

**Report to SFF  
Grant No. 06/067**

**Pasture and forage options for store lamb and  
beef production from South Island hill and high  
country.**

**2009 Field Day booklet**

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April 2009

# Lees Valley Farmer Group FIELD DAY

## Pasture and forage options for SI hill and high country

8 APRIL 2009

Mt Pember Farm Ltd, Wharfedale Station



Photo: LU FSC



## PROGRAMME

- 1.00 pm An introduction to Lees Valley
- 1.15 pm Perennial grass growth  $\pm$  nitrogen –Professor Derrick Moot
- 1.45 pm Animal live weight gain on dryland pastures – Professor Derrick Moot
- 2.15 pm Legumes and herbs –Mr Dick Lucas
- 2.45 pm Forage brassicas agronomy – Dr Warwick Scott
- 3.00 pm Question and Answer session
- 3.30 pm Aluminium toxicity and soil pH – Dr Jim Moir
- 4.15 pm Pasture mixtures and pasture water use – Professor Derrick Moot
- 4.45 pm Overview – Where to from here?
- N.B. Times may be subject to change depending on the number of visitors and weather.

BBQ to follow at the Mt Pember Farm Ltd office, Wharfedale Station

## Lees Valley Farmer's Group

### **Background:**

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 10ha 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

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

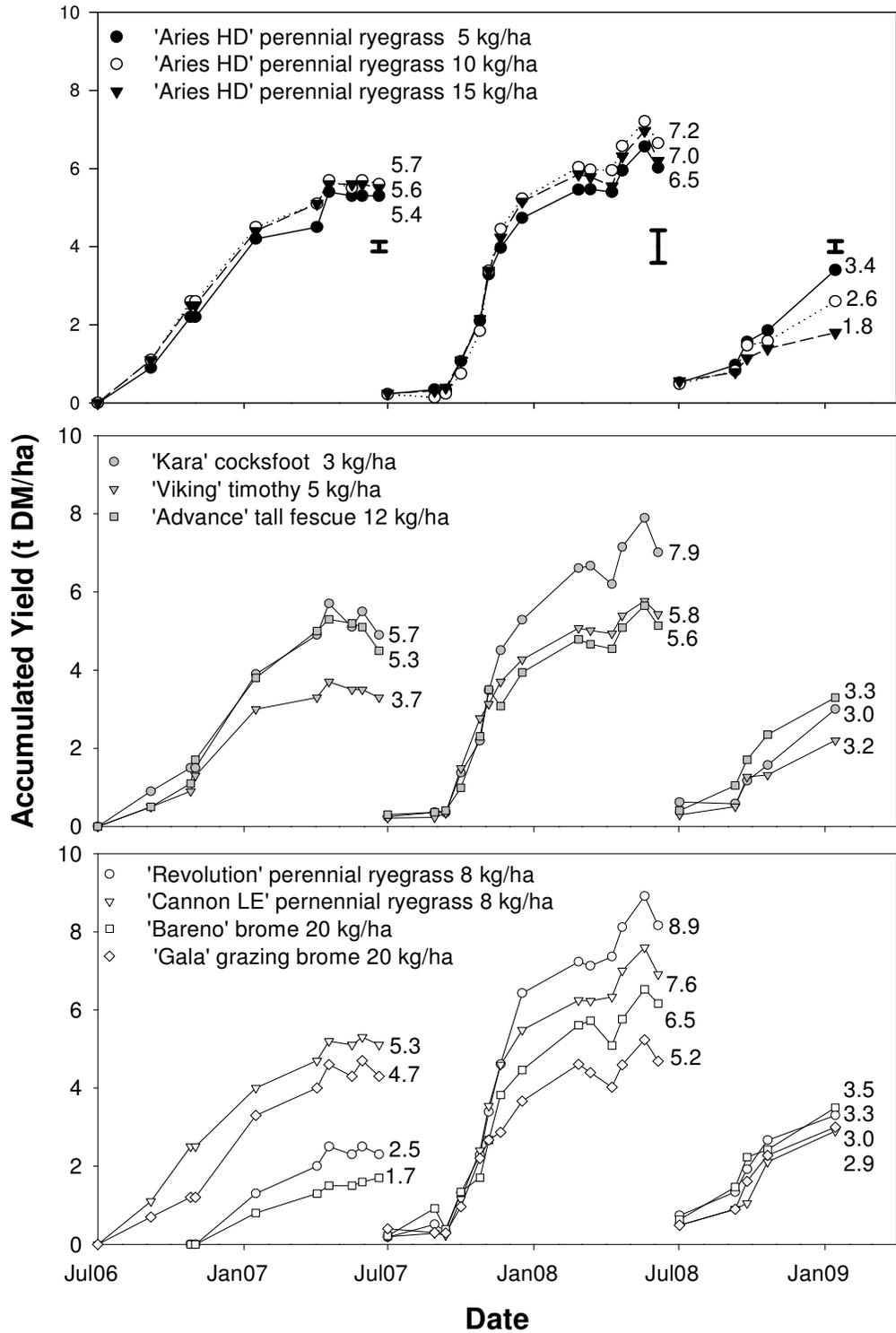
A full time technician has been employed to monitor pasture growth and plot management. Senior students from Lincoln University are involved in research projects based around the plots and an army of overseas visitors has assisted with harvests and data collection. The weather station allows site specific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

The LVFG has funding to maintain the site until June 2009. A further application has been made to MAF SFF based around pasture persistence.

Trial layout is on page 42

## Perennial Grasses

- The site was sprayed with Roundup (4 l/ha) in April and October 2005 and Lime was applied at 5t/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' 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, and then grazed in January 2009.
- **Year 1**
  - In the 10 months after sowing dry matter (DM) production was highest in 'Aries HD' ryegrass, assisted by long fallow prior to sowing.
  - Low rainfall in January 2007 led to drought tolerant species such as cocksfoot and tall fescue having the highest production from summer to May after which soil temperatures dropped.
- **Year 2**
  - In spring 2007 150 kg N/ha was applied. DM yield was highest from 'Revolution' at 5.5 t DM/ha compared with 3.0 t DM/ha in the tall fescue.
  - The dry matter response to N ranged from 8 ('Gala') to 28 kg DM/kg N ('Revolution').
  - Summer production was similar among treatments due to low rainfall (48 mm) and higher soil temperatures (18°C) compared with the previous year (106 and 15°C).
  - In autumn yield was the lowest from Timothy (381 kg DM/ha) and highest from 'Revolution' (794 kg DM/ha).
  - Annual yields ranged from 5.2 to 8.9 t DM/ha for 'Gala' grazing brome and 'Revolution' respectively
- **Year 3**
  - 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).
  - By 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.



**Figure 1.** Accumulated DM yield for perennial grasses in Year 1 (1/7/2006-20/6/2007), Year 2 (1/7/2007-5/6/2008) and Year 3 (2/7/2008-14/1/2009). Values are maximum annual treatment yields achieved during the growing season. Standard error of the means represent total accumulated yield.

- **Year 3 (cont'd)**
  - Summer production in the 'Gala' had a high proportion of unsown grasses and dicot weeds (1.0 t/ha).
  - Yield to January 2009 ranged from 1.8 t/ha for 'Aries HD' established at 15 kg/ha to 3.5 t DM/ha for 'Bareno' brome.
- 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 September 2008.

**Soil Quick Test:**

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

*Main points:*

*Ryegrass was fastest to establish which reduced weed (browntop) invasion.*

*There was no difference in yield of sowing rates between 5 and 15kg/ha of ryegrass seed.*

*Winter fallow was important for spring sowing, as rainfall during this period is unreliable*

*In summer, cocksfoot, tall fescue and 'Bareno' brome production was higher than ryegrasses.*

***Nitrogen on Perennial Grasses (Tables 1-4)***

**Spring 2007**

- In August 2007 0 kg N as CAN (-N) was applied to half of each plot.
- The DM response was measured for the next 97 days.
- In March 2008 50 kg N/ha (Urea) applied to the -N plots

**Spring 2008**

- In September two out of four reps split into six. Three rates of N (0, 75 and 150 kg/ha as urea) were applied September 2008.
- The N response was measured over three regrowth periods of 39 days (spring) 68 days (summer) and 40 days (autumn).
- Spring dry matter response was limited due to lack of rainfall (34 mm) compared with the previous year (53 mm).
- Nitrogen response was found through summer and autumn 2008/09.

**Table 1.** Dry matter yield and response to nitrogen applied during spring 2007. There was an interaction between grass cultivar and nitrogen ( $P<0.05$ ) but the main effect of N fertiliser was dominant ( $P<0.001$ ).

N applied (kg N/ha)	DM yield (t/ha)		DM reponse (kg DM/kg N)
	0 kg N/ha	150 kg N/ha	150 kg N/ha
<b>Grass cultivar</b>			
<b>Spring 2007</b>			
Perennial ryegrass			
‘Aries’ (5 kg/ha)	1.97	3.97	13.4 <sub>bcd</sub>
‘Aries’ (10 kg/ha)	1.43	4.45	20.1 <sub>ab</sub>
‘Aries’ (15 kg/ha)	1.33	4.23	19.4 <sub>abc</sub>
‘Cannon LE’	1.74	4.59	19.0 <sub>abc</sub>
‘Revolution’	1.33	5.52	27.9 <sub>a</sub>
Brome			
‘Bareno’	1.34	3.82	16.5 <sub>bcd</sub>
‘Gala’	1.64	2.87	8.2 <sub>d</sub>
Cocksfoot			
‘Kara’	1.59	4.51	19.4 <sub>abc</sub>
Tall fescue			
‘Advance’	1.64	3.08	9.6 <sub>cd</sub>
Timothy			
‘Viking’	1.35	3.70	15.7 <sub>bcd</sub>
<b>Mean (cultivar)</b>	<b>1.54<sub>b</sub></b>	<b>4.07<sub>a</sub></b>	<b>16.9</b>
SEM	0.085		3.43
Significance	***		**

**Table 2.** Dry matter yield and response to nitrogen applied during spring 2008. For DM yield there were effects of grass cultivar ( $P<0.024$ ) and an effect of N fertiliser ( $P<0.01$ ) but no interaction. Cultivar means are presented for each N rate. For the DM response to applied N fertiliser there was no difference between applied N rates.

