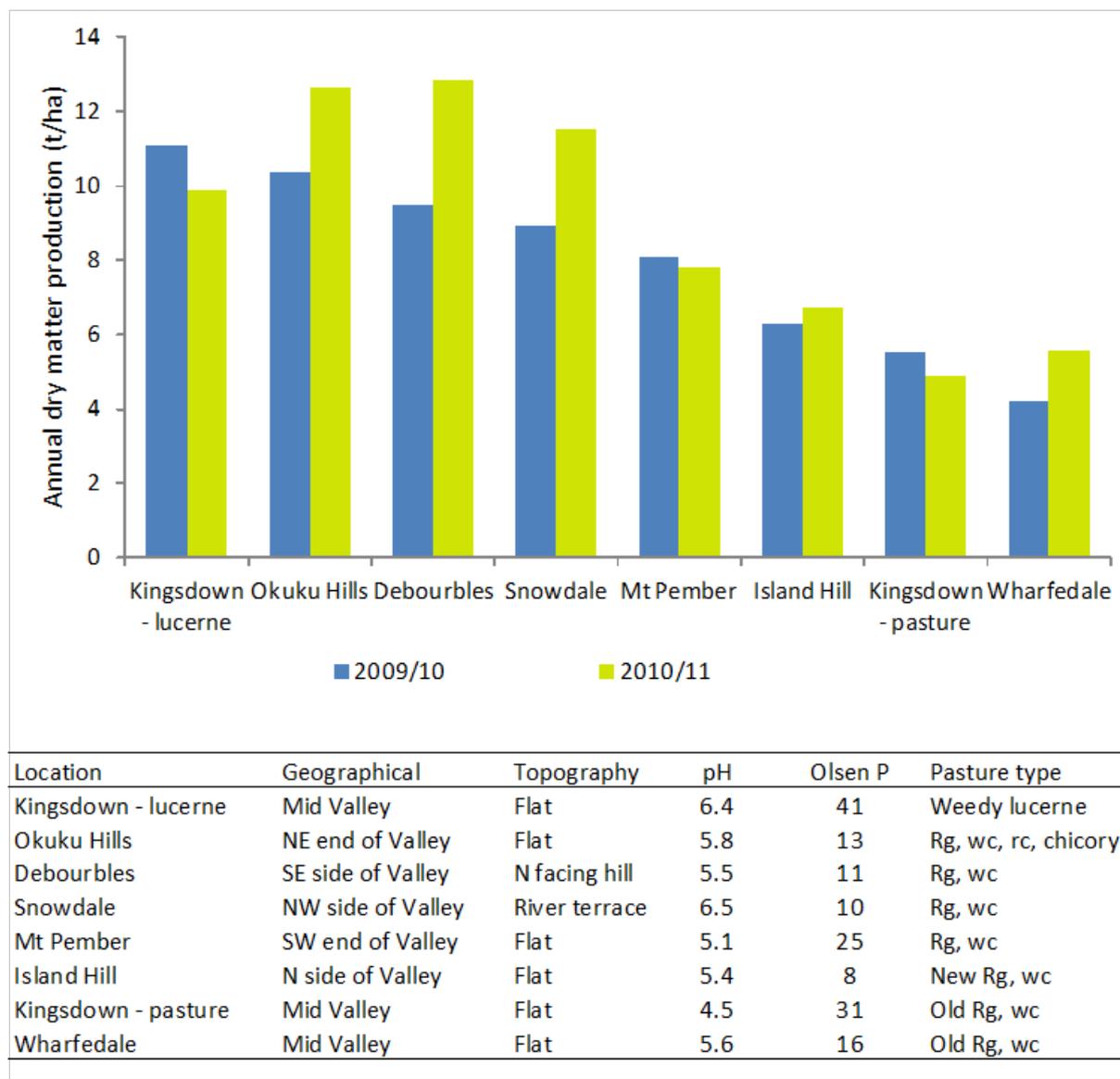


Figure 1 Annual dry matter production, soil pH and Olsen P levels at various locations around Lees Valley from July 2009 to October 2011.

Comparison of \pm cultivation, two drill types and three rates of lime when sowing permanent pasture into undeveloped, depleted grassland

Dick Lucas and Malcolm Smith

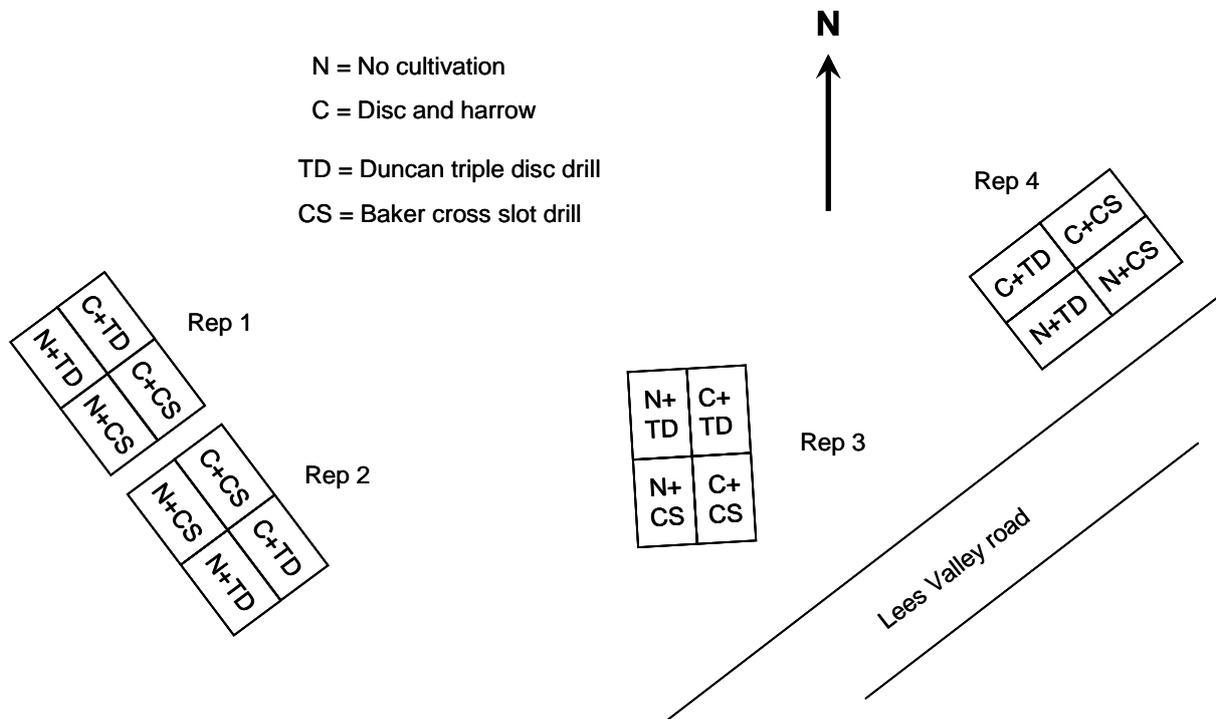


Figure 2 Site plan.

The Lees Valley farmer's group was interested in the effects of various inputs when establishing permanent pasture directly into depleted tussock grassland.

Basal treatments

- Roundup (3 litres/ha) sprayed mid December 2006 to kill resident grasses prior to autumn sowing, was only moderately successful.
- Superphosphate broadcast on all plots at 400 kg/ha on 22 February 2007.
- DAP spread at 350 kg/ha on triple disc plots on 22 February 2007 prior to sowing on 28 February.
- Cultivated plots disced twice on 22 February, harrowed on 26 February.
- DAP applied at 350 kg/ha in cross slot drill plots 7 March 2007 beside seed.

Experimental treatments

Cultivation	Disced (x2), harrowed						None					
Drill type	Baker Cross Slot			Duncan Triple Disc			Baker Cross Slot			Duncan Triple Disc		
Lime rate (t/ha)	0	2	6	0	2	6	0	2	6	0	2	6

Characteristics of drill types

The cross slot drill has:

- Improved ability to sow at a consistent depth due to presence of gauge wheels.
- Seedlings are not as susceptible to desiccation because embryonic root exploration in the inverted T-shaped slot is not hindered by compacted slot walls.
- Placement of fertilizer in a concentrated band beside, but not with, the seed. This reduces the occurrence of fertilizer toxicity or ‘seed burn’.

The triple disc drill has:

- One cutting disc and two opening discs, placing the seed in a V shaped slot. Fertilizer can be either drilled with seed or broadcast separately.

Table 3 Sowing rates (all legumes inoculated with appropriate Rhizobium strains the day before sowing).

Seed sown	Sowing rate (kg/ha)
‘AR1’ perennial ryegrass	10
‘Ella’ cocksfoot	1
‘Nomad’ white clover	2
‘Leura’ subterranean clover	4
‘Woogenellup’ subterranean clover	4
‘Kaituna’ lucerne (pelleted)	1

Table 4 Soil Test results.

Date	Treatment	pH	Olsen P	Ca	Mg	K	Na	S
Initial	All	5.3	9	2	15	8	4	5
11/8/2010	0 t lime/ha	5.0	29	3	13	9	<2	-
	2 t lime/ha	5.2	23	5	14	11	<2	-
	6 t lime/ha	5.5	17	7	13	9	2	-
31/8/2011	0 t lime/ha	5.2	21	3	11	7	2	3
	2 t lime/ha	5.5	15	5	13	8	3	4
	6 t lime/ha	6.0	11	9	13	7	3	6

Botanical Composition

Figure 3 shows the proportions of ground cover of the plant species and bare ground for the different treatments, as visually assessed on 23 October 2011.

- 2 t lime increased total clover cover from 38% to 62%, 6 t lime had 69% clover.
- Most browntop at 0 t lime.
- Sub and white clovers are complementary.
- No large differences between drill types after 5 years although cross slot may favour white clover and triple disc sub clover.
- No obvious advantage in cultivation, possible increase in ryegrass survival and more bare ground but less weed cover and no tussocks.
- Olsen P decreased and sulphate sulphur test increased with increasing lime rate.
- A spring sowing with Caucasian clover on this undeveloped site could have been more successful?

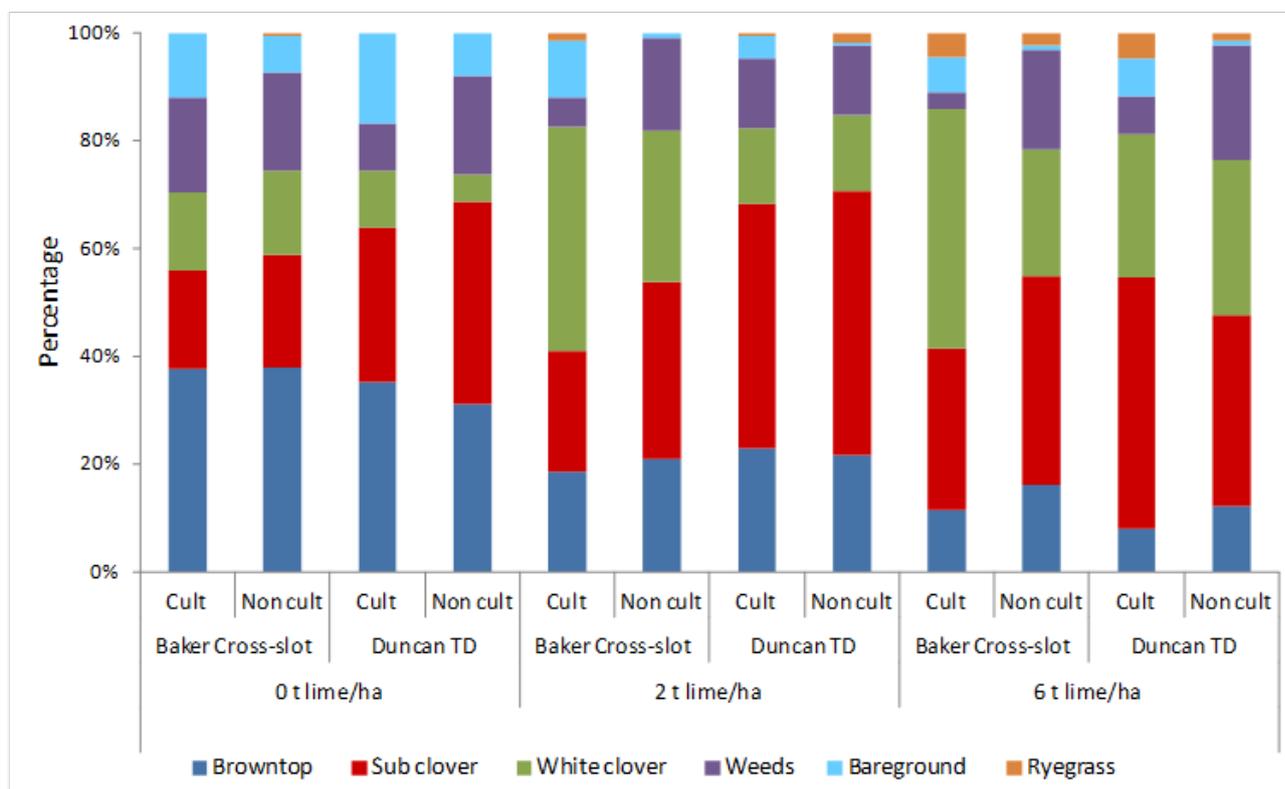


Figure 3 The percentage of the pasture components and bare ground of each treatment on 23 October 2011.



Figure 4 Initial disc cultivation of resident tussock / browntop after herbicide application.

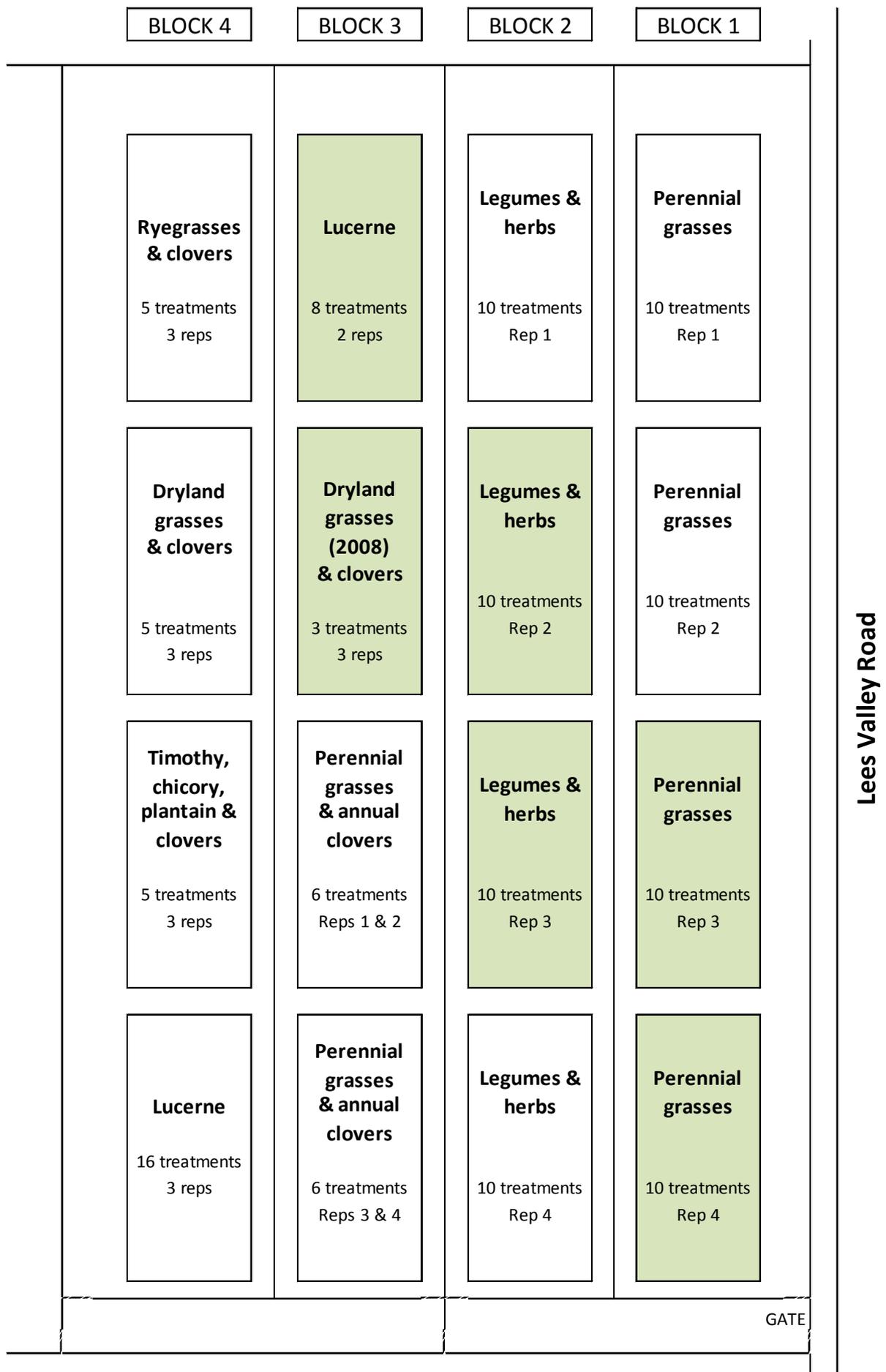


Figure 5 Lees Valley site plan.