N applied (kg N/ha)	DM yield (t /ha)			DM response (kg DM/kg N)	
	0 kg N/ha	75 kg N/ha	150 kg N/ha	75 kg N/ha	150 kg N/ha
<b>Spring 2008</b>					
0.69	0.96	1.38	3.5	4.6	
0.78	1.39	1.43	8.1	4.3	
0.89	1.37	1.63	6.4	4.9	
0.48	1.51	1.23	13.7	5.0	
0.78	1.05	2.04	3.7	8.4	
0.64	0.99	1.12	4.6	3.2	
0.62	0.88	0.86	3.5	1.6	
0.73	0.93	1.27	2.7	3.6	
0.64	1.21	1.32	7.6	4.6	
0.51	1.26	1.02	10.1	3.4	
<b>0.68<sub>b</sub></b>	<b>1.16<sub>a</sub></b>	<b>1.33<sub>a</sub></b>	<b>5.4</b>		
	102.5		0.52		
	**		NS		

Note: \*\*= $P\leq 0.01$ , \*\*\*= $P\leq 0.001$ , treatment means followed by the same letter subscript are similar. The standard error of the mean (SEM) and significance shown for yields in spring 2007 are for the main effect of N. Yields were analysed as a cross-plot design whereas DM responses to applied N fertiliser were analysed by one way ANOVA.

Spring 2007: 15 August – 20 November (97 days) 157mm rain

Spring 2008: 12 September – 21 October (39 days) 39mm rain

**Table 3.** Dry matter response during summer 2008/09 to nitrogen applied in early spring 2008. In summer, neither grass cultivar nor N fertiliser affected DM yield. By late summer, DM yields were affected by cultivar but not by the spring applied N. Neither cultivar nor N fertiliser rate affected the DM response in either summer or late summer.

N applied (kg N/ha)	DM yield (t/ha)			DM response (kg DM/kg N)		DM yield (t/ha)			DM response (kg DM/kg N)	
	0	75	150	75	150	0	75	150	75	150
Grass cultivar	<b>Summer 2009</b>					<b>Late Summer 2009</b>				
Perennial ryegrass										
‘Aries’ (5 kg/ha)	1.05	0.79	0.92	-3.4	-0.9	0.54	0.51	0.55	-0.3	0.1
‘Aries’ (10 kg/ha)	0.85	1.27	1.06	5.7	1.4	0.56	0.53	0.61	-0.4	0.3
‘Aries’ (15 kg/ha)	0.92	1.16	1.01	3.2	0.6	0.62	0.65	0.70	0.4	0.5
‘Cannon LE’	0.81	0.86	1.02	0.6	1.3	0.70	0.70	0.62	0.0	-0.5
‘Revolution’	1.10	1.29	1.43	2.5	2.2	0.61	0.87	0.99	3.6	2.5
Brome										
‘Bareno’	0.77	1.15	1.44	5.0	4.5	0.46	0.84	1.16	5.1	4.7
‘Gala’	0.89	0.93	0.86	0.5	-0.2	0.52	0.45	0.61	-0.9	0.6
Cocksfoot										
‘Kara’	1.06	1.12	1.05	0.8	-0.1	0.72	0.66	0.74	-0.9	0.1
Tall fescue										
‘Advance’	0.99	1.22	1.23	3.0	1.6	0.62	0.77	0.80	2.0	1.2
Timothy										
‘Viking’	0.72	0.64	0.90	-1.1	1.2	0.35	0.33	0.41	-0.2	0.4
<b>Mean (cultivar)</b>	<b>0.92</b>	<b>1.04</b>	<b>1.09</b>	<b>1.7</b>	<b>1.2</b>	<b>0.57</b>	<b>0.63</b>	<b>0.72</b>	<b>0.8</b>	<b>1.0</b>
SEM		0.060		0.71			0.11		0.75	
Significance		NS		NS			P < 0.001		NS	

NS non-significant at P=0.05

Summer 09: 7 November – 14 January (68 days), 78mm rainfall.

Late Summer 09: 9 January – 10 March (40 days), 90 mm rainfall.

**Table 4.** Total DM response (spring08+summer09) to nitrogen applied at 0, 75 and 150 kg N/ha in early spring 2008.

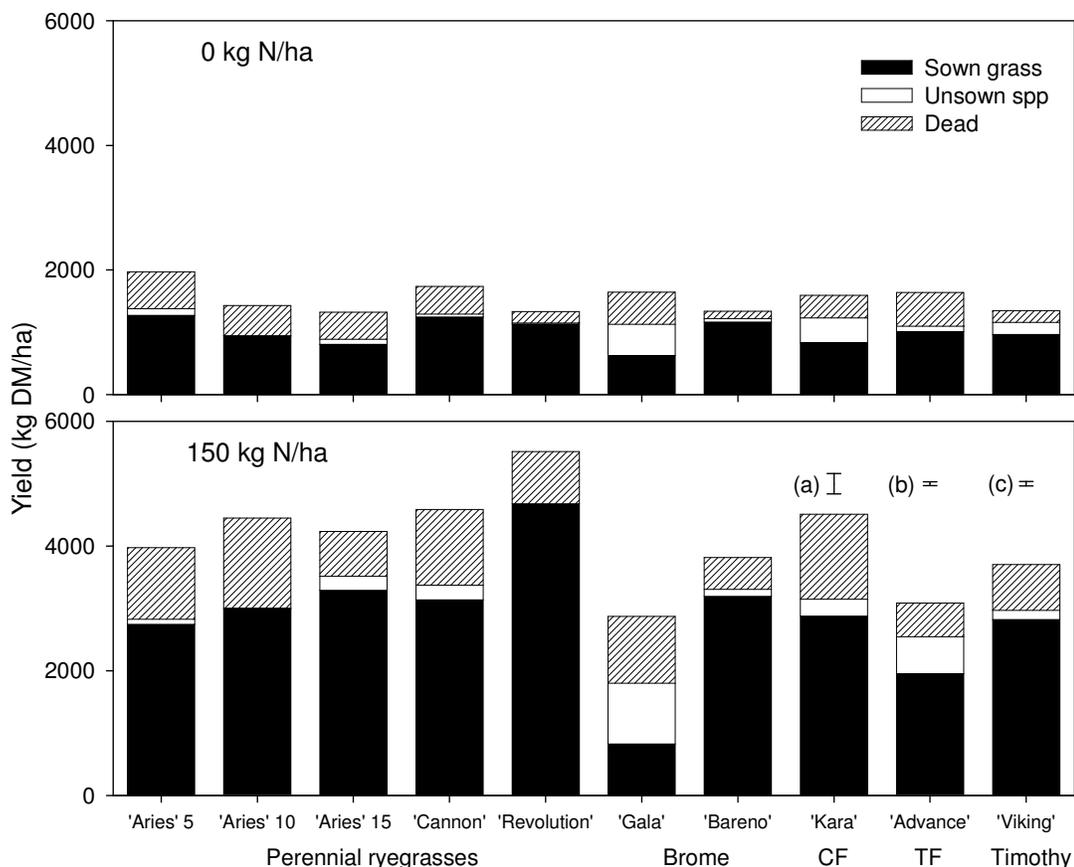
N applied (kg N/ha)	DM response (kg DM/kg N)	
	75	150
<b>Grass cultivar</b>		
Perennial ryegrass		
‘Aries’ (5 kg/ha)	7.1	12.3
‘Aries’ (10 kg/ha)	14.1	15.5
‘Aries’ (15 kg/ha)	12.6	10.9
‘Cannon LE’	13.7	9.8
‘Revolution’	5.2	17.2
Brome		
‘Bareno’	15.0	16.3
‘Gala’	2.4	7.3
Cocksfoot		
‘Kara’	6.2	11.5
Tall fescue		
‘Advance’	9.3	11.7
Timothy		
‘Viking’	7.4	7.5
<b>Mean</b>	<b>9.3</b>	<b>12.0</b>



Photo: LU FSC

## Yield and botanical composition

Spring 2007



**Figure 2.** Yields of sown grass, unsown species and dead material on 20/11/2007 for pastures receiving 0 or 150 kg N/ha. CF is cocksfoot, TF is tall fescue. Error bars are SEM for (a) the effect of N on sown grass, (b) the effect of N on unsown species and (c) the effect of N on yield of dead material.

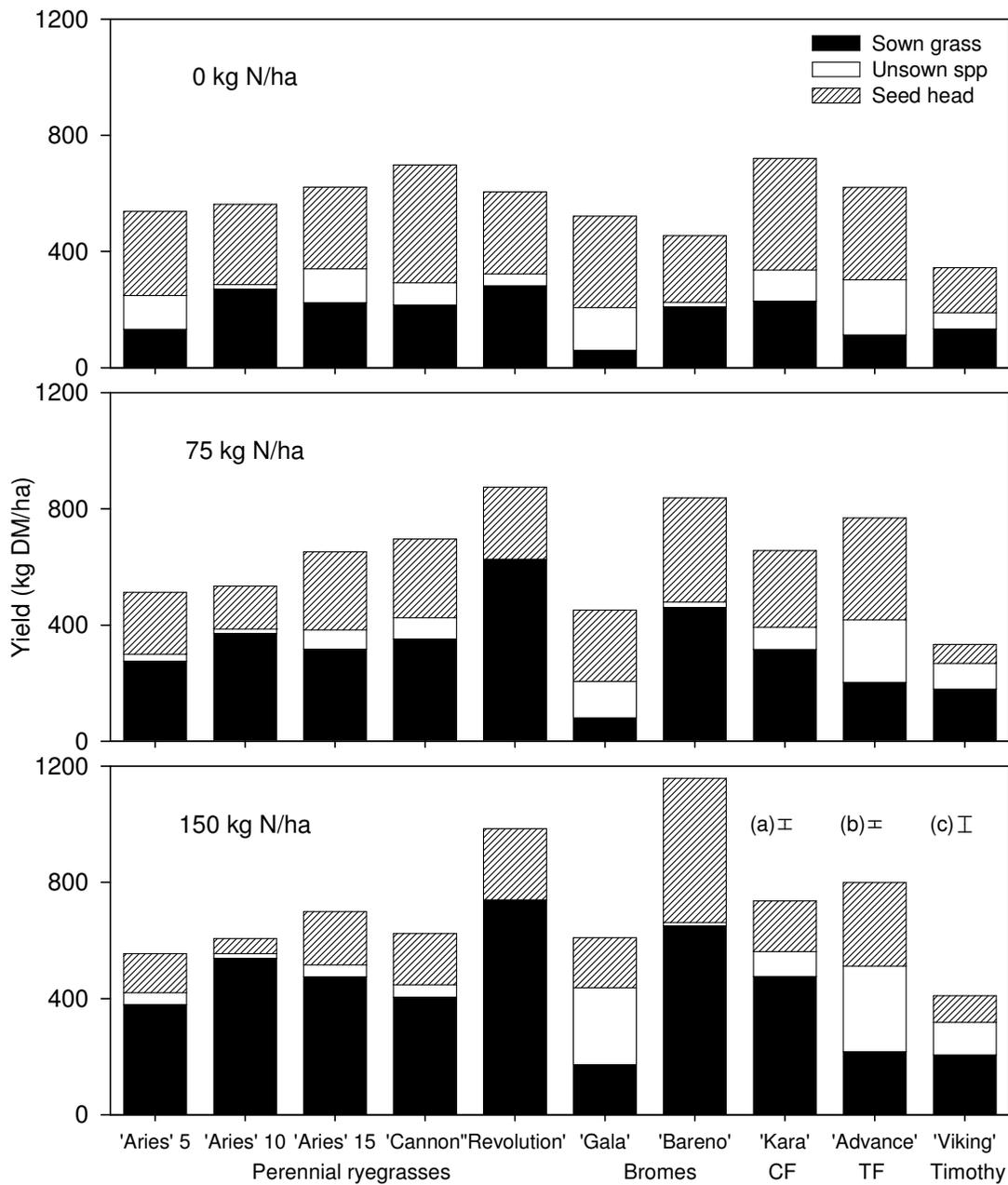
### Spring 2007

0 kg N/ha

- Sown grass yield was similar over all grass cultivars (1.0 t/ha).
- Unsown species dominant in 'Gala' (1.0 t/ha).

150 kg N/ha

- Sown grass yield was at least double that of 0 kg N/ha treatments.
- Revolution had the highest sown grass production (4.7 t DM/ha)



**Figure 3.** Yields of sown grass, unsown species and dead material from 29/1/2009 to 10/3/2009 (end of summer period) for pastures receiving 0, 75 or 150 kg N/ha. CF is cocksfoot, TF is tall fescue. Error bars are SEM for (a) the effect of N on sown grass, (b) the effect of N on unsown species and (c) the effect of N on yield of dead material.

## Spring - late summer 2008/09

- Botanical composition measured in spring (October 08), summer (January 09) and autumn (March 09).
- Summer 2009 showed no effect of N application rate on dry matter response or total dry matter yield. Unsown species highest in 'Gala; grazing brome and tall fescue (630 kg DM/ha) compared to 'Bareno' brome and 'Revolution' perennial ryegrass (84 kg DM/ha).
- By March 2009 sown grass yield increased by 62 and 46% for the 75 and 150 kg N/ha respectively.

### *Main points:*

*High DM response to high rates of N when soil moisture was present over 97 days.*

*Slower establishing species or problems with germination led to invasion of weed species (browntop).*

*Unimproved soil low in N, hence showing a strong response in spring 2007.*

*High inputs of N increased sown grass species and decreased weed invasion.*



Photo: LU FSC

Cocksfoot competing well with browntop

## Cocksfoot Grazing Experiment, Lincoln University



### **Materials & Methods**

- Established on 18/2/2002

**Table 5.** 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 <sup>+</sup>
Subterranean clover	Sub	'Denmark'	10 kg/ha <sup>+</sup>
White clover	Wc	'Demand'	3 kg/ha
Cocksfoot	CF	'Vision'	4 kg/ha
Perennial ryegrass	RG	'Aries AR1'	10 kg/ha
Lucerne	Luc	'Kaituna'	8 kg/ha <sup>+</sup>

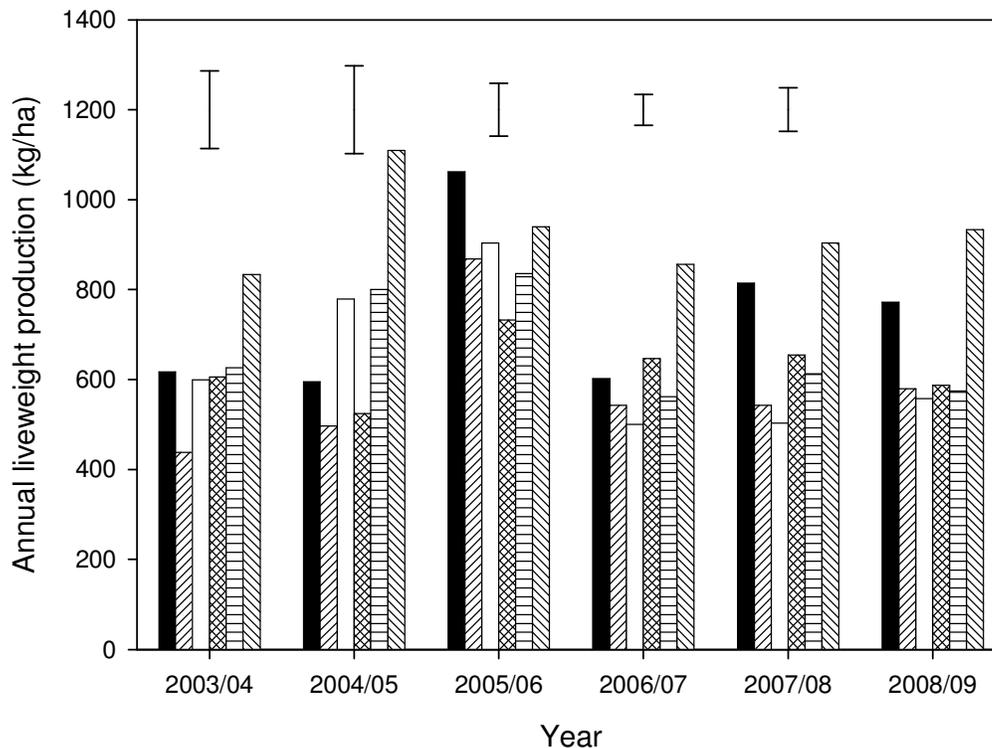
<sup>+</sup> = seed was inoculated prior to sowing

- Dry matter production and botanical composition from exclosure cages cut to 25-30 mm every 20-90 d.

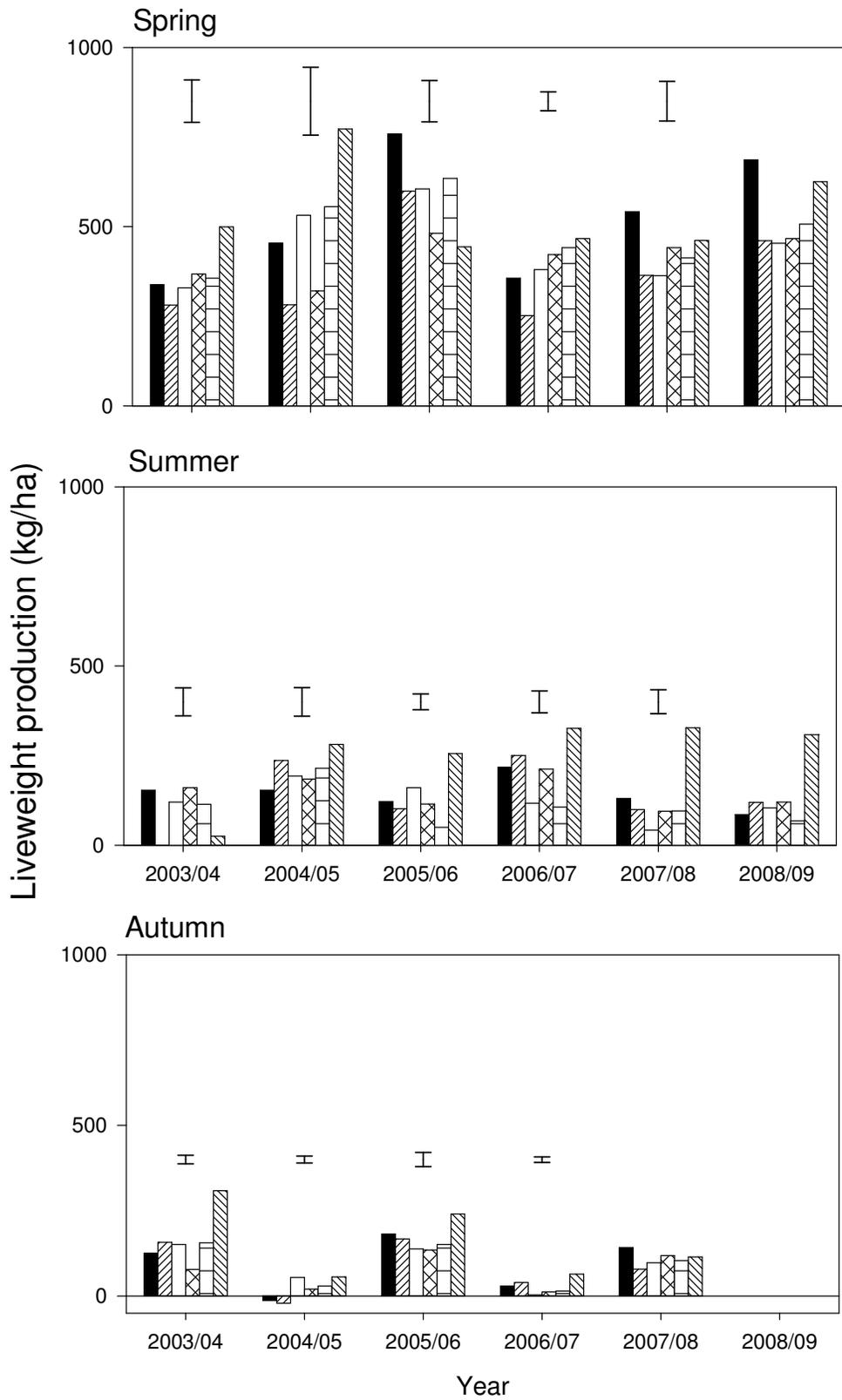
- For lucerne, 5 cuts per plot prior to grazing. Post grazing residuals also measured.
- Liveweight production from Coopworth ewe lambs and hoggets. A 'put and take' system is used. 'Core' animals are weighed 'empty' after being held overnight in a stock yard before and immediately after grazing periods of 3-6 weeks of rotational grazing.
- 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 separated into 'spring' (Jul-Nov), 'summer' (Dec-Feb) and 'autumn' (Mar-Jun). Hoggets are usually put on plots in spring and removed when weaned lambs go on in late spring/summer.

### **Annual and seasonal liveweight production (year 2 –7)**

- In four of the six years lucerne pastures gave superior annual LW production (Fig. 4).
- The superior animal production from lucerne pastures in summer (Fig. 5), especially in 2005/06 and 2007/08, corresponded with below average summer rainfall. (Range 830-1110 kg LW/ha/yr exc. 2008/09 as incomplete).
- Over a five year period, CF/Sub has given the most consistent spring LW production of the grass based pastures (340-760 kg LW/ha/yr).
- A combination of pastures is required to ensure LW production is maintained in different seasons and across years due to variable rainfall.