Perennial Grasses

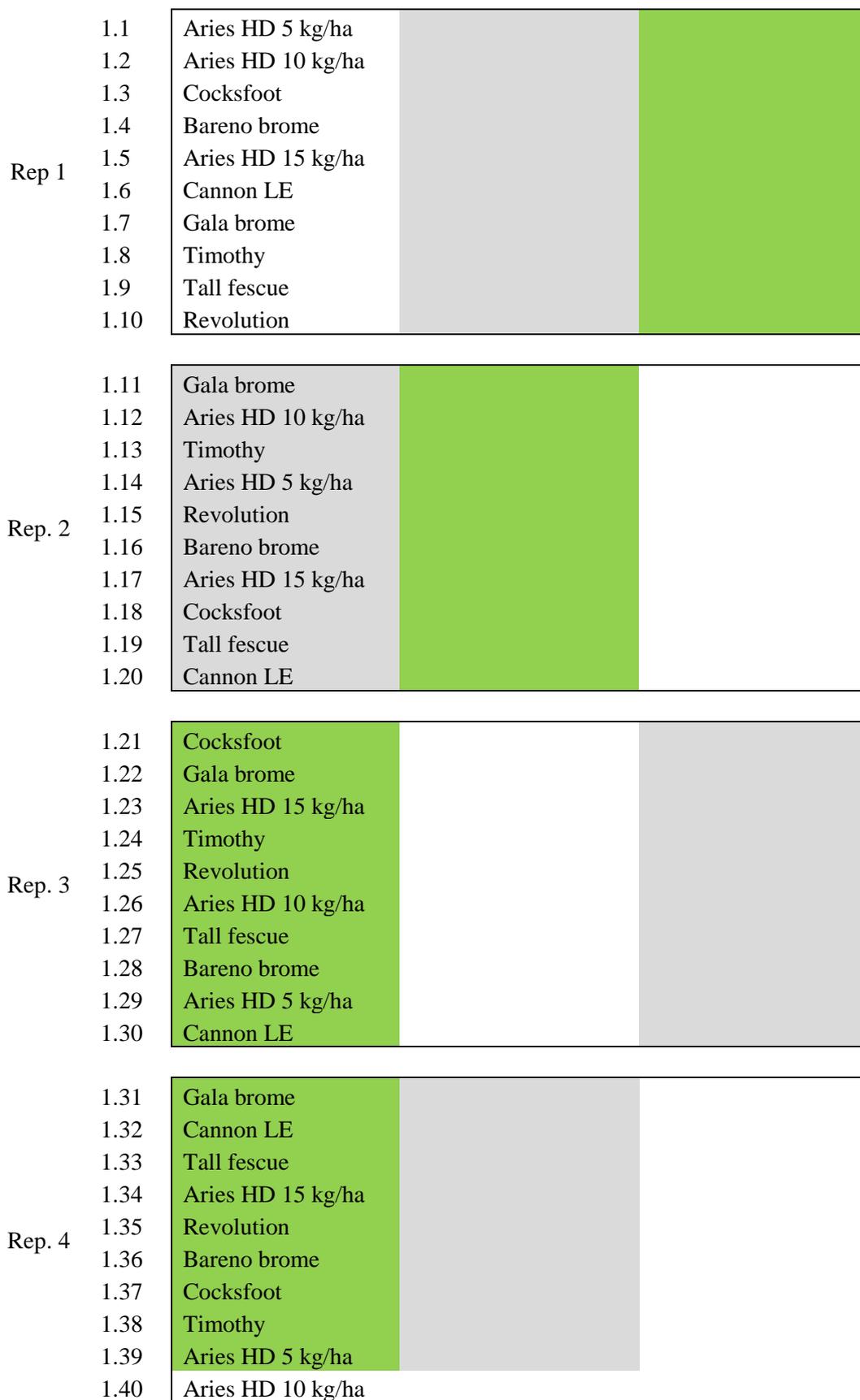


Figure 6 Block 1- Perennial grasses trial plan, shaded areas indicate last fertiliser application on 14 Sept 2011 (green - 100 kg N/ha applied, grey - 50 kg N/ha applied, white – no N applied), plot 40 became part of the stock race in winter 2010.

- The site was sprayed with Roundup (4 l/ha) in April and October 2005 and lime was applied at 5 t/ha. The browntop mat was broken down by hoof and tooth from April to August 2005. In January 2006, 400 kg/ha superphosphate and 300 kg/ha DAP were applied. The site was then disced, harrowed and heavy rolled.
- 13 February 2006 eight improved grass species ('Aries HD' at 5, 10 and 15 kg/ha, 'Cannon LE', 'Gala' grazing brome, 'Kara' cocksfoot, 'Viking' timothy and 'Advance' tall fescue) were sown.
- 1 November 2006 'Revolution' hybrid ryegrass and 'Bareno' brome were sown.
- In April, September and November 2006, January and June 2007 and October 2008 plots were grazed in common. They were mechanically topped in December 2006, January and September 2008. Grazing happened in January and April 2009, September and December 2009, November 2010 and July 2011.
- All plots received 150 kg N/ha in spring 2007. Urea was applied at 100 kg/ha in February 2008. Maintenance fertiliser of 300 kg/ha superphosphate and 50 kg N/ha as urea was applied in September 2008.

Table 5 Soil Quick Tests.

Date	pH	Olsen P	Ca	Mg	K	Na	S
8/08/2007	6.1	16	9	8	9	2	9
19/05/2008	6.2	15	8	10	13	2	6
2/09/2009	6.2	15	7	7	7	2	5
11/08/2010	5.9	21	9	11	12	<2	-
31/08/2011	6.0	19	6	10	9	3	4

Year 3 (July 2008 – June 2009)

- For winter 2008 DM yield averaged 528 kg DM/ha for all grasses and followed a similar trend to autumn yield.
- Early spring growth was sustained by 105 mm of rainfall in July and August. Production ranged from 0.5 (timothy) to 1.5 t DM/ha ('Bareno' brome).
- Between Sept and Oct 08 growth slowed due to lack of soil moisture (43 mm). The yield over spring for all treatments was 1.0 t DM/ha which was similar to summer.
- Summer production in the 'Gala' had a high proportion of unsown grasses and dicot weeds (1.0 t/ha).
- Total yield in 2009 ranged from 2.6 t/ha for 'Aries HD' established at 15 kg/ha to over 4.5 t DM/ha for cocksfoot, 'Bareno' brome and Aries HD at 5 kg/ha.

Year 4 (July 2009 – June 2010)

- In Year 4 annual yields ranged from 1.9 t DM/ha from timothy pastures (Figure 7), which was less than all other pastures ($P<0.01$), to a maximum of 4.0 t DM/ha from 'Aries HD' established at 15 kg/ha.
- Yields from 'Aries' were similar regardless of initial sowing rate and did not differ from the yield produced by the low endophyte 'Cannon'.
- The 2.9 ± 0.31 t DM/ha produced by the tall fescue and 'Gala' brome pastures was less ($P<0.01$) than the 4.0 t/ha/yr produced by 'Aries HD' 15 kg/ha.

Year 5 (July 2010 – June 2011)

- In Year 5 the lowest ($P<0.01$) yield was again 1.9 t DM/ha from timothy pastures and the highest yield was 3.9 t DM/ha produced by the cocksfoot and 'Revolution' ryegrass pastures.
- The yields of 'Aries' pastures were similar to those of the low endophyte 'Cannon'. However, the yield from the 'Aries' 5 kg/ha pastures (3.0 t/ha) was lower than the yield from the 'Revolution' hybrid ryegrass.

Year 6 (July 2011 – October 2011)

- Standing DM at 20/10/2011 in the middle of the first rotation for the year was 1.1 ± 0.12 t/ha.

Main points

- ✓ *Ryegrass was fastest to establish which reduced weed (browntop) invasion.*
- ✓ *There was no difference in yield of sowing rates between 5 and 15 kg/ha of ryegrass seed.*
- ✓ *On average, over five years, spring provided the majority (60%) of pasture growth annually.*
- ✓ *In summer, cocksfoot and 'Bareno' brome production was higher than ryegrasses.*
- ✓ *'Gala' brome, tall fescue and timothy have not been successful pioneer species.*
- ✓ *After Year 5 production from low endophyte 'Cannon' perennial ryegrass is similar to high endophyte cultivars which indicates lower pest pressure in this environment.*

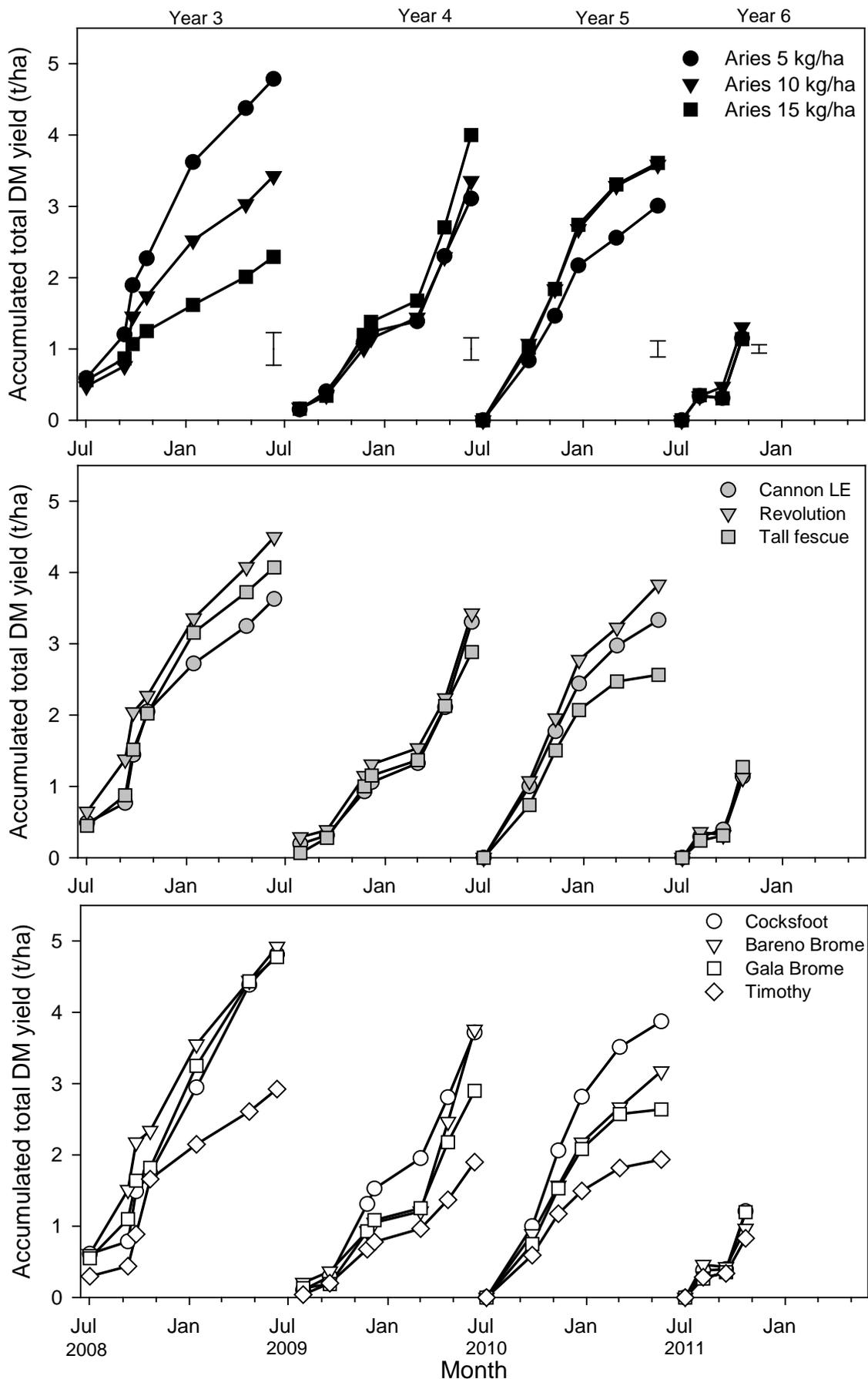


Figure 7 Accumulated total annual dry matter yields (t DM/ha) of ten grass pastures in Year 3 (2008/09), Year 4 (2009/10), Year 5 (2010/11) and spring of Year 6 (2011/12). Pastures were established as monocultures in 2006. Error bar is SEM for total annual yield. For Year 6 yields are from pastures not treated with N fertiliser in spring.

Yield and botanical composition of perennial grasses

Year 4 (July 2009 – June 2010)

- Percentage of unsown species during Year 4 was highest in ‘Gala’ brome.
- High dead content after summer/autumn.

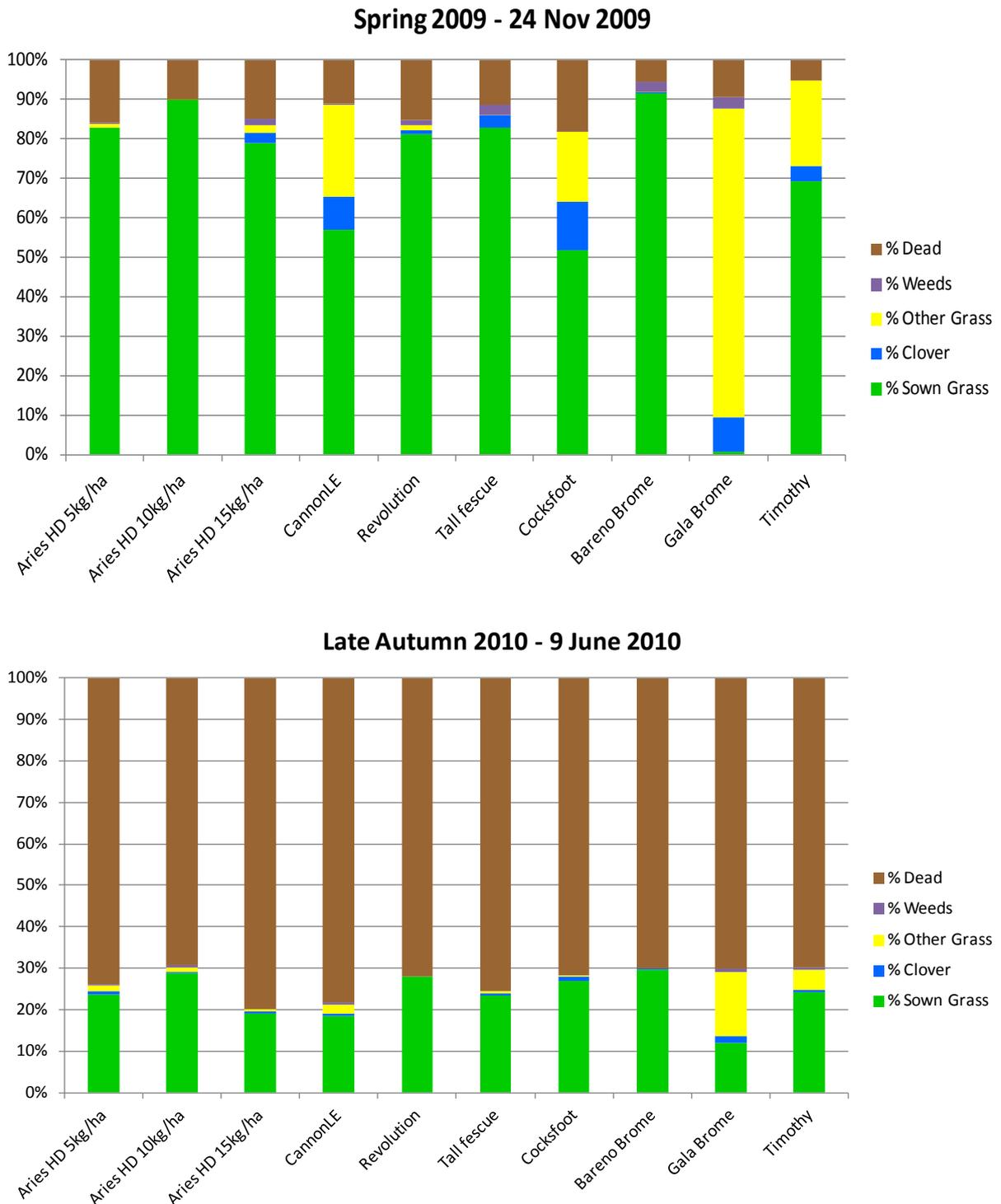


Figure 8 Botanical composition of pastures in spring 2009 and late autumn 2010.

Year 5 (July 2010 – June 2011)

- ‘Gala’ brome had the lowest percentage of sown grass and highest of unsown species during Year 5. Timothy and tall fescue also had the higher unsown species percentage.
- Lowest percentage of unsown species was in ‘Bareno’ brome pastures.