**Figure 4.** Annual liveweight production (kg LW/ha) from the Cocksfoot Grazing Experiment at Lincoln University, Canterbury from dryland CF/Sub (■), CF/Bal (▨), CF/Wc (□), CF/Cc (⊞), RG/Wc (≡) and Lucerne (▩) pastures. Data for 2008/09 is to Feb 2009. Error bars are LSD (P<0.05).



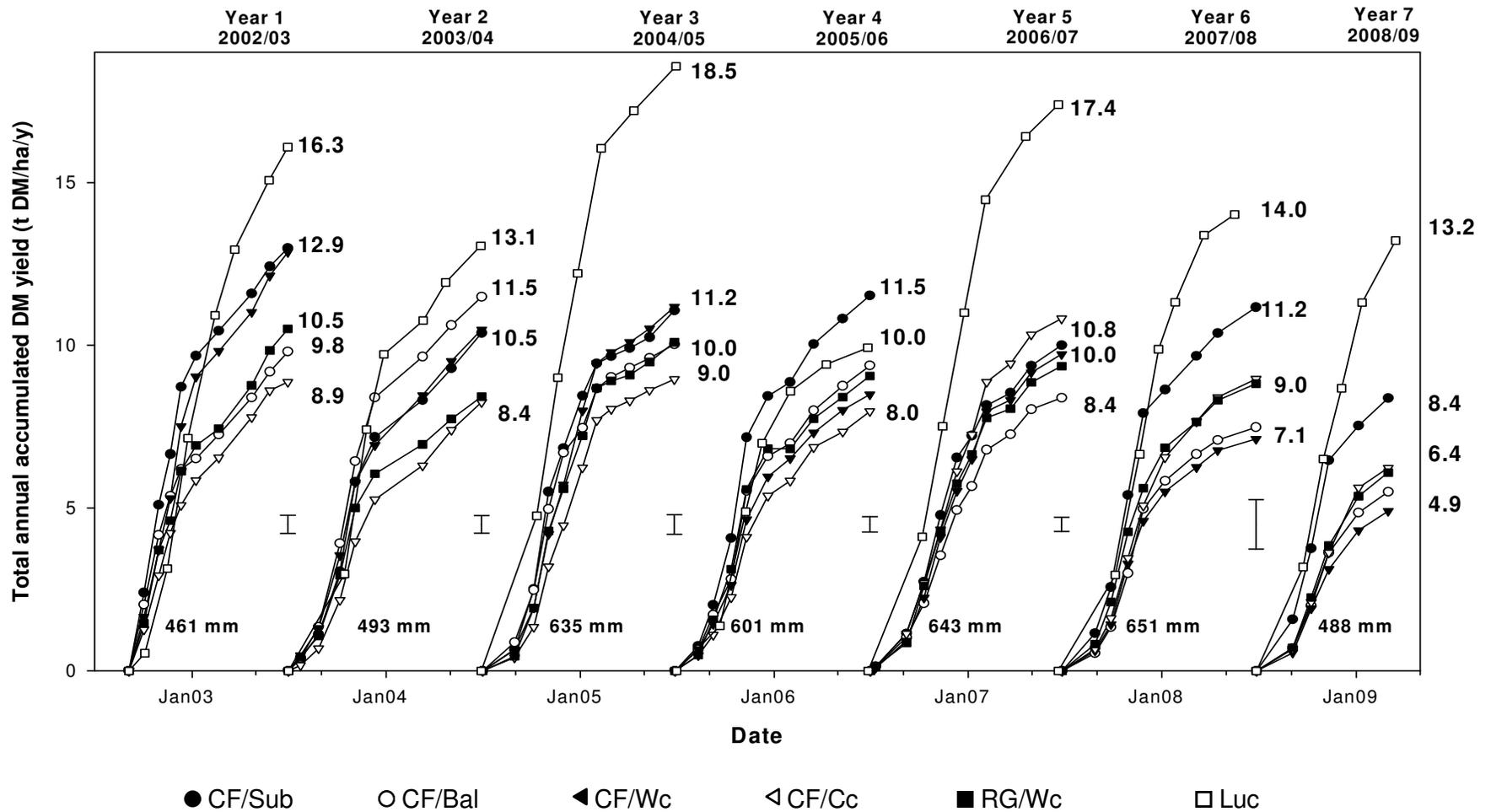
**Figure 5.** Seasonal liveweight production (kg/ha) from dryland CF/Sub (■), CF/Bal (▨), CF/Wc (□), CF/Cc (⊠), RG/Wc (▧) and Lucerne (▩) pastures at Lincoln University. Error bars are LSD (P<0.05). Data for 2008/09 is to Feb 2009.

### ***DM yield and botanical composition (year 1-7)***

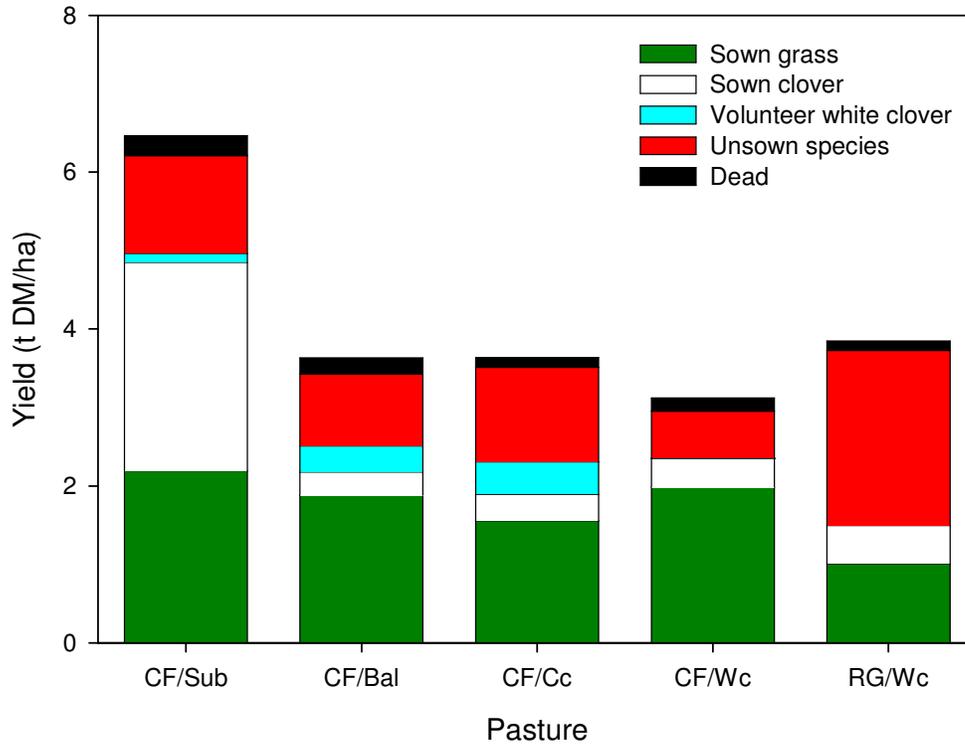
- Total annual yields ranged from 7.1-18.5 t DM/ha (Fig. 6).
- Lucerne produced 13.1-18.5 t DM/ha/y in four out of five years.
- Cocksfoot with subterranean and white clover compliment lucerne production in environments with unpredictable and variable summer rainfall. Production from CF/Sub pastures was highest in spring and CF/Wc pastures provided feed in moist summers.
- Sub clover contributed >3.4 t DM/ha/yr in 3 of the 6 years.
- By Year 5, ryegrass represented 44% of total annual DM while unsown grasses and dicot weeds contributed 24% of annual yield in RG/Wc pastures. In Spring 2008 (start of Year 7) 58% of DM produced in spring was from unsown species (Fig. 7).
- In spring, 2007 there was evidence of grass grub damage in several plots. In 2008 the problem was more widespread. Grass grub populations were determined and counts showed CF/Wc and CF/Bal pastures had 130 grass grubs/m<sup>2</sup>, CF/Cc 97, RG/Wc 67, CF/Sub 52 and Lucerne with 13. However the variation in grub counts between reps was large.



Sub clover in flower



**Figure 6.** Accumulated total annual DM production (t/ha) from the Cocksfoot Grazing Experiment at Lincoln University. Data for 2008/09 is to Feb 2009. Annual rainfall is also shown. Error bars are LSD (P<0.05).



**Figure 7.** Botanical composition of dryland pastures at Lincoln University, Canterbury in spring 2008 (at the start of Year 7).



Hoggets on lucerne at Lincoln



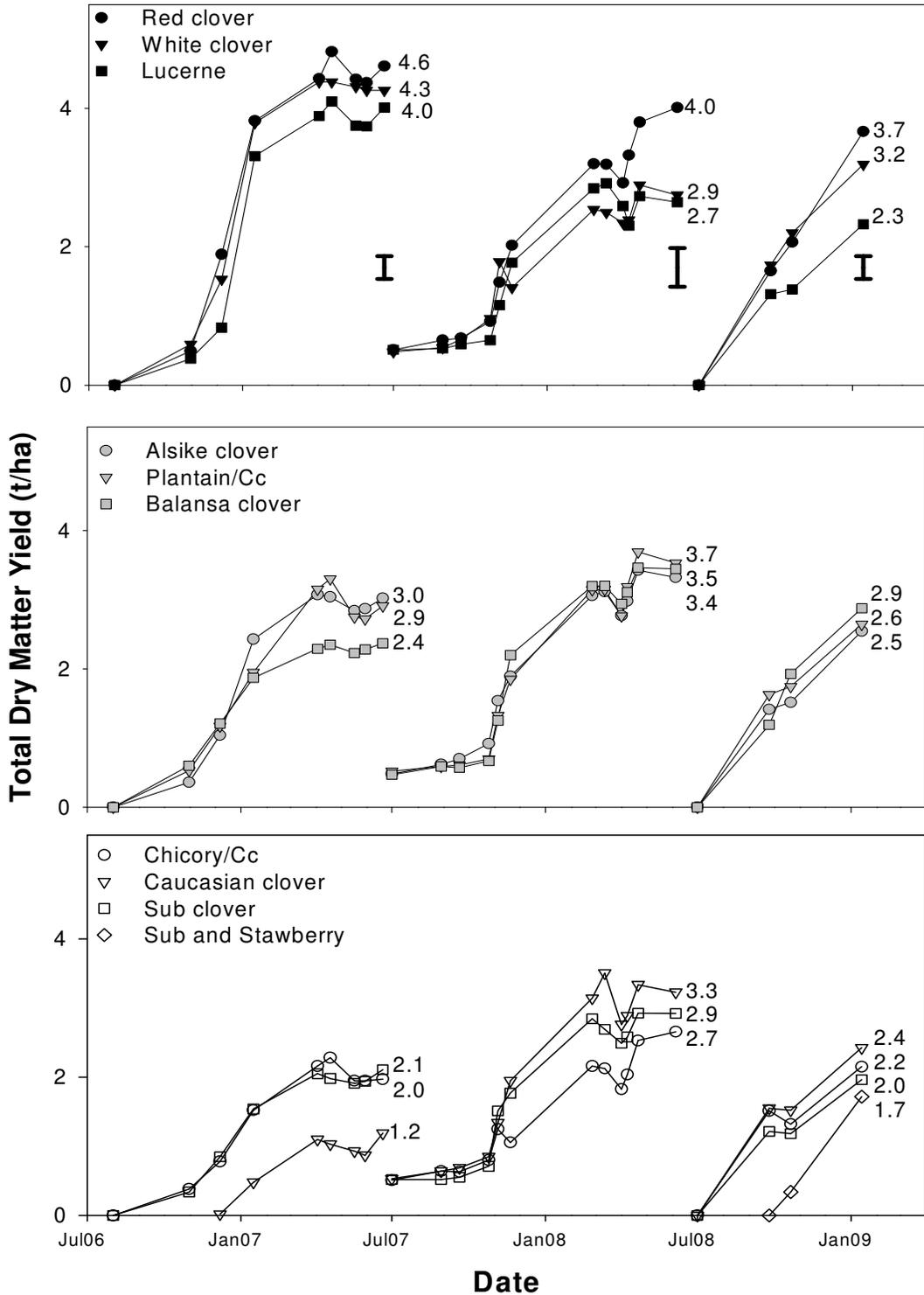
Cocksfoot and sub clover

## Legume/Herbs

- Feb 06: 'Freshcote' Alsike (3.5 kg/ha), 'Demand' white (4 kg/ha), 'Pawera' red (5kg/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 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 1 2006.
- Plots were grazed September and November 2006, January, June and November 2007, April, October 2008 and January 2009.

### ***New sowing on 28<sup>th</sup> February 2008***

- All legume plots were oversown with a strip (9 x 10 m) of 'Bronsyn AR1' perennial ryegrass (10 kg/ha), 'dg25' cocksfoot (2 kg/ha), subterranean ('Denmark' 10 kg/ha) and strawberry clover ('Lucila' 2 kg/ha).
- Fallow plots sown with both subterranean ('Denmark' 10 kg/ha) and strawberry clover ('Lucila' 2 kg/ha).
- **Year 1 (Fig.8)**
  - January to April 2007 rainfall was low (24 mm); hence tap root species such as lucerne and red clover dominated (2.8 t DM/ha).
  - April through to winter, soil temperature was low and therefore slowed growth.
  - Year 1 (2006/07) total production range was 2.0 (Chicory and Caucasian clover) to 4.6 (red clover) t DM/ha
- **Year 2**
  - Spring 2007 had 109 mm rainfall in October but did then only 23 mm until February. White clover dominated in late spring.
  - During summer there was no difference in total yield between any of the treatments. Botanical composition taken in summer showed red clover was the dominant sown legume (1.6 t/ha). Annual clovers have set seed at this time.
  - Year 2 (2007/08) total production range was 2.7 (chicory and Caucasian) to 4.0 (red clover) t DM/ha.
- **Year 3**
  - Yield over spring 2008 showed no difference in total DM. Red clover had the highest amount of sown clover (1.3 t DM/ha) compared with subterranean clover at 0.3 t DM/ha.
  - In January 2009 total sown legume was highest for red clover (1.2 t DM/ha)



**Figure 8.** Accumulated DM yield for legume and herbs in Year 1 (1/7/2006-20/6/2007), Year 2 (1/7/2007-5/6/2008) and Year 3 (2/7/2008-14/1/2009). Values are maximum annual treatment yields achieved during the growing season. Standard error of the means represent total accumulated yield.

- **Year 3 (cont'd)**

- 3.7 (red clover) t DM/ha. The majority of annual clover treatments were invaded by weed (sorrel). Much of the DM yield in alsike was from volunteer white clover.
- In October 2007 750 kg/ha superphosphate was applied in October 2007 and 300 kg/ha applied September 2008. February 2008 nitrogen at 100 kg/ha urea was applied. In May 2008 clover sprayed with Spinnaker (300ml/ha) and Codacide (Adjuvant oil) at 500 ml/ha sprayed to reduce weed invasion. The main weed was sorrel.

**Soil Quick Test:**

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

*Main points:*

*Red clover production has decreased from year 1, 2 and 3 (4.6 4.0 and 3.7 t DM/ha/year respectively) But it has had the highest yield every year.*

*Caucasian clover was slow to establish but in year 2 had a higher production than white clover. It appears to improve over time whereas most other species decline.*

*Lucerne production is low. This is thought to be due aluminium toxicity*

*Annual clovers failed to regenerate in the second year. Germination tests on seeds taken from burrs in October 2007 show Leura had 100 % hard seed. This may break down over time. More work is needed on annual clovers in this cool continental environment.*

Caucasian clover



Photo: LU FSC

## Dryland brassicas

Dr Warwick Scott

- Brassicas produce about 20 kg/ha of dry matter (DM) per mm of water used.
- Shallow-rooted crops (turnips and swedes) are more sensitive to soil moisture deficit than deeper-rooted ones (kale and rape).
- Yield is limited by the amount of water available from stored soil water and in-season rainfall.
- Most brassica crops will extend their roots to about 1.0 m depth.
- Water available in the 1.0 m root zone ranges from about 80 mm in light, shallow soils to about 140 mm in heavier, deeper soils.
- Fallow before sowing to conserve water in soils with low water holding capacity.

**Table 6.** Potential available soil water capacity (mm) for brassicas in soils with variable depth to stones.

Soil Depth to gravel (m)	Swedes, Turnips (0.6 m root depth)	Kale, Rape (1.0 m root depth)
0.20	65	80
0.30	80	90
0.50	100	110
0.75	130	140
1.00	130	165

- Provide an optimum rooting environment for crops.
- Sow early to allow survival through mid and late season drought.
- Choose brassica types that grow mainly at less droughty times of the year.
- Maximise productive use of available water.
- Manage crops so they can take best advantage of rainfall when it occurs.

### ***Winter brassicas on dryland stones: a bit of a gamble***

(Adapted from Forage Brassica Development Group Workshop Modules)

- Without irrigation, water availability is the main source of yield variation in brassicas
- Brassicas produce about 20 kg DM/ha per mm of water used
- A bony stony soil will store about 70 mm of available water in the 1.0 m root zone. Heavier deeper soils may store up to 140 mm of available water in the zone
- Kale and rape have a more vigorous root system than the root crops such as swedes and turnips

### ***Increasing the odds or reducing the risks***

- Choose the heaviest soil available for the earliest sowing
- Fallow the soil to ensure the top 1 m is at Field Capacity at sowing time
- Eliminate barriers to root penetration such as pans, poor aeration or low pH
- Spread sowing times: Kales and Swedes late November to mid December, soft turnips mid December to late January
- With adequate moisture, delaying sowing reduces yield
- The earliest sowings are most likely to run out of water first under dryland conditions
- Once a crop emerges it starts to spend precious water by transpiration.
- Ensure brassica seedlings are not attacked by springtails, aphids or Nysius Fly
- Be conservative with the use of nitrogen fertiliser: N produces more leaves and leafy crops spend more water.

### ***Salvaging a failed brassica crop***

- The hard decision to abandon a failed brassica crop needs to be made early
- The number of salvage alternatives declines rapidly as the season progresses
- A failed swede or kale crop can be resown in soft turnips in January
- An Italian type ryegrass may be sown up to early March depending on location – lower yields, great quality and regrowth
- A cereal greenfeed crop can either be direct drilled into a failed brassica crop or sown alone. This option is possible until early April in most parts of NZ
- Salvage operations must address the reason(s) why the crops failed

Growing brassicas is like fishing: apart from the rainfall luck has little to do with it.

### ***Brassicas and soil fertility***

- The soils ability to supply nutrients depends on its fertility
- A soil test indicates the level of each nutrient in the soil

**Table 7.** Macronutrient availability at three soil fertility levels.

Test/Nutrient	Soil fertility level		
	Low	Medium	High
Available N (kg/ha)	<80	80 to 160	>160
Olsen P	<15	15 to 25	>25
Soil test K	<4	4 to 8	>8
Sulphate-S	<3	3 to 9	>9
Soil test Mg	<3	3 to 8	>8
Response to fertilizer	likely	may occur	unlikely

**Table 8.** Macronutrient content and requirements of kale and leaf turnips.

		Typical Nutrient Content (%)				
Species	Component	N	P	K	S	Mg
Kale	Leaf	3.5	0.3	1.7	0.77	0.17
	Stem	1.5	0.27	2.8	0.48	0.17
Leaf Turnip	Leaf	2.5	0.3	1.6	0.57	0.17

		Nutrient uptake (kg/ha)				
Species	Crop Yield (t/ha)	N	P	K	S	Mg
Kale	6	126	17	148	34	10
	9	189	25	222	51	16
	12	252	33	296	68	21
	15	315	42	370	85	26
Leaf Turnip	2	50	6	32	11	3
	4	100	12	64	23	7
	6	150	18	96	34	10
	8	200	24	128	46	14

### ***Green globe turnips with nitrogen and phosphorus at Lees Valley***

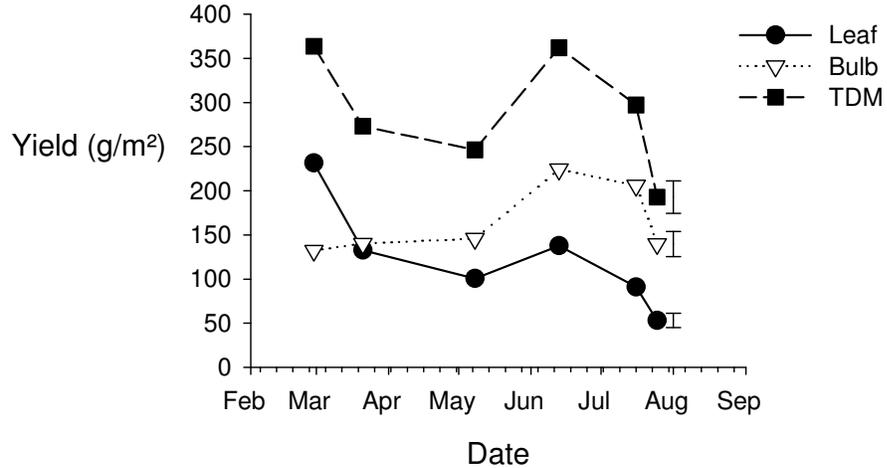
#### **Background**

- Site established April 2005 sprayed with Roundup (4 l/ha) and again in October. Browntop mat broken down by hoof and tooth from April to August 2005.
- 400 kg/ha super phosphate and 300 kg/ha DAP applied in January 2006 then disced, harrowed and heavy rolled. Glyphosate (540 g/l a.i. at 2 l/ha) applied September 2006.
- Green globe turnip sown at 1.5 kg/ha and 100 kg C.A.N. broadcast over all plots (21 kg N/ha – first application) on 14 December.
- Second application of N (20 kg/ha to designated 40 kg N/ha plots) applied 28 February 2007. Final application of N (20 kg/ha to designated 60 kg N/ha plots) 14 March 2007.
- Three treatments of Phosphorus (0, 30 and 60 kg P/ha) applied prior to sowing.