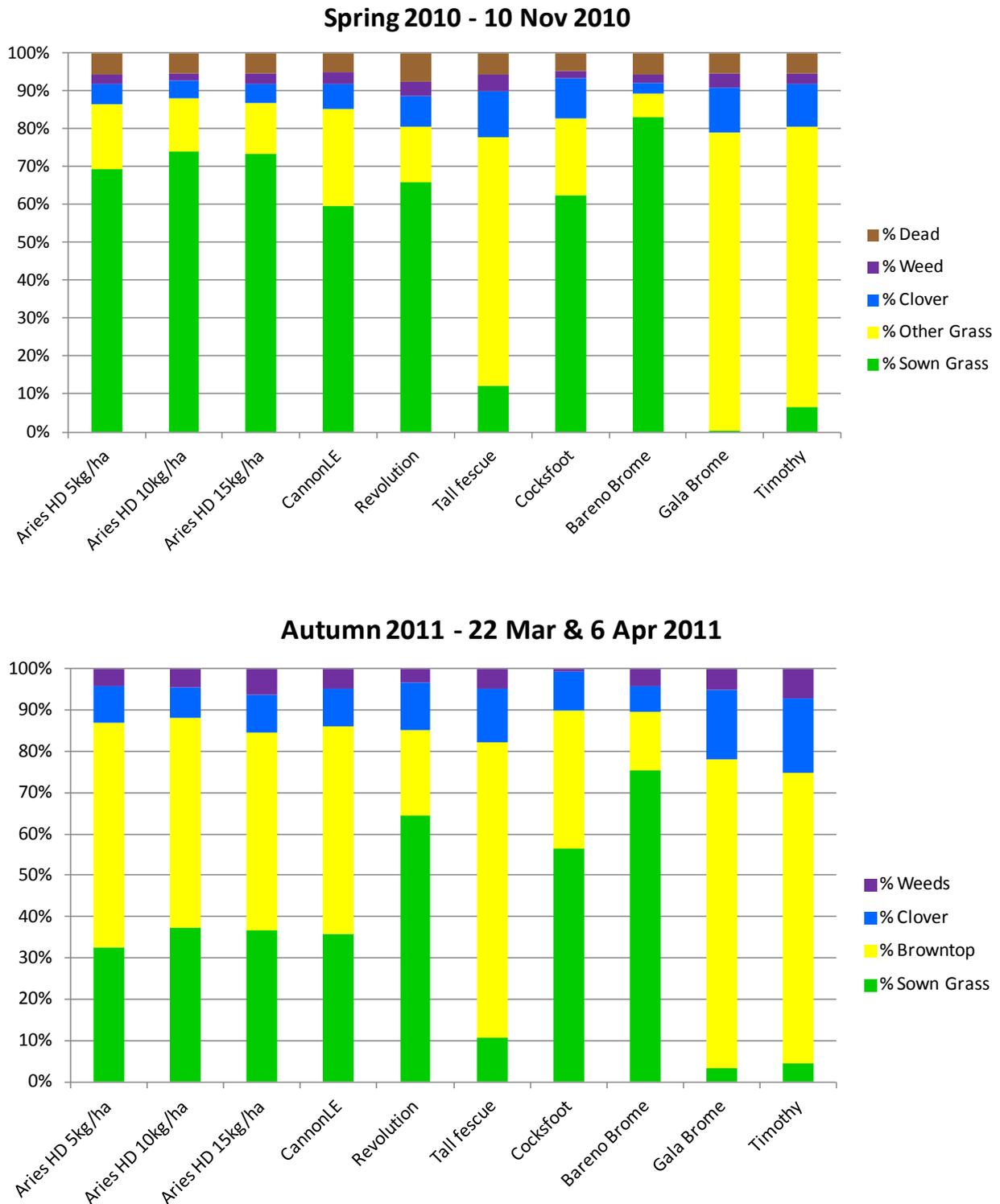


Figure 9 Botanical composition of pastures in spring 2010 and autumn 2011.

Main points

- ✓ *'Gala' brome has virtually disappeared after five years (Figure 8).*
- ✓ *'Bareno' brome, cocksfoot and 'Revolution' have the highest summer/autumn production (Figure 9).*
- ✓ *Tall fescue and timothy have not been able to compete with re-invading browntop (Figure 8).*
- ✓ *'Cannon' LE is persisting – suggesting insect pressure is low (Figure 9).*
- ✓ *The 5 – 15 kg/ha of 'Aries HD' have similar yield and botanical composition of sown grass.*



Figure 10 Lees Valley trial site in early spring.

Nitrogen effects on perennial grass yield

Year 4 (July 2009 – June 2010)

- In Year 4, 100 kg N/ha as CAN was spread on 6 Oct 2009 to half of each plot.
- Annually, yields ranged from 1.2 t DM/ha (-N timothy) to a maximum of 3.7 t DM/ha from ‘Aries HD’ established at 5 kg/ha sowing rate (Figure 11).
- Application of fertiliser N in spring increased total annual production by 62% from 1.9 t/ha/yr from the -N pastures to 3.2 t/ha/yr from +N pastures.
- The yields from all ryegrasses, cocksfoot and ‘Bareno’ brome (~2.8 t DM/ha/yr) were similar. However, tall fescue, ‘Gala’ brome and timothy pastures produced less (~1.9 t/ha/yr).

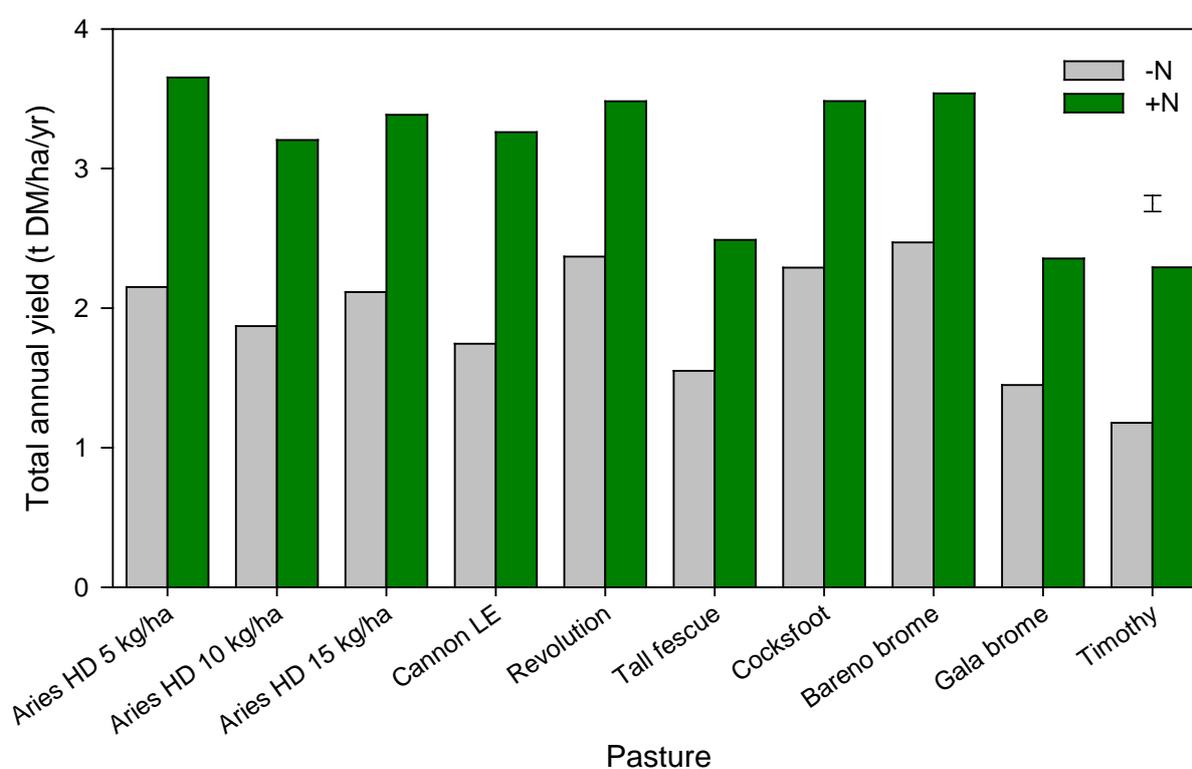


Figure 11 Total DM yield (t DM/ha) accumulated during Year 4, showing the influence of spring applied N treatments (0 kg N/ha and 100 kg N/ha) on total annual production. Error bar is SEM pooled across pasture type and N level.

Spring nitrogen response

- Total DM yield of the grass pastures was 1.0 t DM/ha from the -N pastures which was less than half the 2.2 t DM/ha produced by pastures which received 100 kg N/ha in early spring (not shown).
- The DM response was 14.9 ± 3.42 kg DM/kg N applied (Table 6) and was similar for all 10 grass pastures.

Table 6 Dry matter response (kg DM/kg N applied) of 10 grass pastures established in 2006 at Lees Valley, Canterbury in spring of Year 4 (2009). Nitrogen was applied at 100 kg N/ha as CAN (27% N) on 6/10/2009 and yield was estimated 2 months later prior to grazing on 7/12/2009.

Pasture	Spring N response
'Aries' HD ryegrass 5 kg/ha	18.8
'Aries' HD ryegrass 10 kg/ha	16.7
'Aries' HD ryegrass 15 kg/ha	15.9
'Cannon' LE ryegrass	18.9
'Revolution' hybrid ryegrass	13.9
'Advance' tall fescue	11.7
'Vision' cocksfoot	14.9
'Bareno' brome	13.3
'Gala' brome	11.3
'Viking' timothy	13.9
Mean	14.9
SEM	3.42
P	ns

Note: level of significance is ns = non significant.

Year 6 (July 2011 – October 2011)

- Between 14/9/2011 and 20/10/2011 the amount of DM produced has ranged from 0.5 to 1.5 t/ha (not shown).
- Over 35 days N fertiliser increased DM yield by about 50% from 0.8 t/ha to 1.2 t/ha.
- DM production by timothy and 'Gala' brome (0.9 t/ha) was lower than the 1.1 t/ha produced by the ryegrasses and cocksfoot over the same period. This effectively shows the browntop response to nitrogen.

Spring nitrogen response

- In the current spring regrowth period either 50 or 100 kg N/ha was applied to the pastures on 14/9/2011. The difference in DM yield produced between 14/9/2011 and 20/10/11 of the pastures was used to calculate a mid rotation N response (Table 7).
- 35 days after N was applied to the pastures they had produced 5 kg of DM for every 1 kg of N applied.
- All pastures responded in the same manner regardless of pasture species or N application rate.

Table 7 Dry matter response (kg DM/kg N applied) of ten grass pastures established in 2006 at Lees Valley, Canterbury in spring of Year 6 (2011). Nitrogen was applied at either 50 or 100 kg N/ha as CAN (27% N) on 14/9/2011 and yield was estimated by pasture probe in the middle of the current regrowth cycle (20/10/2011).

Pasture	Spring N application rate (kg/ha)	
	50	100
'Aries' HD ryegrass 5 kg/ha	3.0	5.5
'Aries' HD ryegrass 10 kg/ha	11.1	4.5
'Aries' HD ryegrass 15 kg/ha	8.0	6.2
'Cannon' LE ryegrass	7.4	5.8
'Revolution' hybrid ryegrass	10.1	4.5
'Advance' tall fescue	-2.5	2.3
'Vision' cocksfoot	6.1	5.6
'Bareno' brome	5.2	1.0
'Gala' brome	4.5	0.9
'Viking' timothy	8.4	5.4
	Mean	5.1
	SEM	0.80
	P	ns

Note: level of significance is ns = non significant.

How nitrogen affects water use in spring

- Figure 12 shows how water stored in the top 0.8 m of the soil was depleted by a cocksfoot monoculture at Lincoln University.
- By the time about 130 mm of water had been extracted during growth there was no more water for plants to continue growing until rain (bars) fell to recharge the soil.
- Both pastures extracted and used about 400 mm of water per year but the nitrogen (N) deficient cocksfoot pasture (white triangles) produced 5-7.5 t DM/ha/yr and the pasture given nitrogen (black triangles) produced 15.7 t DM/ha per year.
- This yield difference meant that on an annual basis the N deficient pastures were producing about 17 kg DM/ha for every millimetre of water used. This was only about half the 36 kg DM/ha per millimetre of water produced by the pasture which had sufficient N for growth.

What it means...

- *On dryland properties it is important to make sure that stored soil water available in spring is used to maximum benefit – that is to produce as much DM for stock as possible before water stress limits growth.*
- *An N deficient pasture will use the same amount of water as a pasture with adequate N but it will produce only half the feed.*

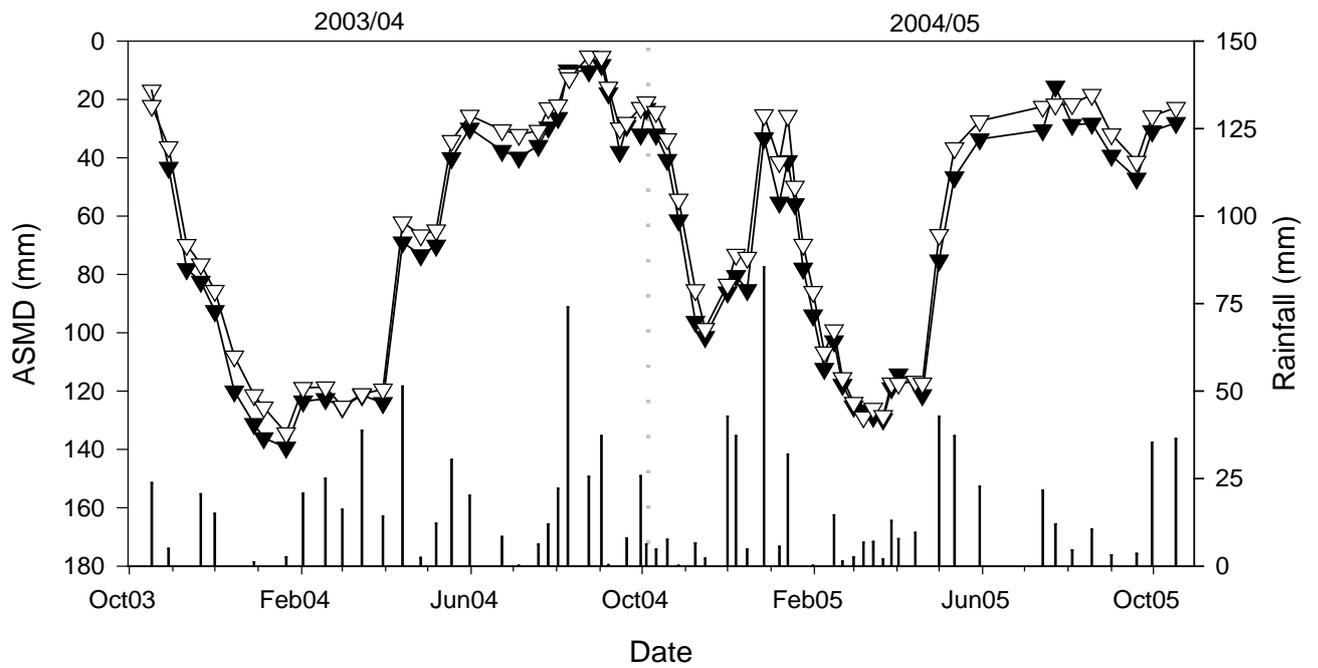


Figure 12 Accumulated soil moisture deficit under a dryland ‘Wana’ cocksfoot monoculture at Lincoln University which received non-limiting N fertiliser (▼) or no nitrogen fertiliser (▽). Bars are rainfall received between each measurement date and the grey dashed line is the end of the 2003/04 growth season.



Figure 13 Sheep grazing in Lees Valley.

Legume and Herbs

Rep 1	2.1	White clover
	2.2	Chicory/Cc
	2.3	Lucerne
	2.4	Cefalu Arrowleaf C.
	2.5	Plantain/Cc
	2.6	Prima Gland Clover
	2.7	Mihi Persian C.
	2.8	Caucasian clover
	2.9	Red clover
	2.10	Bolta Balansa C.
Rep. 2	2.11	Lucerne
	2.12	Red clover
	2.13	Bolta Balansa C.
	2.14	White clover
	2.15	Cefalu Arrowleaf C.
	2.16	Caucasian clover
	2.17	Prima Gland Clover
	2.18	Chicory/Cc
	2.19	Plantain/Cc
	2.20	Mihi Persian C.
Rep. 3	2.21	Red clover
	2.22	White clover
	2.23	Cefalu Arrowleaf C.
	2.24	Lucerne
	2.25	Caucasian clover
	2.26	Chicory/Cc
	2.27	Mihi Persian C.
	2.28	Prima Gland Clover
	2.29	Plantain/Cc
	2.30	Bolta Balansa C.
Rep. 4	2.31	Bolta Balansa C.
	2.32	Chicory/Cc
	2.33	Prima Gland Clover
	2.34	Caucasian clover
	2.35	Red clover
	2.36	White clover
	2.37	Plantain/Cc
	2.38	Mihi Persian C.
	2.39	Cefalu Arrowleaf C.
	2.40	Lucerne

Figure 14 Block 2, Legume and Herbs, trial plan.