#### **Turnips**

##### **Results**

- Maximum turnip dry matter production occurred on the 28 February at an average yield of 3640 kgDM/ha, before the drought reduced yield to 2460 kgDM/ha in early May.



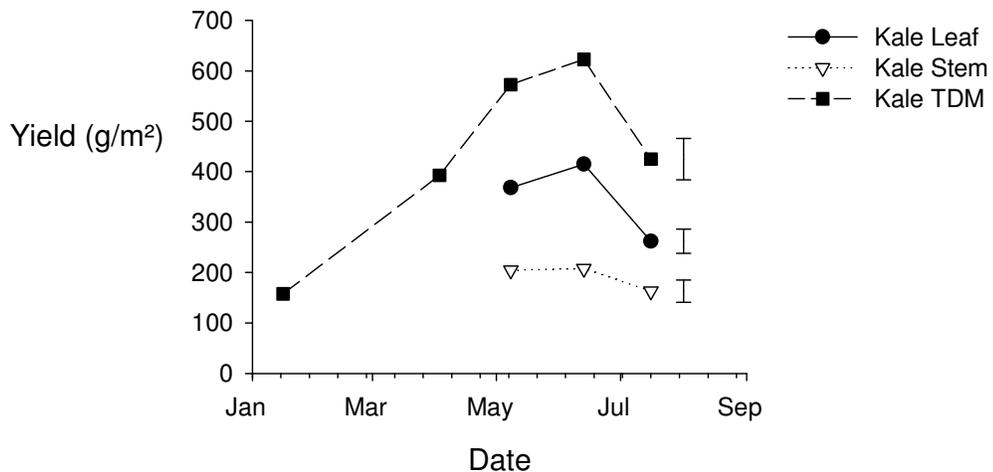
**Figure 9.** Yield of turnips (*Brassica campestris* L.) over time, showing leaf, bulb and total dry matter accumulation. Error bars are LSD at the 10% level (From Reynolds 2007).

### Kale

- Sown 9 November 2006 at 3 kg/ha.
- Half of the plots had nitrogen applied (urea) at 30 kg N/ha on 8 May.

### Results

- The yield rose from 1580 kg DM/ha in mid-January and reached a maximum of 6230 kg DM/ha in mid-June.



**Figure 10.** Yield of kale (*Brassica oleracea* L.) over time, showing leaf, stem and total dry matter accumulation. Error bars are LSD at the 10% level (From Reynolds 2007).

## ***Radiation Interception***

- The light interception was low in May, due to incomplete leaf canopies after the drought.
- Kale recovered quicker, responded to nitrogen and produced higher yields by mid winter than turnips.
- 30 kg N/ha produced 2180 kg DM/ha more by mid June compared to no autumn N application (70 kg DM/ha increase per unit of N).
- Light interception increased as the plants redevelop leaf canopies after the drought.
- At the start of May the proportion of radiation intercepted was 33% for turnips and 59% for kale.
- By mid July radiation interception had increased to 46% for turnips and 76% for kale.

### *Main points:*

*Kale recovered from drought faster than turnips and therefore can respond faster to N.*

*Maximum DM achieved in February for turnips and mid-June for kale.*



Photo: LU FSC

Kale growing at Mt Pember station, 2006

## ***Autumn application of nitrogen to commercial brassica paddock (Sown November 2007)***

- Kale x nitrogen type (C.A.N and urea) x nitrogen rate (0, 50 and 100 kg N/ha)
- 50 kg N/ha applied on 12<sup>th</sup> of March and 28<sup>th</sup> of April 2008.
- The 12<sup>th</sup> of March application of 50 kg N/ha improved the yield of the kale by 23%, but the further application of another 50 kg N/ha on 28<sup>th</sup> of April resulted in no further yield increase.

**Table 9.** The effect of nitrogen type (Calcium ammonium nitrate or urea) at three rates (0, 50 or 100 kg N/ha) on total, leaf and stem DM of kale.

Nitrogen		Wharfedale Kale DM ( t DM/ha)			DM response to applied N (kgDM/kg N)
		Total DM	Leaf DM	Stem DM	
Rate (kg/ha)	0	4.67 <sub>b</sub>	2.68 <sub>b</sub>	1.99	
	50	5.76 <sub>a</sub>	3.62 <sub>a</sub>	2.14	21.8
	100	5.57 <sub>a</sub>	3.71 <sub>a</sub>	1.86	9.0
	SEM	0.24	0.12	0.16	
Form	CAN	5.36	3.44	1.93	
	Urea	5.30	3.24	2.06	
	SEM	0.30	0.19	0.11	

### **Conclusions:**

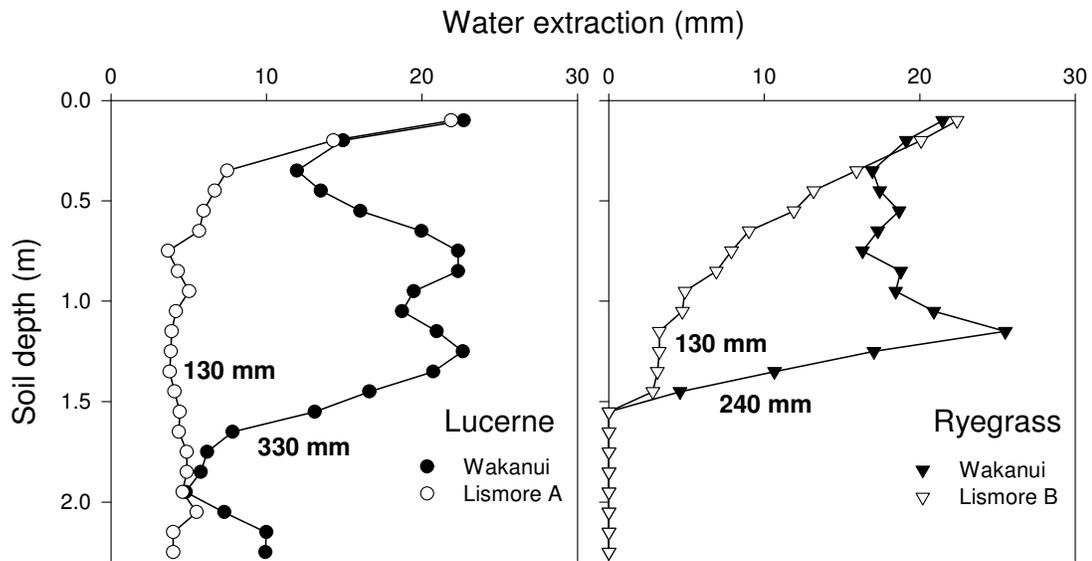
- The form of N fertiliser (Urea or CAN) had no effect on the yield on 17<sup>th</sup> of June.
- Autumn application of N must be timed to take advantage of autumn rain but late applications may show a poor response once temperatures reduce growth rates (e.g. May and June).
- Late applications of N may also increase the risk of nitrate poisoning in animals.



## Pasture Water Use

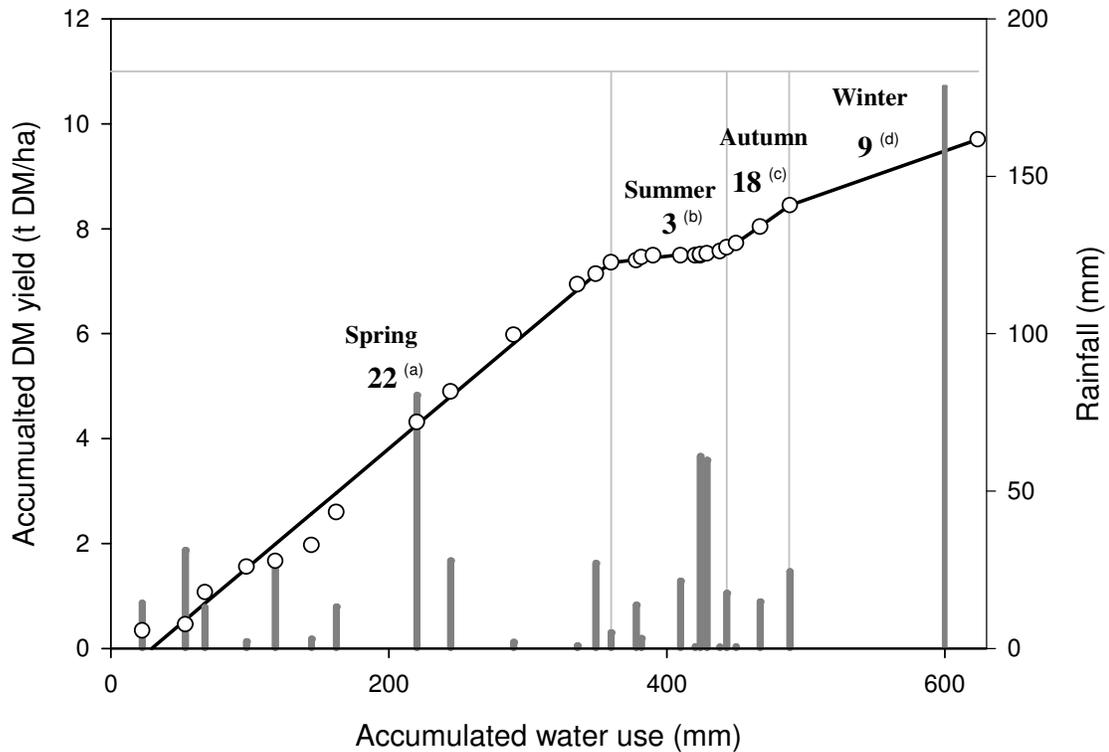


- Dry matter production on dryland properties is compromised when rainfall is insufficient to replenish soil moisture used for DM production.
- Water use efficiency (WUE) quantifies the amount of water required to produce each unit of dry matter (how many millimetres of water are needed to produce each kg of DM). Water use efficiency of intensively monitored pastures ranged from 6-40 kg DM/ha/mm.
- Roughly, a pasture which uses 1 mm water/d has used 1L water/m<sup>2</sup> extracted from the soil by the roots or 10000 L water/ha. Over 95% of water used is transpired and released into the atmosphere through the leaves.
- The amount of soil water available for pasture growth depends on rainfall (replenishment), soil type and depth (storage ability) and rooting depth of the pasture (ability to access water stored).
- Figure 11 shows the 1) difference in the amount of water available for growth on two different soils and 2) the difference between lucerne and perennial ryegrass root extraction depths



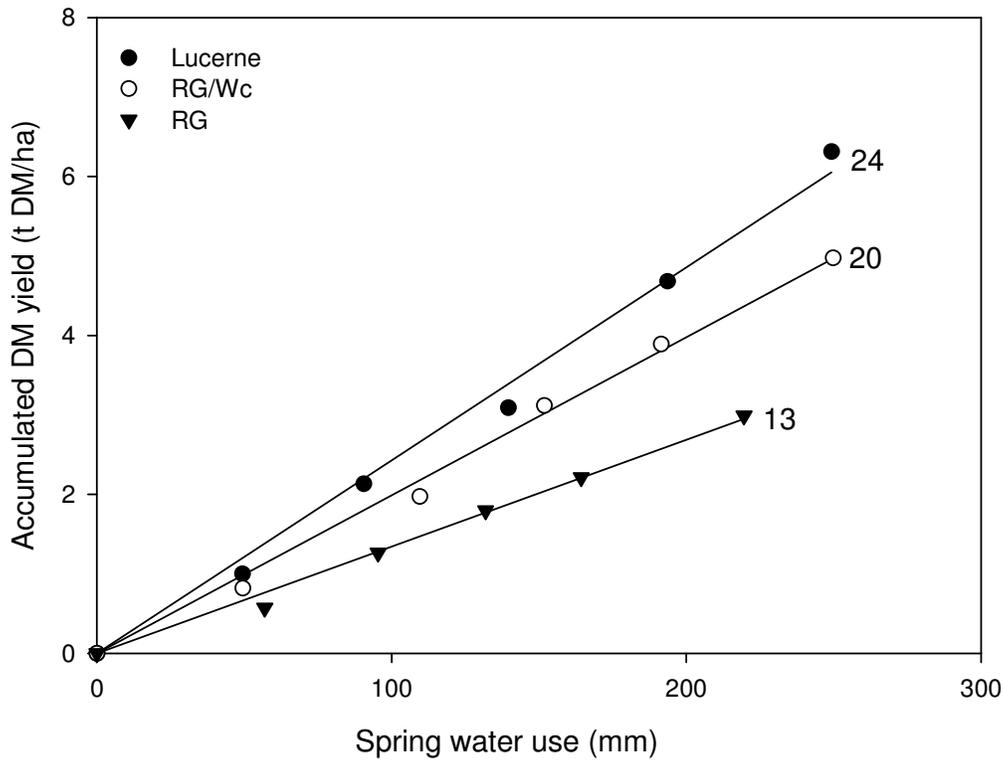
**Figure 11.** Water extraction (mm) in each 0.1 m soil layer from 0-2.3 m soil depth for a lucerne stand (circles) and grass based pasture (triangles) on a deep Wakanui silt loam (solid symbols) at Lincoln University or two different Lismore very stony loams (open symbols) at Ashley Dene. The numbers show total plant available water (mm to 2.25 m soil depth) which can be extracted by the roots for plant growth.

- Water use efficiency varies throughout the year (Fig. 12).
- In spring, as temperatures increase the rate of DM production increases. Soil moisture is usually adequate for growth because rainfall over winter has recharged soil moisture levels (supply matches plant demand). Potential evapotranspiration figures are lowest.
- As the season progresses soil moisture is depleted and pasture growth is compromised (plant demand exceeds soil moisture supply from the soil). Summer drought can compromise DM yields more than low winter temperatures. This reflects an increase in soil evaporation (ineffective small rainfall events) and an inability of plants to respond to rainfall due to premature senescence of green leaf under water stress. (Cocksfoot tends to respond faster than perennial ryegrass).
- As autumn rain begins, soil moisture levels recharge and pastures recover (supply periodically matches plant demand). When autumn temperatures are warm DM production and water use are comparable to those in spring months.
- In winter, temperature is the main limitation to DM production. As growth slows the amount of water required decreases (supply exceeds plant demand). For shallow soils, drainage occurs and water is lost from the profile.



**Figure 12.** Accumulated yield (t DM/ha/y) and water use (mm) of a dryland perennial ryegrass pasture at Ashley Dene, Canterbury. Dark grey bars represent rainfall, light grey lines differentiate periods which have different WUE where (a) had a WUE of 22 kg DM/ha/mm (17/9/02-23/1/03), (b) was 3 kg DM/ha/mm (23/1/03-29/4/03), (c) was 18 kg DM/ha/mm (29/4/03-12/6/03) and (d) 9 kg DM/ha/mm (13/6/03-16/9/03).

- Pastures which are nitrogen deficient do not use water as efficiently as pastures which have sufficient N (Fig. 13).
- Research indicates that N deficient and N sufficient pastures may use similar amounts of water. However, pastures with adequate N may produce double the DM yield of N deficient pastures.
- Inclusion of an appropriate legume can increase WUE. Legumes fix their own nitrogen and they can increase the N status of the companion grass by N returns in urine from grazing animals or decomposition of legume roots/leaves.



**Figure 13.** Spring WUE (kg DM/ha/mm) of lucerne (24 kg DM/ha/mm), perennial ryegrass/white clover (RG/Wc, 20 kg DM/ha/mm) and perennial ryegrass (RG, 13 kg DM/ha/mm) pastures on a Templeton silt loam soil 4 km northwest of Lincoln, Canterbury between 29/9-9/12/93.

### ***Soil moisture conservation for early summer sowing***

The old annual/forage block has been resown with either permanent pasture or lucerne.

The lucerne in this area was to be sown in December 2008; however with low rainfall between September and November 2008 (35 mm) there was concern that there would not be sufficient moisture available for germination. Top soil showed that after 12 months of fallow there was sufficient moisture for establishment.

This area was herbicided (Roundup 2l/ha and 540 g/l pulse) twice (1<sup>st</sup> of November 2007 and February 2008). New lucerne x lime trial area had regrowth of previous sown plants and therefore sprayed (18<sup>th</sup> of November 2008) with glyphosate (4 l/ha and codacide 500 ml/ha). This spray had no effect on the proportion of volunteer white clover and therefore Buster (5l/ha) was applied on 4<sup>th</sup> of December prior to sowing.



27 November 2008 12 months after fallow

Photo: LU FSC

4 December 2008 with regrowth (ex Sonik plot sown 30 January 07) after two sprays



Photo: LU FSC



Photo: LU FSC

4 December 2008 without regrowth after two sprays

## Pasture Mixtures

- October. Lime applied at 5 t/ha. Browntop mat broken down by hoof and tooth from April to August 2005. 400 kg/ha superphosphate and 300 kg/ha DAP applied in January 2006 then disced, harrowed and heavy rolled.
- Sown on 30 January 2007.
- All plots have a basal clover mixture of ‘Leura’ subterranean clover at 10 kg/ha and ‘Nomad’ white clover at 2 kg/ha.
- Grazed August and November 2007 and April 2008. Topped January, September (excluding Timothy Mixes) 2008.
- Years 1 and 3 are partial years. Year 1 is from sowing to July 2007. Year 3 is from July to January 2009.
- October 2007 750 kg/ha superphosphate applied October 2007 and 300 kg/ha applied in September 2008. February 2008 urea applied at 100 kg/ha).

## Dry Matter Yields

### Ryegrass mixtures

Main grass	Sow rate (kg/ha)	Other species	sow rate (kg/ha)
Revolution AR1	10		-
Samson AR1	10		-
Cannon HE	10		-
Revolution AR1	20		-
Revolution	10	Cocksfoot (dg25)	2

- No significant difference in annual yields for years 1, 2 and 3 (Fig. 14).
- **Year 1** annual yield ranged from 612 (‘Cannon HE’) to 857 kg DM/ha (‘Revolution’ 20 kg/ha).
- **Year 2** annual yield ranged from 5.3 (‘Revolution’ 10 kg/ha and CF) to 6.9 t DM/ha (‘Revolution’ 20 kg/ha).
- **Year 3** annual yield ranged from 2.9 (‘Samson’) to 3.7 t DM/ha (‘Revolution’ 20 kg/ha).
  - From botanical composition no subterranean clover in spring 2008. The cocksfoot (dg25) in the ‘Revolution’ 10 kg/ha increased from 9 kg DM/ha (18 July 2007) to 329 kg DM/ha (22 January 2009).

### Soil test results:

Date	pH	Olsen P	Ca	Mg	K	Na	S
8/08/2007	5.7	12	5	7	7	2	8
19/05/2008	6.0	12	7	8	8	3	22

## Dryland mixtures

Grass	Sow rate (kg/ha)
'Advance' tall fescue	20
'Advance' tall fescue +endophyte	20
'Bareno' brome	20
Agriseeds (dg25) cocksfoot	2
'Ella' cocksfoot	2

- No significant difference in annual yield for year 1 and 2.
- **Year 1** annual yield ranged from 643 ('Agriseeds' CF) to 794 ('Advance' TF) kg DM/ha.
- **Year 2** annual yield ranged from 5.1 ('Agriseeds' CF) to 6.4 ('Bareno' brome) t DM/ha.
- **Year 3** annual yield ranged from 2.3 ('Advance' TF+E) to 4.8 ('Agriseeds' CF) t DM/ha.
  - Despite the higher sowing rate and faster emergence rate of tall fescue compared with cocksfoot annual yield in year 3 was higher in cocksfoot.
  - Botanical composition shows little difference in treatments until September 2008 when 'Bareno' brome and 'Agriseeds' cocksfoot had an average of 851 kg/ha of sown grass compared to other treatments at 261 kg/ha of sown grass.
  - In January 2009 cocksfoot treatments had an average of 950 kg/ha of sown grass compared to other treatments at 280 kg/ha of sown grass.