- Feb 06: 'Freshcote' Alsike (3.5 kg/ha), 'Demand' white (4 kg/ha), 'Pawera' red (5 kg/ha), 'Leura' subterranean (10 kg/ha), 'Bolta' balansa (3 kg/ha) clovers, 'Choice' chicory (0.6 kg/ha), 'Tonic' plantain (1 kg/ha) and 'Kaituna' lucerne (10 kg/ha) were sown 8 – 13 February 2006. Site preparation was the same as for perennial grasses.
- Nov 06: 'Endura' Caucasian clover (Cc) was over drilled at 8 kg/ha in chicory and plantain treatments and sown with rape on November 1st 2006.
- Plots were grazed September and November 2006, January, June and November 2007, April, October 2008, January, September and December 2009, November 2010, and January 2011.
- 750 kg/ha superphosphate was applied in October 2007 and 300 kg/ha in September 2008. In May 2008, clover was sprayed with Spinnaker (300 ml/ha) and Codacide (Adjuvant oil) at 500 ml/ha to reduce weed invasion. The main weed was sorrel.

Table 8 Soil Quick Tests.

Date	pH	Olsen P	Ca	Mg	K	Na	S
8/08/2007	6.0	17	7	10	11	2	8
19/05/2008	5.9	19	7	12	16	2	30
2/09/2009	6.0	20	6	10	11	2	6
11/08/2010	5.6	18	7	12	12	<2	-
31/08/2011	5.9	19	8	11	10	3	5

Year 4 (July 2009 – June 2010)

- Caucasian and red clovers had the highest amount of sown clover (2.3 t DM/ha) and lucerne the lowest at 0.7 t DM/ha (Figure 15).

Year 5 (July 2010 – June 2011)

- In November 2010 Caucasian clover had the highest amount of sown clover (0.97 t DM/ha) and lucerne the lowest at 0.15 t DM/ha (Figure 15).
- Dry matter production for sown legumes was lower in spring 2010 due to low October rainfall (25 mm) compared with 2009.
- Lucerne plots continue to grow a significant weed component. Chicory and plantain production has declined over time (Figure 17).

Year 6 (July 2011 – October 2011)

- In October 2011 total sown legume was highest for red clover and Caucasian clover (1.2 t DM/ha) and lowest for lucerne at 0.47 t DM/ha (Figure 15).
- Legume content was at least 40% in all plots in October harvest (Figure 18).

- Significant weed grass invasion apparent in all plots in early spring but this is likely to decline as legumes growth rates increase with warmer temperatures.

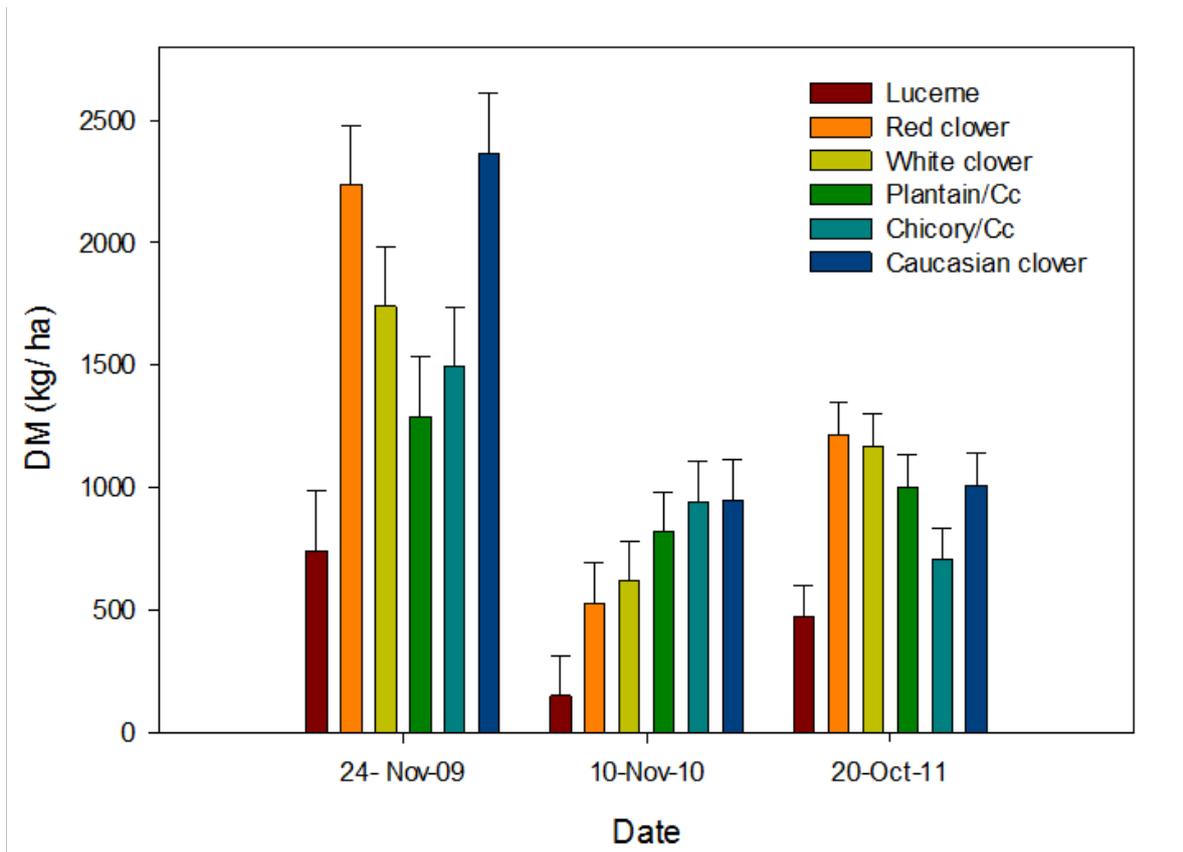


Figure 15 Dry matter production for sown legumes from spring harvests in Years 4 (Nov 09) 5 (Nov10) and 6 (Oct 11).



Figure 16 Plantain and Caucasian clover in Block 2, 20 October 2011.

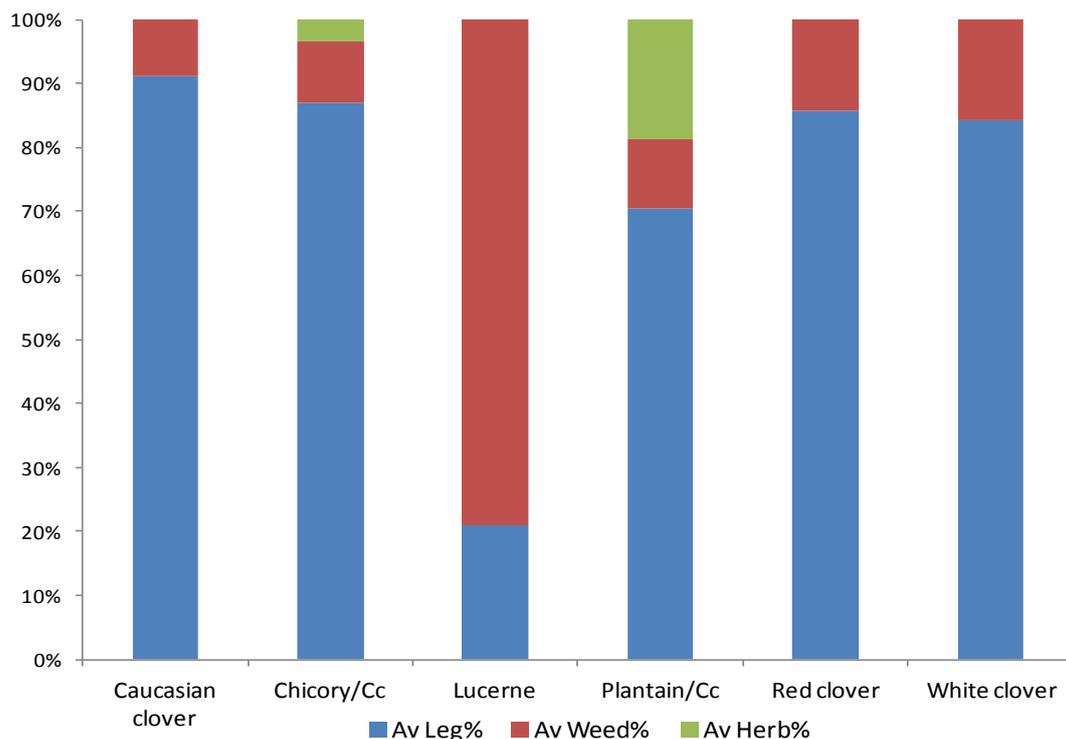


Figure 17 Botanical composition of dryland legumes & herbs in the Lees Valley, November 2010.

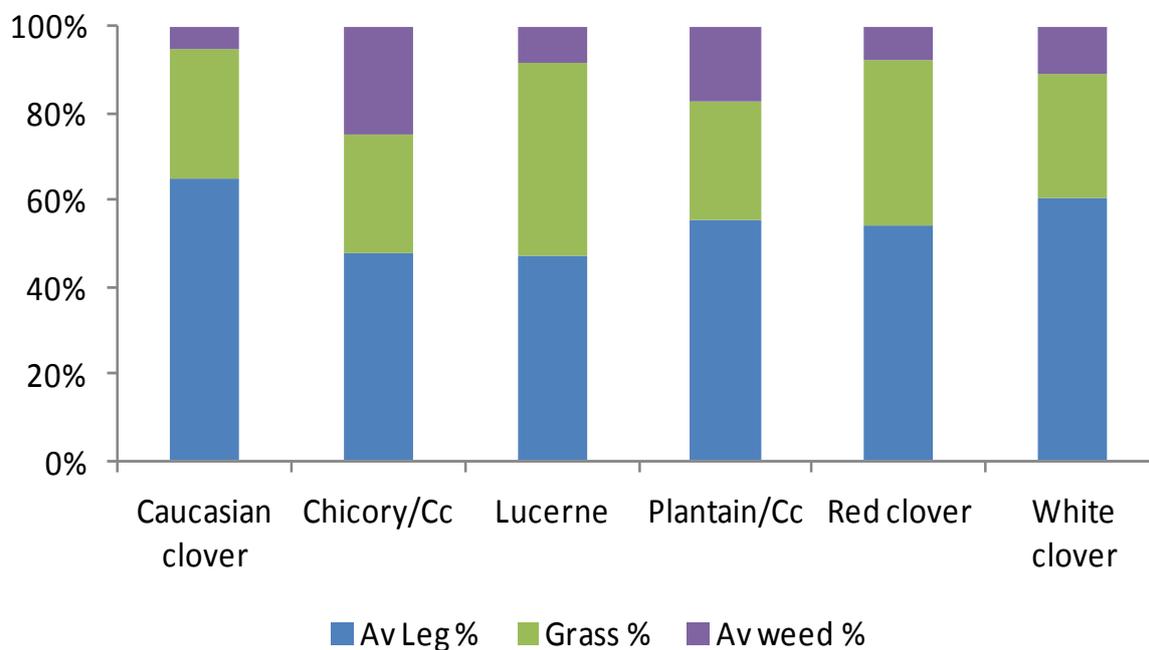


Figure 18 Botanical composition of legumes grass and weeds in the Lees Valley, October 2011.

Main points

- ✓ *Caucasian clover has persisted and its production and ground cover have increased over time.*
- ✓ *Red clover plants have persisted for six years but numbers are declining.*
- ✓ *Chicory and plantain content have diminished significantly between years 3 and 6.*
- ✓ *White clover production has varied with spring summer rainfall and re-established from buried seed. Original plants died.*
- ✓ *Lucerne production has been low in these plots in all years but appears to be improving slowly.*



Figure 19 Caucasian clover is the most persistent and productive clover on the Lees Valley trial site after 6 years.

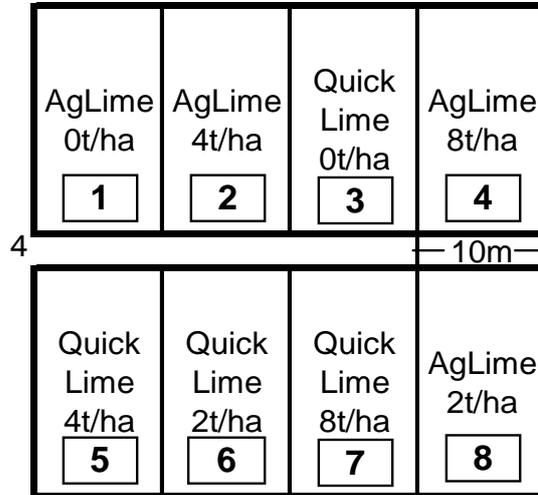
Lime / Lucerne trial

Jim Moir

Lucerne x LimeType x LimeRate (2008)

Plot Size = 10 x 20 m
with 3 m headlands
between ends of plots.
And a 4 m strip between
reps

Rep 1



Rep 2

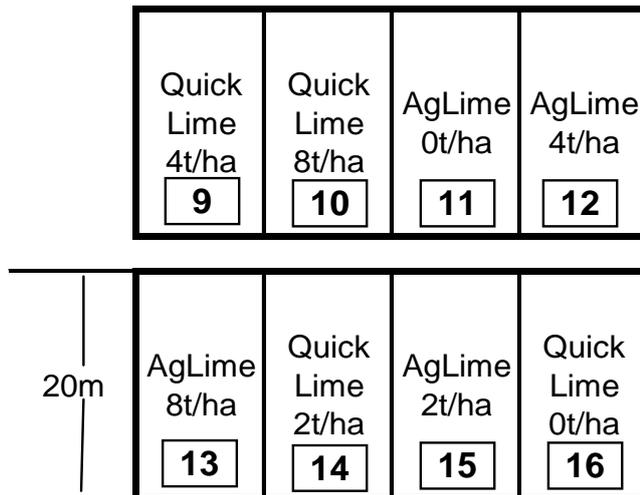


Figure 20 Plot plan for Lucerne x Lime Type x Lime Rate (2008).

- The previous lucerne experiment (sowing rate by date) produced poor yields. Some plots showed horizontal root growth, suggesting Aluminium toxicity.
- Previous studies (Edmeades *et al.* 1983) found a 50% reduction in DM yield of pastures when Aluminium levels were > 1 me/100 g of soil.
- Aluminium toxicity is more likely to occur in the subsoil than topsoil (Edmeades *et al.* 1983). Therefore need to lift pH at depth.

- A new lime rate and type by lucerne trial was established in 2008:
 - Lime applied March 2008 (Aglime or Quicklime; @ 0, 2, 4 or 8 t/ha).
 - Trial site sprayed out in Mid Nov 2008.
 - Kaituna lucerne sown in early Dec 2008 (rate = 14 kg/ha).



Figure 21 Horizontal root growth of Lucerne.

Soil pH and Aluminium

- Over all soil sampling depths and liming rates, soil pH was strongly related to soil plant-available Aluminium (new soil data, August 2011).

Relationship between Soil Al³⁺ and pH at Lees Valley

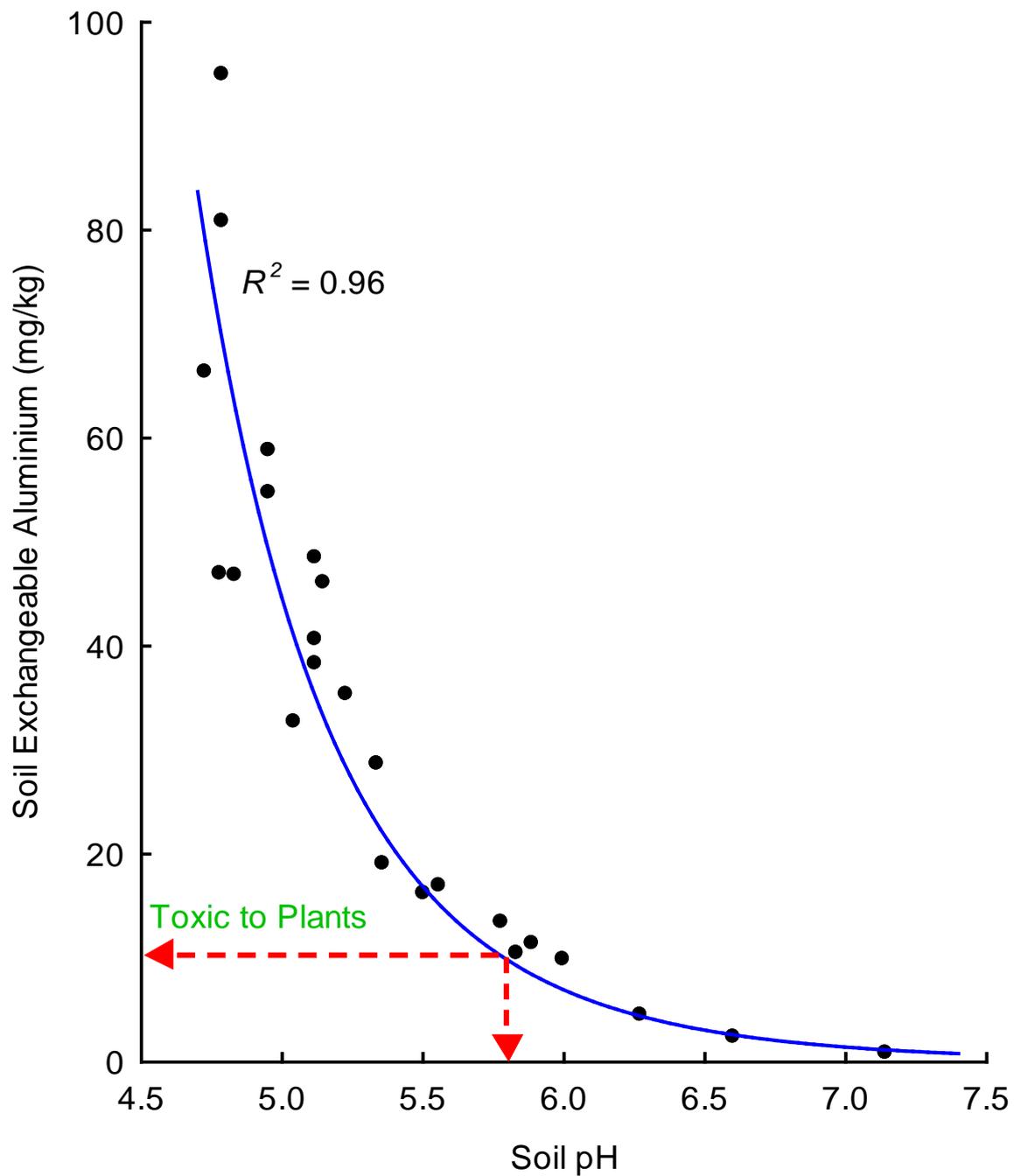


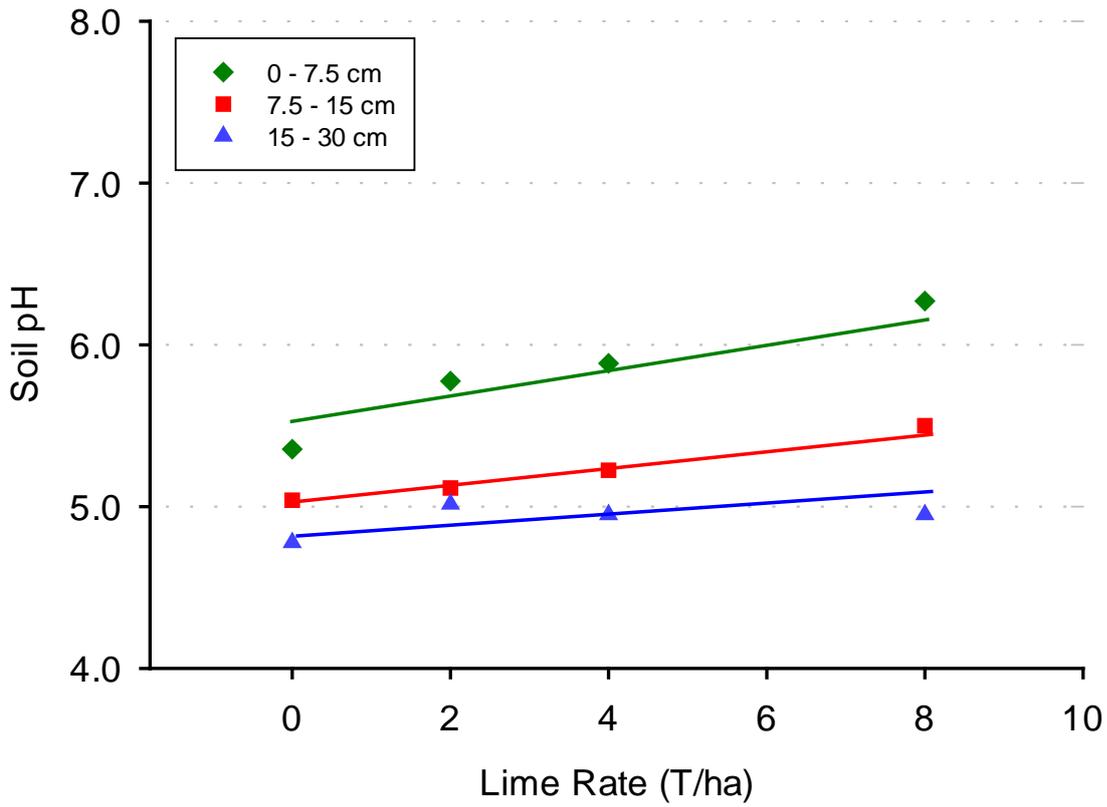
Figure 22 Relationship between Soil Al and pH at Lees Valley.

- Soil exchangeable aluminium levels increased sharply below a soil pH of 5.8.
- At a soil pH of 5.8, exchangeable Al increased to 10 mg/kg or above. At this level, exchangeable Al is likely to reduce DM yield.

How did the Lime change soil pH and Al?

- Liming had a large effect on increasing soil pH and lowering soil plant-available Al at the surface (top 7.5 cm of soil), especially for Quicklime at high rates.
 - The liming effect was small in the 7.5 – 15 cm depth, though significant for Quicklime at high application rates.
 - pH has remained low in the 15 – 30 cm depth, with soil Al remaining at high (toxic) levels in this horizon.
- In general, higher rates of lime resulted in higher soil pH and lower plant-available Al levels down the soil profile, though most pH change occurred in the 0 – 7.5 cm horizon.
- In the ‘medium term’ (now 3.5 years post lime application), Quicklime was more effective at increasing soil pH at the high (8 t/ha) liming rate.

AgLime: Lime Rate, Soil pH & Horizon Relationships



Quick Lime: Lime Rate, Soil pH & Horizon Relationships

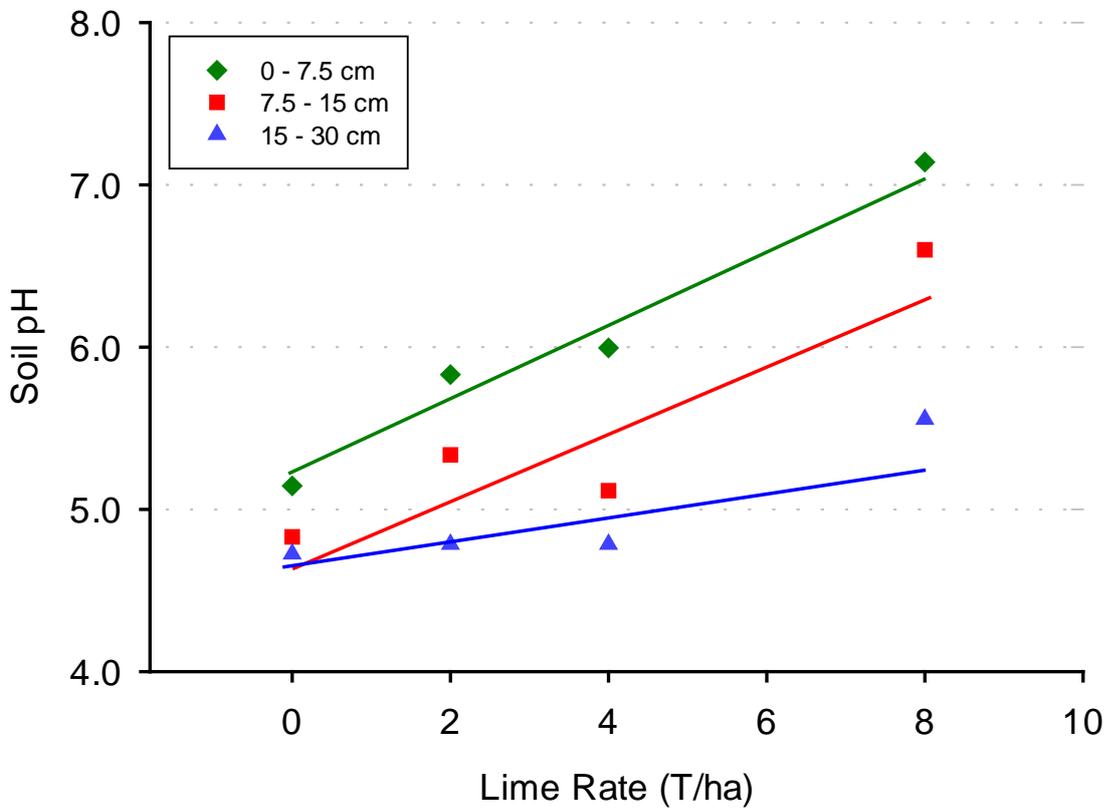


Figure 23 Lime rate, soil pH and horizon relationships in Ag and Quick lime treatments.

Lime and Lucerne Yield

- DM cover (yield) is often low at this site and is soil moisture limited.
- Effect of lime / liming rate on yield has previously been unclear and is probably confounded by other factors.
- However, the full data set (mean values of many yield measurements) has now confirmed a yield response to liming at this site. Maximum yields were seen 4 – 8 t Aglime / ha, and 2 – 4 t Quicklime / ha.
- From results of our other research; it is possible that the higher soil pH at high Quicklime application rates limited soil phosphorus availability, which limited yields for those treatments.

Lime Trial - Lucerne Yield (Mean 25/8/09-17/7/11)

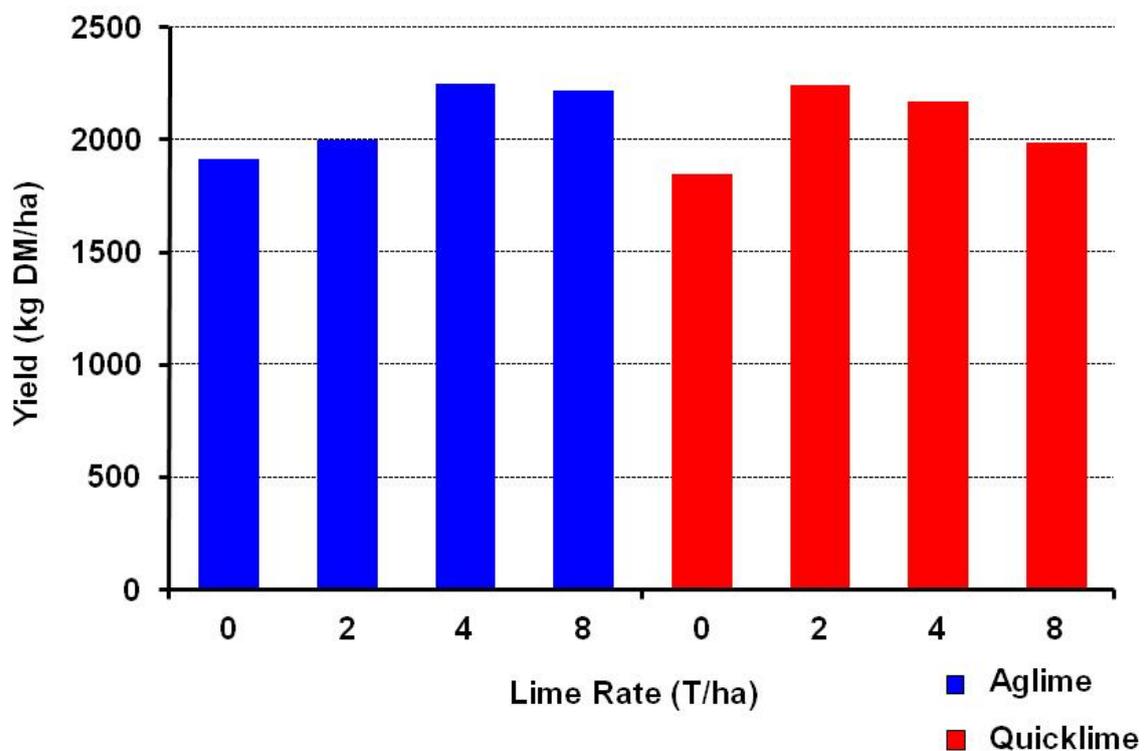


Figure 24 Lucerne yield (mean at 25/8/09 – 17/7/11) after different forms and rates of lime were applied in March 2008.

What other factors are currently influencing yield at this site?

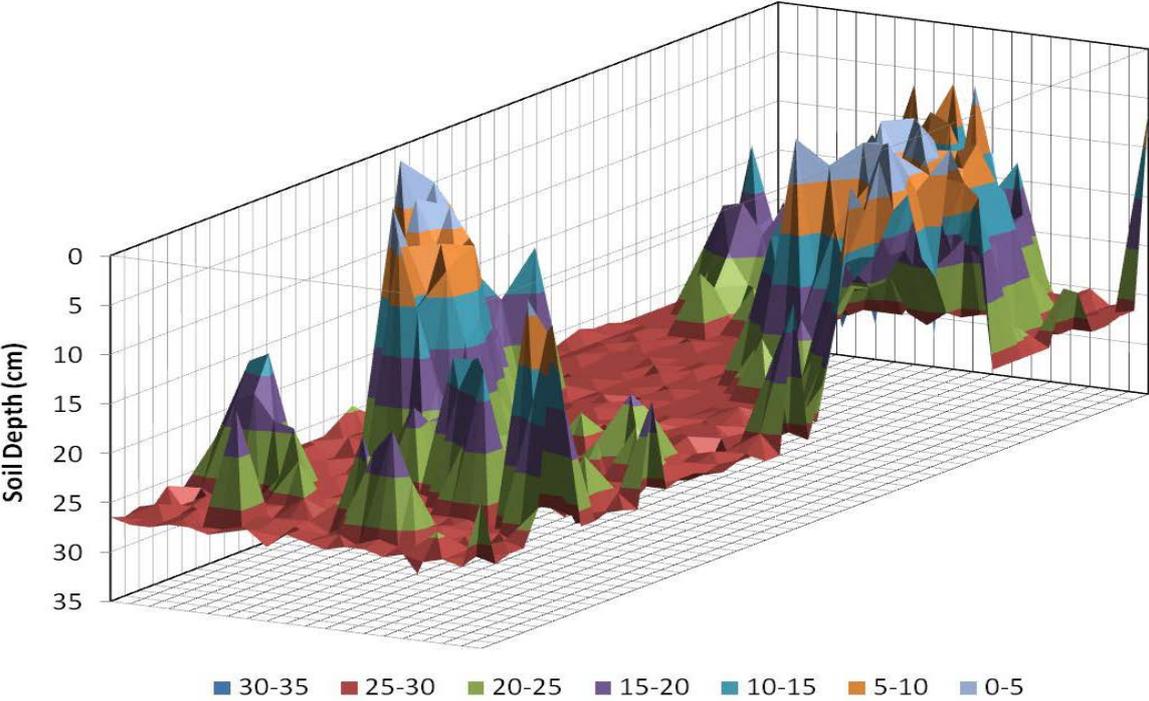


Figure 25 Depth of topsoil across the lime experimental site at Lees Valley.

- A comprehensive topsoil depth survey (depth to gravel) at this site has shown that topsoil depth is extremely variable, even over small distances (1 – 2 m). This results from soil deposition patterns from old braided river systems.
- Lucerne yields also seem strongly related to topsoil depth / depth to gravel, and therefore the plant-available water storage capacity of the soil.

Glasshouse Studies at Lincoln (2010/2011)

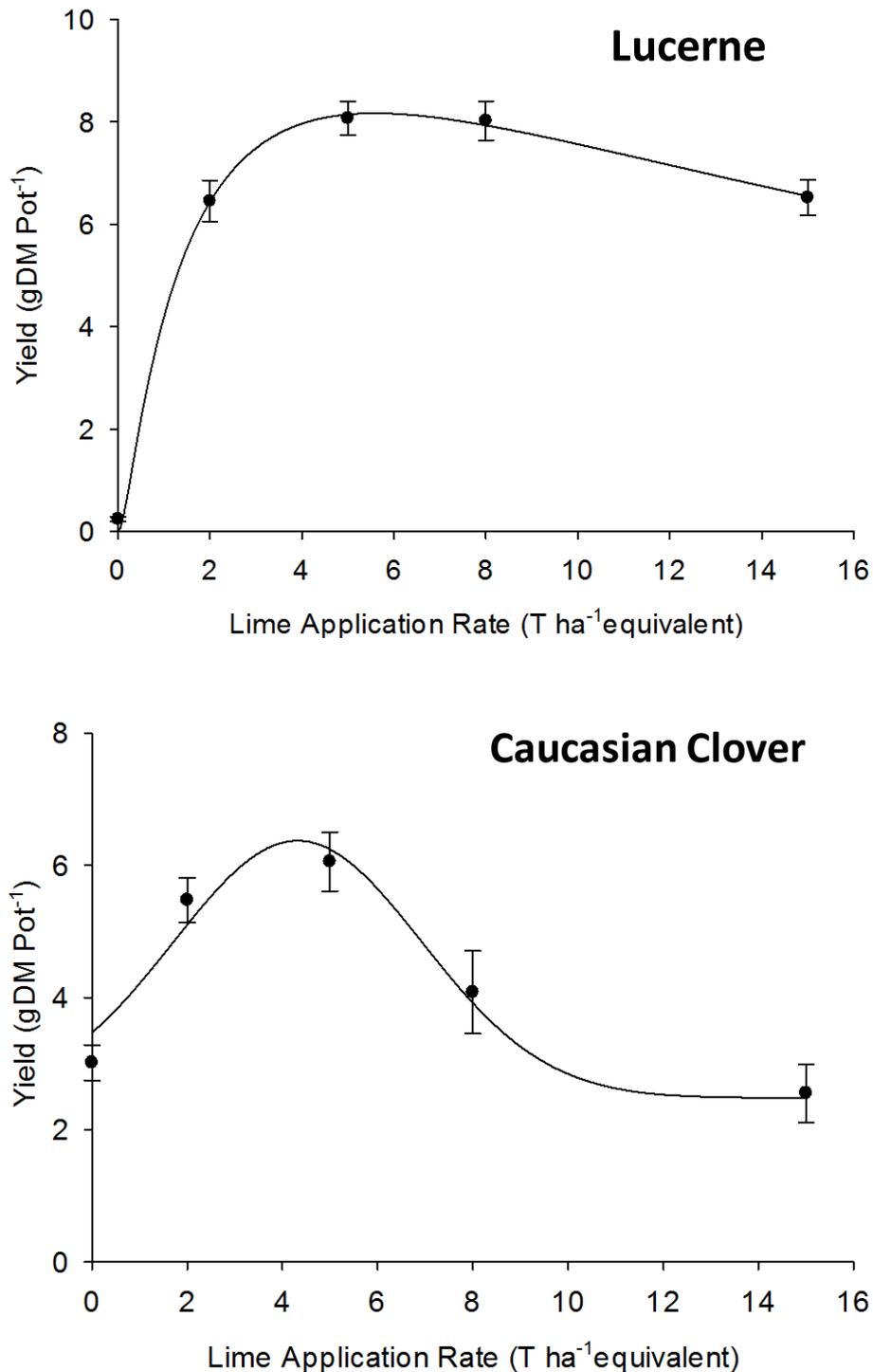


Figure 26 Yield of Lucerne and Caucasian clover plants (g/pot) after different rates of lime were applied to soils from Lees Valley (Jordan 2011).

- Current glasshouse studies at Lincoln have focused on characterising several potential high country legumes in terms of optimum soil pH and P requirements.
- The two species above, grown in soil from the Lees Valley, show Lucerne having a maximum yield between 4 and 6 t lime/ha, and Caucasian clover peaking at 3 - 4 t lime/ha.
- These results highlight the higher lime requirement of Lucerne (which agree well with the field trial results) and also indicate that Caucasian clover may have a higher tolerance of acid soil / high soil Al conditions.
- The depression in yield at high liming rates likely results from reduced soil P and trace element plant availability (at high soil pH).

Conclusions

- *Soil pH was strongly related to levels of soil plant-available Aluminium.*
- *Liming increased soil pH and reduced soil plant-available Aluminium in the short – medium term.*
- *Liming was most effective in the 0- 7.5 cm horizon and much less effective at depth (15 – 30 cm). The 7.5 – 30 cm horizon generally remained at pH and exchangeable Al levels which would restrict Lucerne growth, even for the limed treatments.*
- *Higher rates of lime were more effective and Quicklime showed an advantage over Aglime at the 8 t/ha rate, though not in terms of plant yield.*
- *Soil pH / Al levels positively influenced Lucerne yields. Extreme variability in depth of topsoil (micro-topography) and hence plant-available water storage have also influenced yields, especially in the first year of the trial.*

Lucerne and Caucasian clover in the Lees Valley soil, a pot trial

Saman Berenji, Jim Moir, Derrick Moot

Treatments

- Lime (CaCO_3) equivalent rates of 0.5, 1, 2, and 4 t/ha, mixed with soil two weeks before sowing. \pm Phosphorus 250 mg/kg soil and \pm rhizobia.
- Lucerne and Caucasian clover seeds were sown on 29 March 2011 in tubes at Lincoln University. Growth and establishment were evaluated after five months.



Figure 27 Lucerne and Caucasian clover could not grow in the original Lees Valley soil.

Table 9 Typical pre development soil test result from Lees Valley (MAF units).

Date	pH	Olsen P	Ca	Mg	K	Na	Al
10/10/10	5.2	12	2	6	12	22	15.1

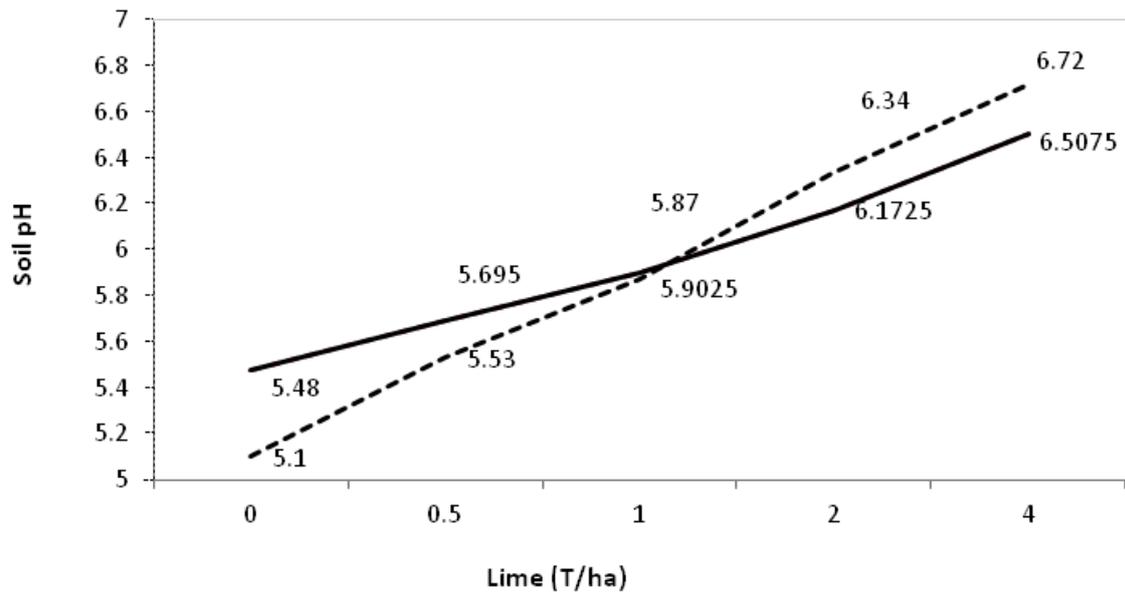


Figure 28 Soil pH change by lime treatment (- - -) before starting the experiment and (—) after 5 month growth.

- Equivalent field rates of 2 t lime/ha, increased the soil pH from 5.1 to 6.3.



Figure 29 Lucerne grown in tubes in Lincoln University in soil from the Lees Valley.

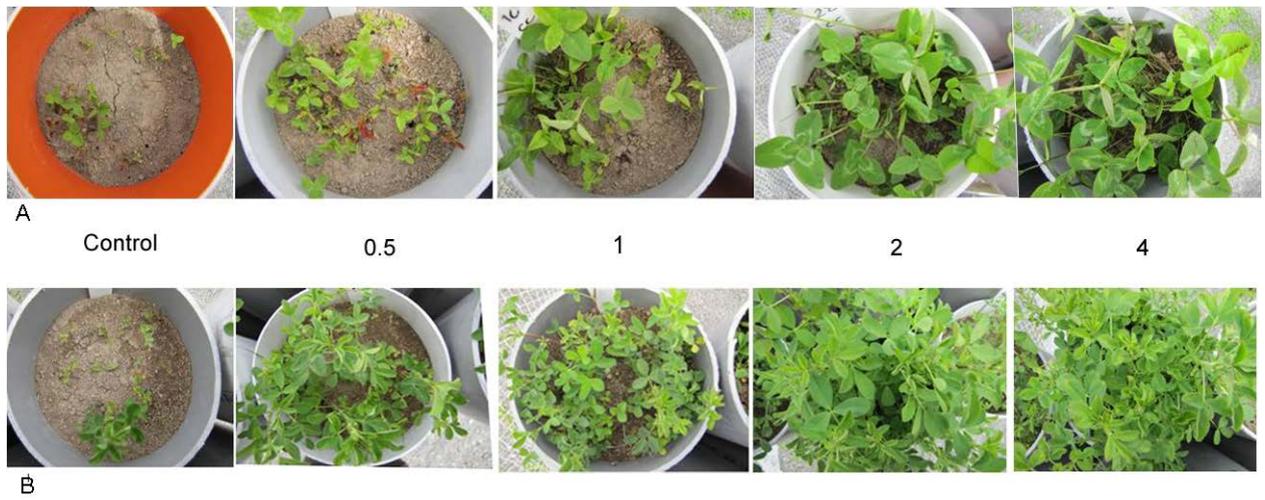


Figure 30 Growth response to lime rates (t/ha). (A) Caucasian clover (B) lucerne.

- Higher growth rates and establishment achieved by adding 2 and 4 t lime/ha.

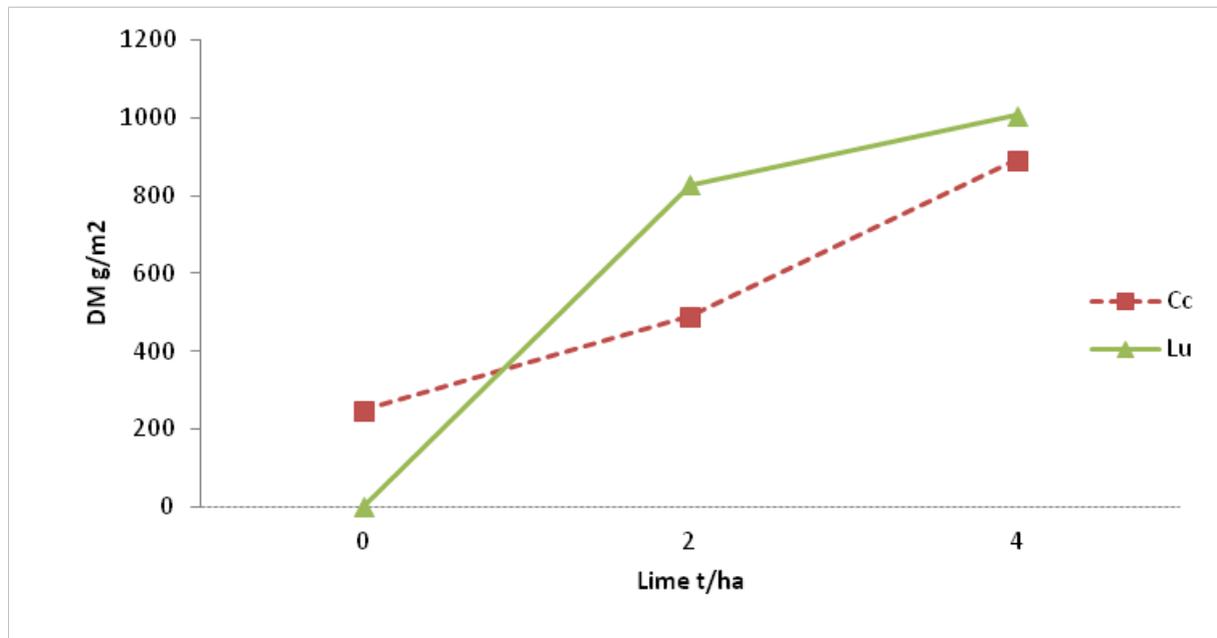


Figure 31 Lucerne and Caucasian clover dry matter (g/m²) in response to lime rates after 15 months growth.

S. Berengi acknowledges the Miss E L Hellaby Indigenous Grassland Research Trust for providing a research fund for this experiment as a part of a PhD. Project.

Annual Clover Options

Dick Lucas and Hollena Nori, Lincoln University

Sub clover

- In general sow 50/50 mix of two contrasting cultivars to allow for climatic and site variability. Sow in autumn with at least 6 kg bare seed/ha, preferably 10 kg/ha. Keep your ryegrass sowing rate below 10 kg/ha. Sub clover can be over drilled successfully but tends to be more vulnerable to weather conditions when broadcast than the smaller seeded clovers.
- Management for a good seed set in the first spring after sowing is the best time to build the sub clover seed bank. The sooner the seed bank is loaded the sooner your pasture will give spring lactation pastures with over 50% clover on offer. Livestock prefer to select a diet of 70% legume and 30% grass; they produce maximum milk and live weight gain if they can approach that ideal clover/grass balance. To get a good seed set do not graze lower than 1500 kg DM/ha – that is keep pasture height above about 5 cm with at least one layer of clover leaves. Once the sub clover defoliated below that, the seed yield and quality (size) will be greatly reduced. Ideally, if it is a good season, spell new sub clover paddocks for up to 6 weeks from the time of full flowering. That should give a seed crop at least 20 times the amount sown.
- Nitrogen fixation by pasture legumes is vital to the dryland pasture system. Conservative estimates of the amount of nitrogen (N) fixed by clovers in grass/clover pastures show that 25 kg of N is fixed for every ton of clover DM grown. If the contribution of the clover roots is included then it is probable that the clovers contribute 45 kg N/t clover herbage DM grown. Hence all farmers who prefer to avoid N fertilisers should rejoice at the sight of their legume dominant pastures!

Sub Clover cultivar options

- **Campeda:** mid flowering date, mix with later cultivar if paddock normally dries out before mid November. Some hard seed is produced so it is less vulnerable to false strike in autumn. We have well balanced mixtures of Campeda and Denmark sub clovers with both cocksfoot and ryegrass on stones at Ashley Dene, the Lincoln University dryland farm.
- **Woogenellup:** mid/late flowering date, soft seeded and vulnerable to false strike but high yielding. Does well at “Tempello” in Marlborough.
- **Denmark:** late flowering, prostrate to tolerate close grazing, high seed yield. Disease resistant. Has persisted well for 10 years with cocksfoot on Templeton soil at Lincoln.
- **Leura:** latest flowering available. Is contributing well at Tom Costello’s in North Canterbury.

New on the Australian market and recommended for NZ conditions based on Australian experience

- **Napier:** late flowering, is in the *yannicum* sub species of sub clover. This means it is better adapted to wet soils in winter/early spring than most sub clover cultivars which are in the *subterraneum* sub species. Cream/amber seed colour. High yielding, taller than Denmark so may be less tolerant of hard set stocking.
- **Rosabrook:** late flowering and prostrate growth form similar to Denmark. Has been selected for tolerance to red legged earth mite (RLEM). If RLEM is shown to be a significant challenge to sub clover in NZ this tolerant cultivar should be used.

Top flowering annual clovers

- Top flowering annual clovers have much smaller seeds than sub clover. Lower seeding rates of 2 to 5 kg/ha are therefore recommended. The smaller seeded species may be more successfully established from broadcasting than sub clover. When drilling they must be sown shallow, (<10 mm) and competition from resident pasture/weeds minimized. When broadcasting seed, 20 to 50% bare ground is ideal and if possible trample seed in after spreading. Keep grass seeding rates at a minimum when sowing these small seeded clovers; sow more clover and less grass but spend the same amount per hectare on seed.
- Because stock eat flower stems of the top flowering species it is essential to let these annual clovers set a large amount of seed in their first spring. This will load the seed bank for the following 3 to 5 years.
- **Prima gland clover:** early flowering and therefore has lower maximum DM yield potential. As with most other top flowering species gland clover is very hard seeded and needs some bare ground in summer to encourage seed softening. So hard summer clean up grazing is an important part of managing these clovers for persistence.
 - Gland clover is one of the few annual legumes which tolerates RLEM. It can therefore be sown with other legumes to provide an indication of the severity of RLEM attacks. It is well adapted to dry north and west faces where other sown legumes struggle to establish and lower yielding volunteer annuals such as haresfoot clover may be the only legumes present.
- **Bolta balansa clover:** mid flowering, very tolerant of wet soils in winter/early spring. Susceptible to RLEM at seedling stage. High growth rate in early spring. High quality hay or late spring feed after seed set. Potential for use in mixtures with sub clovers in paddocks with variable drainage but dry out in summer. Balansa paddocks need hard grazing in summer to ensure some hard seed is softened. Balansa is faster away in early spring than sub clover.
- **Persian clovers:** Persian clovers are later flowering than sub clovers and have high yield potential. Persian is very tolerant of water logging and grows well in clay soils. Tall growth form is ideally suited to hay or silage.
 - There are two sub species of Persian clover. One has very soft seed and is susceptible to false strikes and is unlikely to survive in the seed bank of a permanent pasture. The sub species suited to permanent pasture has a moderate level of hard seededness (e.g. Prolific, Nitro Plus, Kyambro).

- **Arrowleaf clovers:** Arrotas is the latest flowering annual clover on the NZ market. It is unlikely to complete its full life cycle and will not set seed in low rainfall areas with low water holding capacity soils. But on sites which normally stay green till early summer its deep tap root helps it to provide good feed for weaned lambs well into January. Arrotas seed is very hard and is not mature till late summer and therefore has little chance to soften on bare soil surfaces before autumn rains come. Hence, after a good seed crop, it will appear to miss a year as seed will soften in the following summer to germinate in the second autumn after its initial sowing.
 - Earlier flowering arrowleaf clover cultivars such as Cefalu are later flowering than Leura sub clover so they will provide quality feed into December.
 - Arrowleaf clovers are slower growing in the cool season than other annual clovers but compensate with very rapid growth in late spring/early summer.
 - Arrowleaf clovers do not tolerate wet soils. Chris Dawkins (“Pyramid”, Marlborough) has had good late spring production from the Arrotas component in the better drained areas of his ryegrass/sub clover/Arrotas trial paddocks.



Figure 32 Balansa clover (top) and Gland annual clover (bottom) in flower at Lincoln in spring 2010.

Why sow annual clovers in autumn?

- The data for four annual clovers in the graphs on Figure 33 provides evidence to explain why annuals sown in spring rapidly bolt to seed before they have a chance to produce much dry matter. In contrast annual clovers sown in early autumn may produce over 10 t DM/ha before first flowers appear in spring.
- For example, Bolta balansa clover sown in February requires about 2000 degree days ($^{\circ}\text{Cd}$) before it will flower in the following October. The declining day length (photoperiod) during autumn inhibits flowering and the clover uses the large amount of energy (2000 $^{\circ}\text{Cd}$) for vegetative growth. As day length increases in spring it accelerates the onset of the reproductive phase and shortens the life cycle of annual clovers. If balansa clover is sown in November it will flower after an accumulation of only 600 $^{\circ}\text{Cd}$. These plants will be less than a third the size of the February sown plants because they have had much less time for growth.
- The flowering and seed production phase of an annual clover's life cycle is followed by death and decay of the plant. The species then survives dry summers as dormant seeds until autumn rains encourage germination of a new generation of seedlings.
- Once annual clovers start to flower their stem to leaf ratio increases and the nutritive value of the dry matter declines. It is therefore important that annual clovers should be sown in late summer/early autumn to produce maximum DM yields.

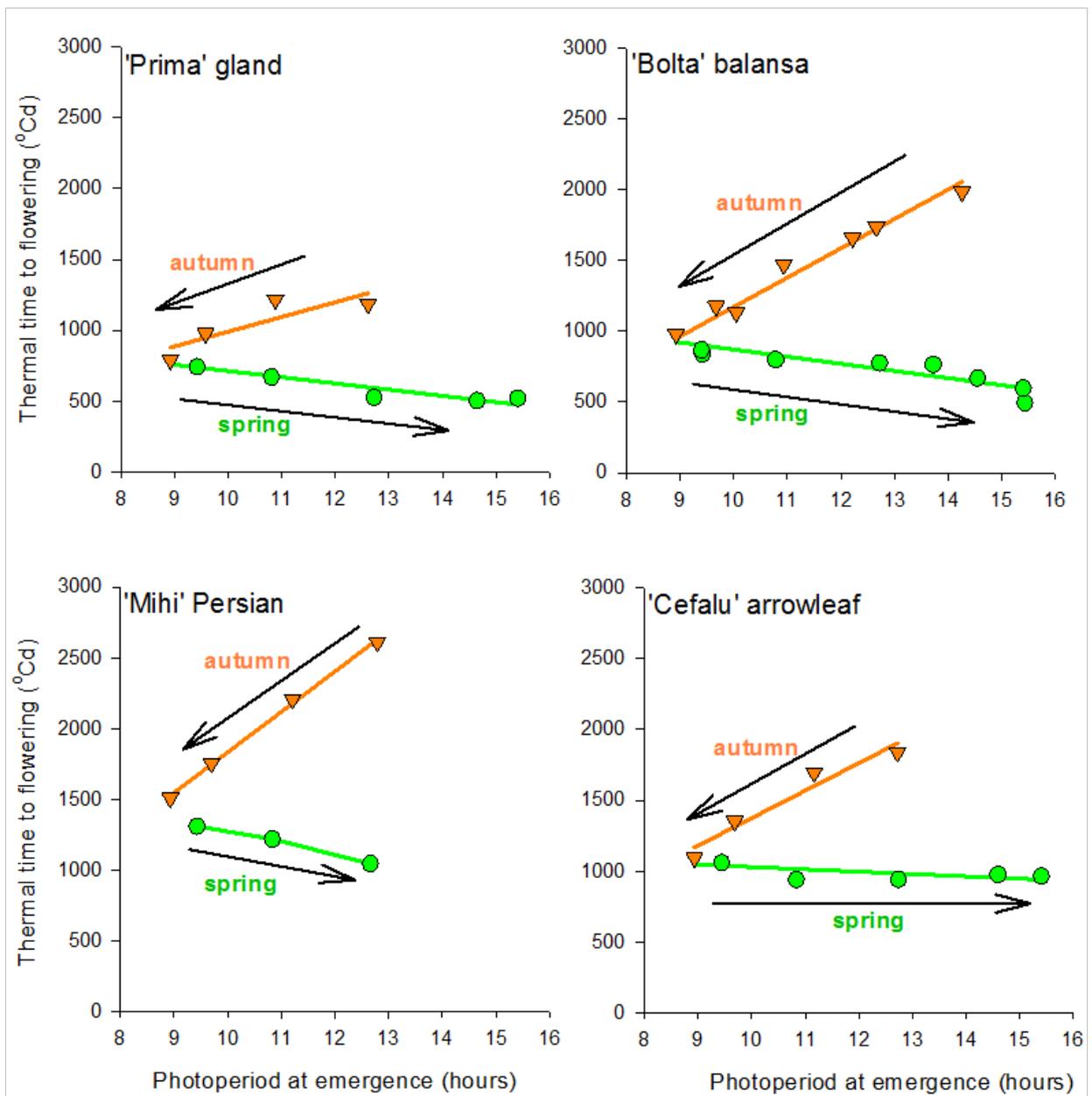


Figure 33 Time to flowering in four annual clover species in relation to photoperiod at emergence in Lincoln University. Triangles are data collected in autumn and circles are spring data.

Practical Lucerne Grazing Management

Professor Derrick Moot and Malcolm Smith

Email: Derrick.Moot@lincoln.ac.nz

1. Getting started (Paddock 1)

One of the most difficult things to understand when grazing lucerne is what stocking rate to use and when to start grazing. At Lincoln University we have been faced with this dilemma over many years and we don't always get it right. This guide summarizes our experiences to date;

- Start spring grazing of lucerne when it is about 15-20 cm tall – the first paddock grazed and sprayed in the autumn clean-up round is likely to be the first one ready for grazing in spring.
- Put ewes with lambs at foot onto lucerne as early as your management allows i.e. lamb onto older stands with some fibre available or start drifting stock on when lambs are no more than 2 weeks of age. The younger the lambs are on lucerne the better!
- Stock at 10-14 ewes plus lambs (180%+) per hectare in one mob to commence grazing in the first paddock (Paddock 1) of a six paddock rotation. e.g. if you have 30 hectares of lucerne that is 300-420 ewes and lambs all being put on the first 5 ha when it is 15-20 cm tall in spring or about 1500 kg DM/ha. (And then you can wonder where all your stock have gone as they come off lambing blocks letting those areas recover).
- The exact number of animals to put on is location and spring dependent and will take a year or two to work out for yourself. For us it is 12-14 ewes plus twins for 10 -12 weeks.
- Paddock 1 needs to be consumed in 3-4 days. There will be little post grazing pasture mass (PGPM) because all of the herbage on offer is leafy rocket fuel (all herbage ME=12+ and protein 26%+).
- Animals grazing lush lucerne are most prone to health issues as guts adjust – but it is really important to start grazing lambs on lucerne as young as possible. Ensure fibre and salt are available. Ewes that have previously been on lucerne are likely to take to it with little adjustment.
- If you find you are losing lambs or ewes (usually the best ones) check your vaccination programme is up to date and consider 10 in 1 vaccine. Fast growing animals are more prone to clostridia disease from rapid bacterial growth in the rumen that causes sudden death. This is often mis-reported as bloat because they blow quickly after death.

2. First rotation (Paddocks 2-5)

Having started ewes and lambs on lucerne the next issue is when to move them onto Paddocks 2-6. This is a combination of observation and experience and not always easy to get right the first year you start grazing. Some tips:

- The lucerne continues to grow in front of you as you are grazing a paddock- so you are building a wedge or bank of feed ahead of you – managing this is the key to maintaining animal quality to maximize animal growth in this vital spring period.
- As you open the gate to Paddock 2 the ewes will usually walk (not run) because they know they are getting good quality feed and won't have to hunt for the tasty legume amongst grass. But make sure there is fibre and salt on offer.
- Paddock 2 will be taller and contain more dry matter than when you started in Paddock 1.
- Figure 35 is an example of one years grazing management from our six paddock rotation for the 'MaxClover' experiment at Lincoln. Grazing of hoggets started in Paddock 1 in early September 2005. The dry matter increased from 1500 kg DM/ha to 2200 kg DM/ha before entry to Paddock 2.
- Paddock 3 was about 2600 kg DM/ha upon entry. The PGPM is shown as less than 500 kg DM/ha for these first three paddocks.
- Paddocks 4-6 were all around 3300 kg DM/ha upon entry and the PGPMs were closer to 1000 kg DM/ha.
- To get an idea of how much to leave behind after grazing test the herbage as animals go in. Either squeeze or bend a step until you can find where the woody part begins - this is low quality (ME=8, Protein = 12%) that is maintenance feed at best so not recommended for fast growing stock!



Figure 34 Hoggets grazing lucerne in spring 2007 at the MaxClover Grazing Experiment at Lincoln University, Canterbury, New Zealand.

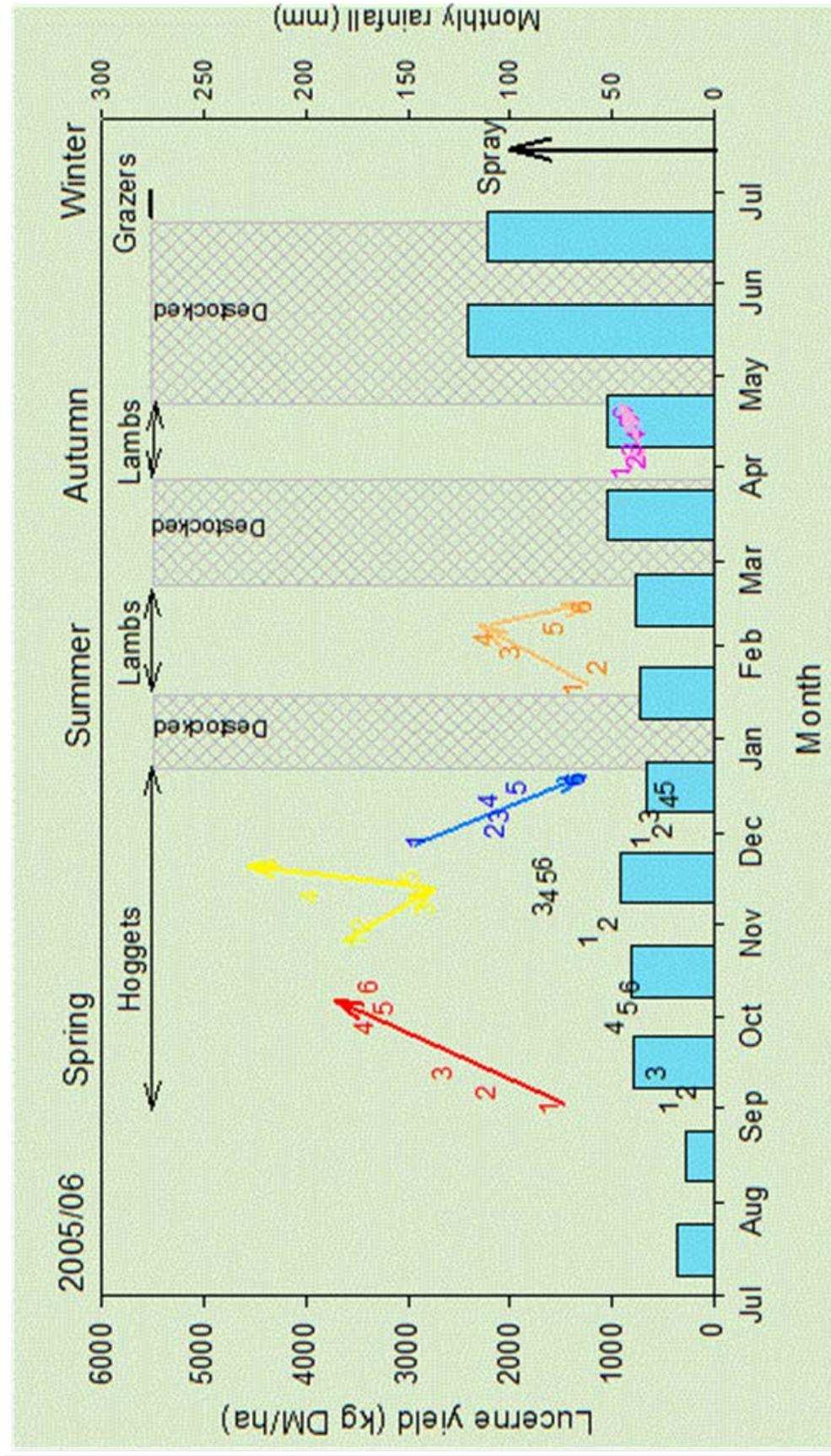


Figure 35 Yields in paddocks 1-6 as stock begin grazing the MaxClover experiment at Lincoln University in 2005. Values at the bottom of the 1st, 2nd, and 3rd grazing cycles are post grazing pasture (stem) mass (PGPM) when stock were moved to a new paddock.

3. When to go back to Paddock 1?

When you enter Paddock 4 you should look to see if recovery in Paddock 1 is 10-15 cm tall. How this grows over the next two weeks dictates paddock rotation. If regrowth is rapid you may not want to graze Paddock 6 but drop it out of the rotation for hay or silage or increase the mob size to cope. As a guide, the time of return to Paddock 1 after leaving should be between 30 and 42 days (or you will have grown too much stem).

- Ideally Paddock 1 will have about 3300 kg DM/ha upon entry the second time (Figure 35 shows this was similar to Rotation 1 in Paddocks 4, 5 and 6). In our example, Paddocks 1 – 5 were all grazed at reasonable yields for the second rotation but Paddock 6 was starting to become too heavy/stemmy.
- The PGPM for Paddocks 1-6 shows about 2000 kg DM/ha was grazed or about 70% utilization. Herbage analyses indicate this level of DM utilization will see over 80% of the total ME and CP consumed. There is no point in making growing animals eat the lower quality residual.
- The amount of regrowth in the second cycle will depend on in season rainfall. In our 2005/06 example the monthly average rainfall was around the long term mean of 50 mm. This was sufficient to keep lucerne growing in Paddock 1 for a third rotation with another 3000 kg DM upon entry.
- For Paddocks 2-6 this level of in season rainfall is inadequate and meant growth was reduced. Paddock 6 only 1200 kg DM/ha was available for grazing in late December.
- Conveniently our experimental plots were destocked from late December until mid January – beach time for dryland farmers!
- The average summer rainfall until May was inadequate for much regrowth so only a single summer rotation was possible with lambs before a clean-up graze in April followed by destocking and a winter weed spray in mid July.

4. Annual Production Summary

- Figure 35 shows the timing of production from each paddock varied across the season. However, when the total dry matter yields were accumulated each grew 10-11 t DM/ha.
- For spring, Paddock 1 produced 7.8 t DM/ha (1.5+ 3.4+2.9) across the first three rotations compared with 8.8 t DM/ha (3.4+4.2+1.2) for Paddock 6. If we converted these to herbage quality the difference would be smaller with the higher yield from Paddock 6 resulting from more stem production, particularly in the second rotation.
- The annual rainfall for this season was 600 mm which is similar to our long term average. Of note, the 230 mm of rainfall in May and June did not result in any significant autumn lucerne growth. At this time the moisture would be accumulated in the soil for use the following spring.
- Ideally the stock on these experimental plots would have been ewes and lambs. However, the small size meant hoggets and weaned lambs are more appropriate.

5. Estimating Dry Matter Yields

One of the key questions when determining stocking rate is assessing current herbage yields. Over the life of the 'MaxClover' experiment and other Lincoln University experiments we have examined the relationship between yield and height and can show a distinct seasonal relationship.

- Figure 36 shows that in spring the lucerne yield can be estimated by multiplying the height (cm) by 90 to get an estimate of yield (kg DM/ha). For example, when a paddock is ready for grazing at about 35 cm height it contains about 3200 kg DM/ha.
- Figure 36 also shows that for summer and autumn the relationship is lower with the multiplier being 60. Thus, that same 35 cm height equates to 2100 kg DM/ha.
- Figure 37 gives a picture of the multiplier on a calendar basis. The overall pattern of a higher multiplier in spring than summer held for stands of many different ages. At Lincoln the highest multiplier of 100 is appropriate in the main growth period of September and October but it then declines to be about 60 from December on.

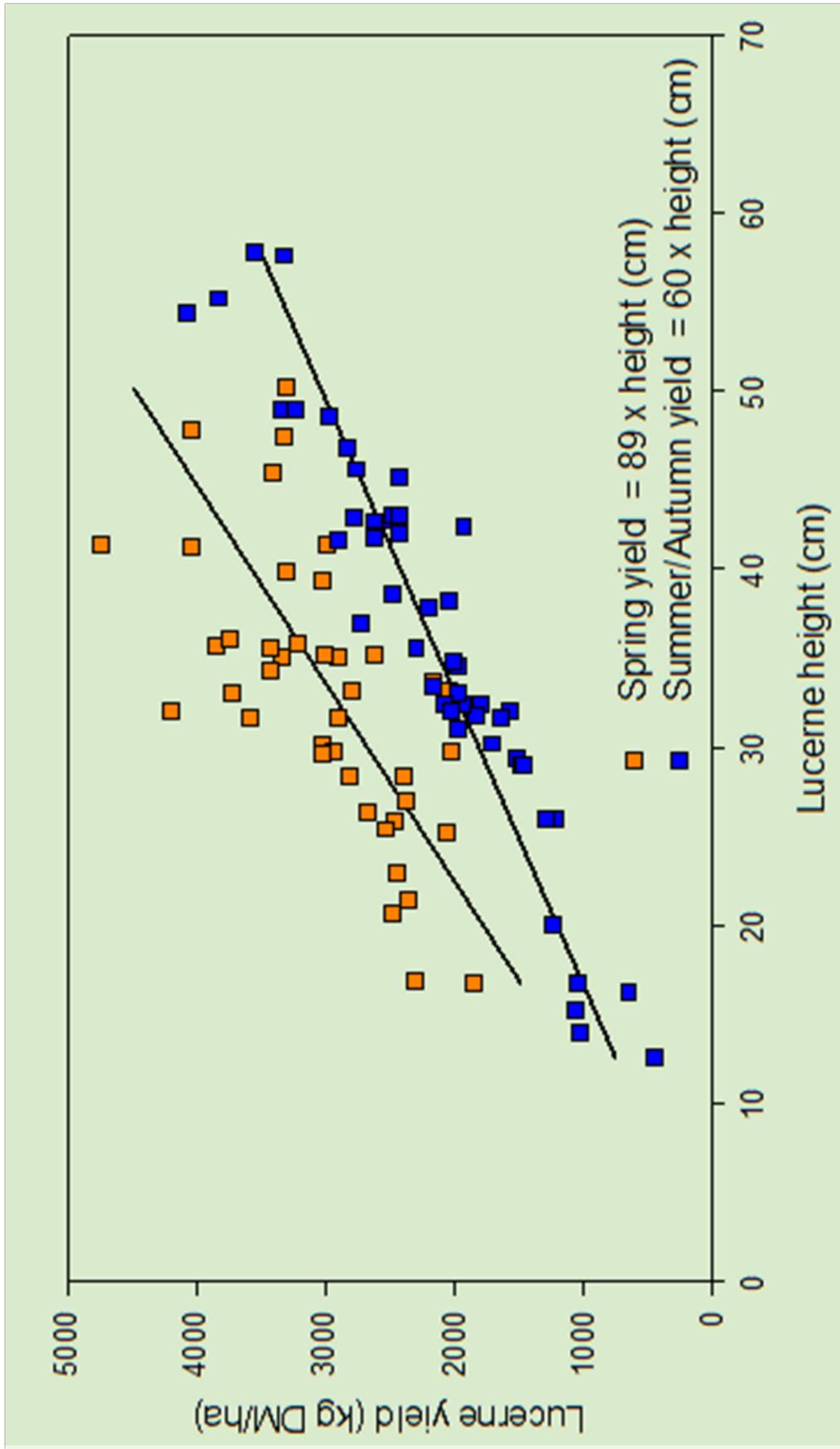


Figure 36 Lucerne dry matter yield estimated from height measurements in Spring (orange squares) and Summer/Autumn (blue squares). Changes in the multiplier used to predict dry matter from lucerne height over a year.

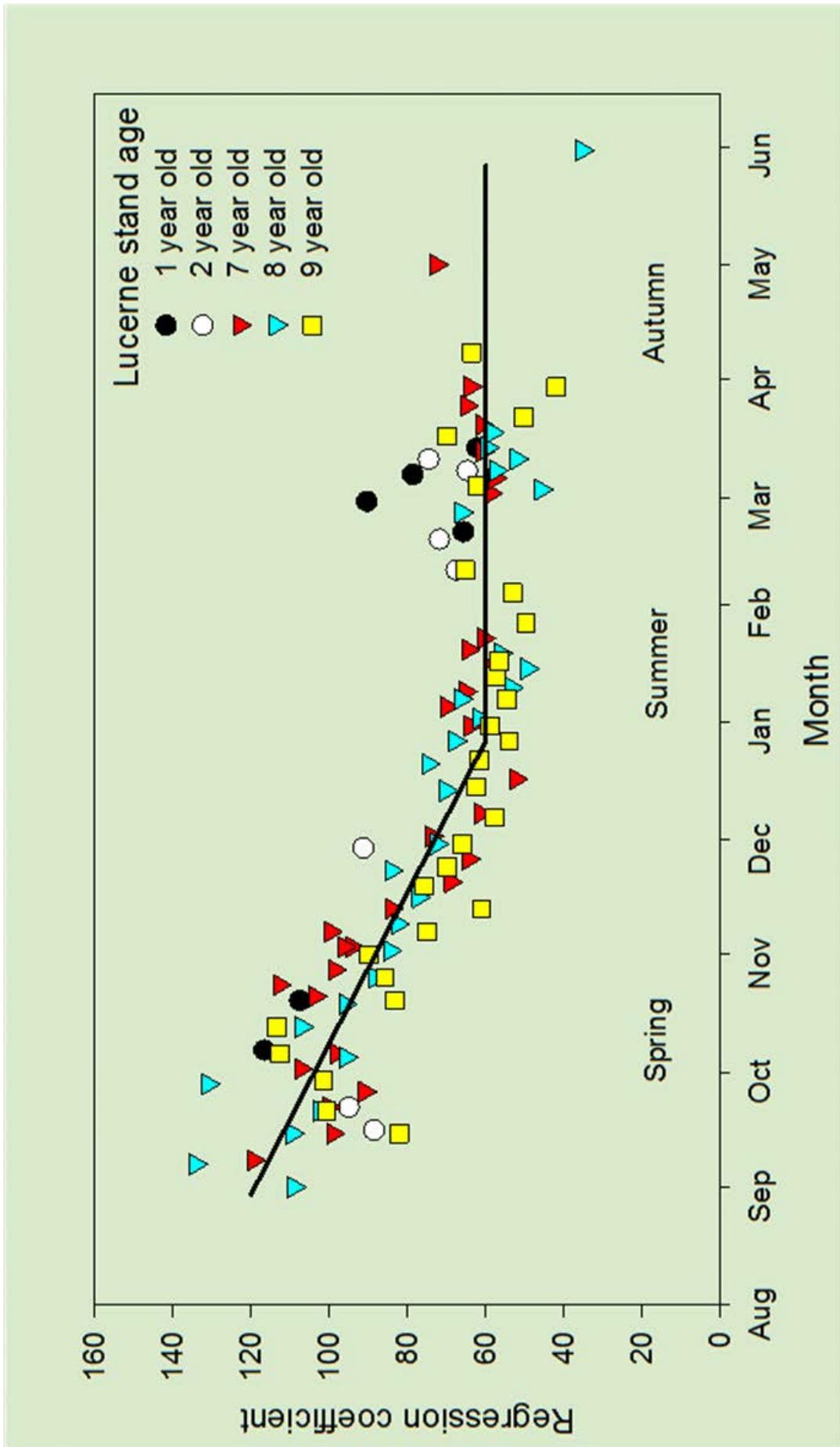


Figure 37 Changes in the multiplier used to predict dry matter from lucerne height over a year.

Cocksfoot Grazing Experiment

2002-2011

Background

- Established At Lincoln University, Canterbury. Reps 1 – 4 on 18/2/2002.
- Reps 5 and 6 sown in 2002/03.

Table 10 Species, cultivar and bare seed sowing rates.

Common name	Acronym	Cultivar	Sowing rate
Balansa clover	Bal	'Bolta'	6 kg/ha
Caucasian clover	Cc	'Endura'	8 kg/ha ⁺
Subterranean clover	Sub	'Denmark'	10 kg/ha ⁺
White clover	Wc	'Demand'	3 kg/ha
Cocksfoot	CF	'Vision'	4 kg/ha
Perennial ryegrass	RG	'Aries' ARI	10 kg/ha
Lucerne	Luc	'Kaituna'	8 kg/ha ⁺

⁺ = seed was inoculated prior to sowing

- Dry matter production and botanical composition were measured from enclosure cages cut to 25-30 mm every 20-90 days.
- For lucerne, five quadrats cut per plot pre and post grazing.
- Live weight production from Coopworth ewe lambs and hoggets. A 'put and take' system is used. 'Core' animals are weighed 'empty' after being held overnight in a stock yard before and immediately after grazing periods of 3-6 weeks of rotational grazing.
- In Years 1 to 7, treatment plots were stocked with hoggets in early spring and replaced with weaned lambs in late spring/early summer. However in Years 8 and 9, ewes rearing twin lambs were put on to plots in spring.
- Pastures are de-stocked over winter (Jun-Aug) except for ewes used to clean up pastures in preparation for the subsequent spring.
- Seasonal LW production is separated into 'spring' (Jul-Nov), 'summer' (Dec-Feb) and 'autumn' (Mar-Jun).

Key points - annual live weight production (Year 2 – Year 9)

- In five of the eight years reported, lucerne pastures gave superior total annual live weight production (See Figure 38).
- Over the eight year period, CF/Sub has given the most consistent spring live weight production of the grass-based pastures (338 - 1022 kg LW/ha).
- A combination of pastures is required to ensure LW production is maintained in different seasons and across years due to variable rainfall.

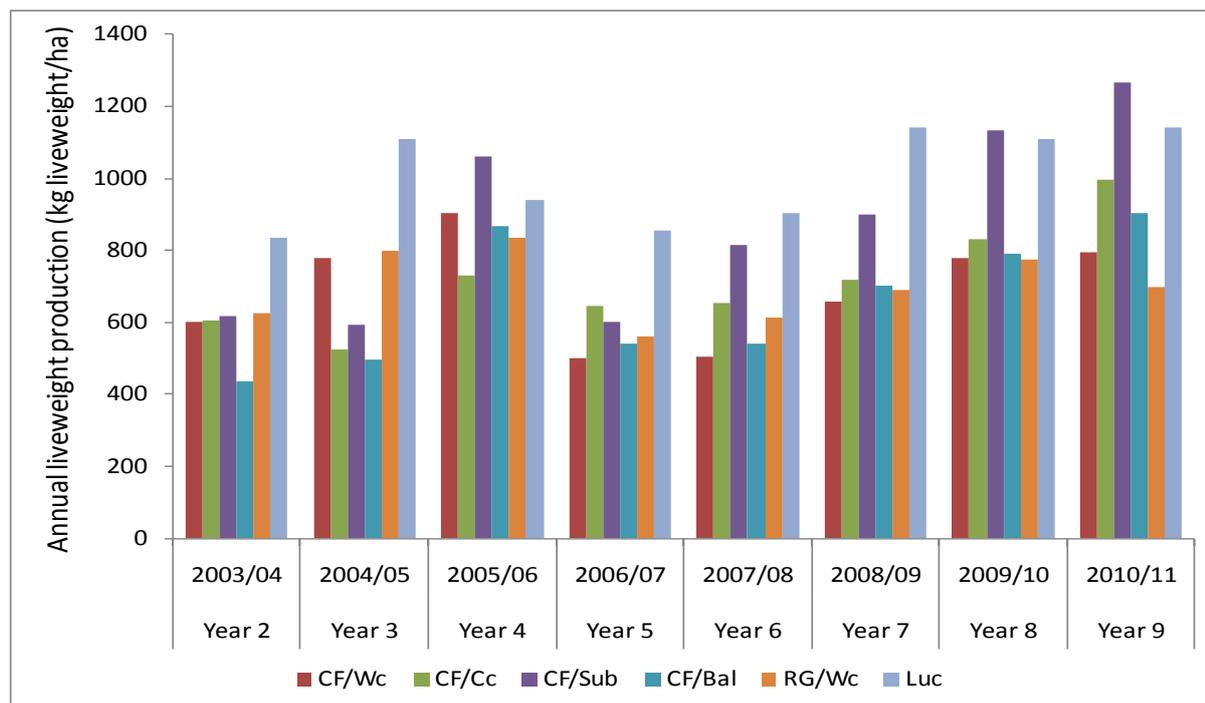


Figure 38 Annual live weight production (kg LW/ha) from the Cocksfoot Grazing Experiment at Lincoln University, Canterbury from six dryland pastures. Note: in Years 8 & 9 pastures were grazed by ewes with twin lambs at foot and liveweight production was measured on animals “weighed full” prior to weaning.

Key points – dry matter yield and botanical composition (Year 1 – Year 9)

- Total annual dry matter yields ranged from 5.7-18.5 t DM/ha (See Figure 39).
- Lucerne produced 12.8-18.5 t DM/ha/y in eight out of the nine years.
- Cocksfoot with subterranean and white clover compliment lucerne production in environments with unpredictable and variable summer rainfall. Production from CF/Sub pastures was highest in spring and CF/Wc pastures provided feed in moist summers.
- Sub clover contributed more than 2.4 t DM/ha/yr in 6 of the 9 years and more than 3.4 t DM/ha/yr in 3 of those 6 years. Over the nine years average sub clover yield was 2.7 t/ha annually.

- Invasion of unsown species is most apparent in the RG/Wc pastures. In Year 2, the contribution of the sown ryegrass to total annual DM production was 65%. By Year 5, it had decreased to 44% and in Year 9 to 12%. By the end of Year 9 unsown grasses and dicot weeds accounted for about 80% of the total annual yield.
- In contrast, in Year 9 sown species still contributed >60% of total DM in all of the cocksfoot based pastures.
- In spring, 2007 there was evidence of grass grub damage in several plots. In 2008 the problem was more widespread. Grass grub population counts showed CF/Wc and CF/Bal pastures had 130 grass grubs/m², CF/Cc 97, RG/Wc 67, CF/Sub 52 and Lucerne with 13. However the variation in grub counts between reps was large. The following year, counts showed the grub populations had changed to 120 grubs/m² in CF/Cc and RG/Wc, 103 in CF/Wc, 75 in CF/Sub and CF/Bal and 36 in lucerne.

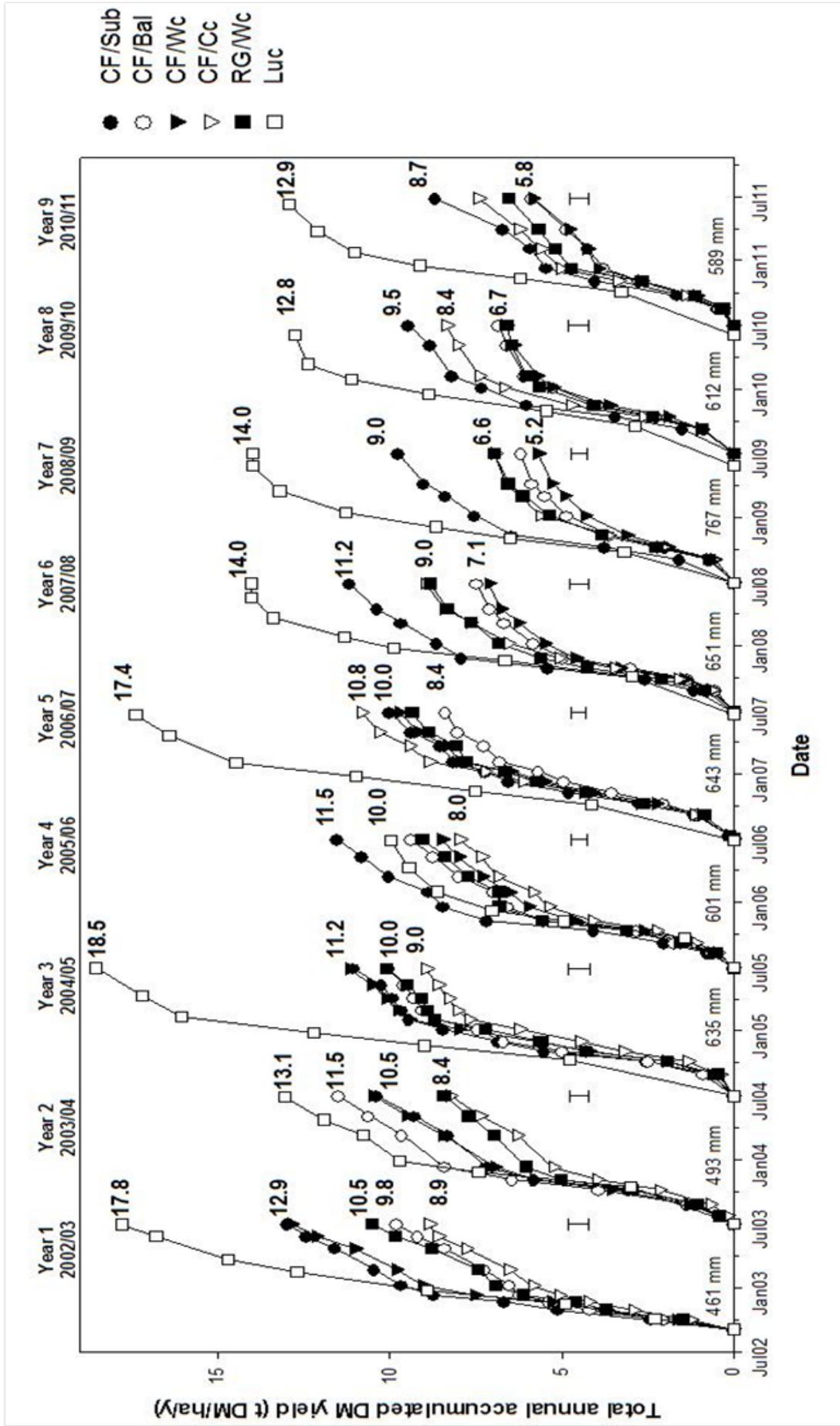


Figure 39 Accumulated total annual DM production (t/ha/yr) from the Cocksfoot Grazing Experiment at Lincoln University, Canterbury. Annual rainfall totals are also shown.