### Soil test results:

Date	pH	Olsen P	Ca	Mg	K	Na	S
8/08/2007	5.7	16	5	9	11	<2	10
19/05/2008	5.7	23	6	10	14	3	32

## Timothy mixtures

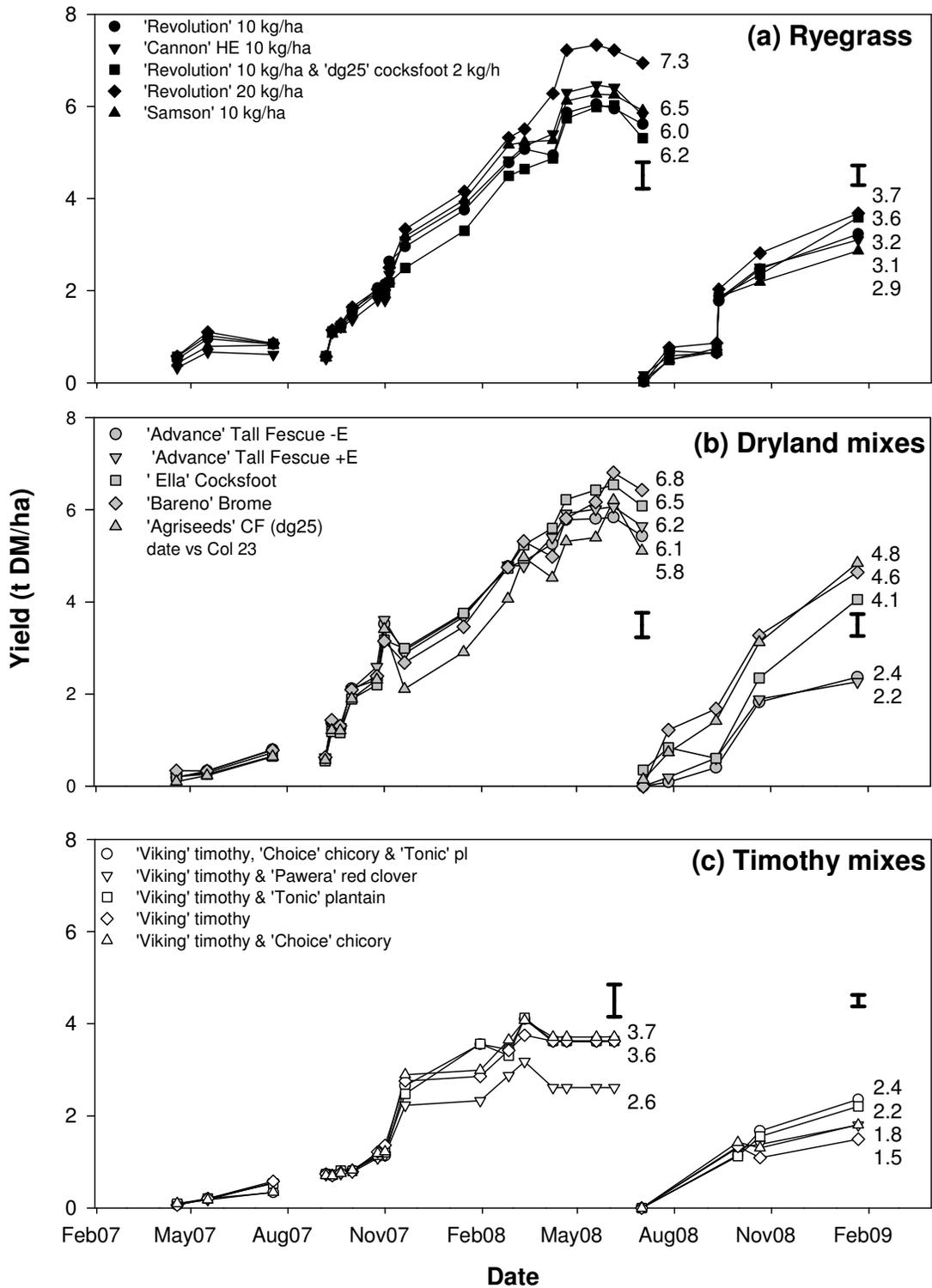
Main grass	sow rate (kg/ha)	Other species	Sow rate (kg/ha)
'Kahu' timothy	2	-	
'Kahu' timothy	2	Chicory	1
'Kahu' timothy	2	plantain	1
'Kahu' timothy	2	Chicory & plantain	1 & 1
'Kahu' timothy	2	Red clover	4

- No significant difference in annual yield for year 1, 2 and 3.
- **Year 1** annual yield ranged from 341 (Tim/Chic/Plantain) to 584 (Tim) kg DM/ha.
- **Year 2** annual yield ranged from 2.6 (Tim/Red clover) to 3.7 (Tim/Chic) t DM/ha.
- **Year 3** annual yield ranged from 1.5 (Tim) to 2.3 (Tim/chic/Plantain) t DM/ha.

- Botanical composition from spring 2007 shows white clover dominance (1321 kg DM/ha) compared to Tim (240 kg DM/ha). In spring 2008 similar trend with less white clover (627 kg DM/ha) and Tim (244 kg DM/ha). Reduction in white clover due to drier season and possible loss of taproot.
- Timothy mixes had less (two) grazing rotations compared to other treatments, due to lower grazing residual and hence took longer to recover.

**Soil test results:**

<b>Date</b>	<b>pH</b>	<b>Olsen P</b>	<b>Ca</b>	<b>Mg</b>	<b>K</b>	<b>Na</b>	<b>S</b>
8/08/2007	5.8	16	5	8	9	<2	11
19/05/2008	5.9	19	7	12	16	2	30



**Figure 14** Accumulated DM yield for pasture mixtures in Year 1 (18/4/2007-18/7/2007), Year 2 (6/9/2007-2/7/2008) and Year 3 (3/7/2008-22/1/2009). Values are maximum annual treatment yields achieved during the growing season. Standard error of the means represent total accumulated yield

*Main points:*

*No difference in sowing rates of perennial ryegrasses (10 and 20 kg/ha)*

*Cocksfoot at low sowing rates mixed with ryegrass can spread feed supply over summer during a drought. Despite being sown at lower sowing rate than ryegrass cocksfoot has increased.*

*Cocksfoot was slower to establish compared to tall fescue however three years after sowing has increased in production compared to tall fescue.*

*Timothy mix placed on stoniest part of the trial and therefore has lacked vigour. Animal's strong grazing preference for timothy has led to a longer recovery period which has led to less grazing opportunities compared to ryegrass and dryland mixes. White clover has dominated more in this mix due to timothy being a less aggressive grass.*

*Mixes sown with Leura, which has failed to regenerate in year 2.*



Cocksfoot (left) and tall fescue (right) with mainly white clover

## New trial: Lime / Lucerne

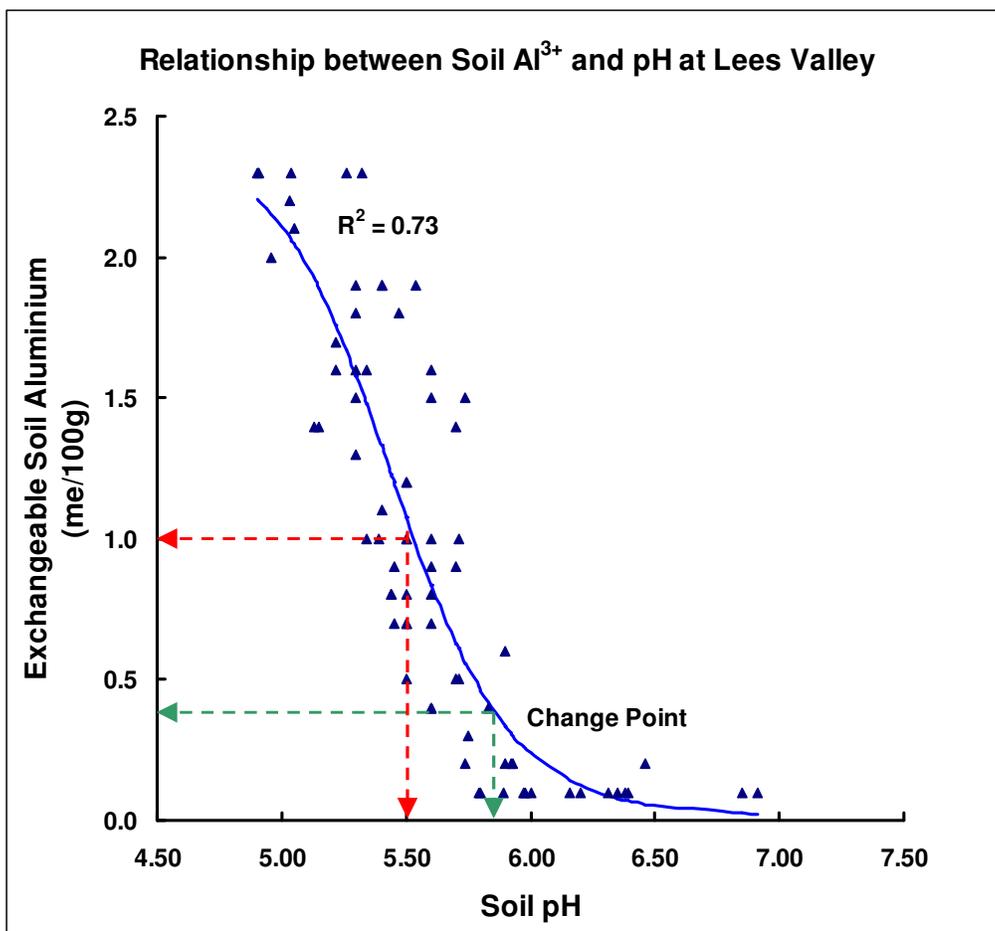
Dr. Jim Moir

### Background

- 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 = 14kg/ha).

### Soil pH and Aluminium

- Over all soil sampling depths and liming rates, soil pH was strongly related to soil plant-available Aluminium:



- Soil exchangeable aluminium levels increased sharply below a soil pH of 5.8.
- At a soil pH of 5.5, exchangeable Al increased to 1.0 me/100g or above. At this level, exchangeable Al is likely to reduce DM yield.



Horizontal root growth of lucerne

### ***How did the Lime Change soil pH and Al?***

- The top 7.5 cm of soil is slightly less acidic than deeper horizons, and hence contains slightly lower levels of plant-available 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)
  - The liming effect was similar but more variable at the 7.5 – 15 cm depth.
  - Comparable but inconsistent soil pH changes occurred at the 15 – 30 cm depth, with soil Al remaining at high 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, but the data was variable.
- Product ‘type’ (Aglime or Quicklime) did not appear to differ in terms of their effect on soil pH or soil plant-available Al levels.

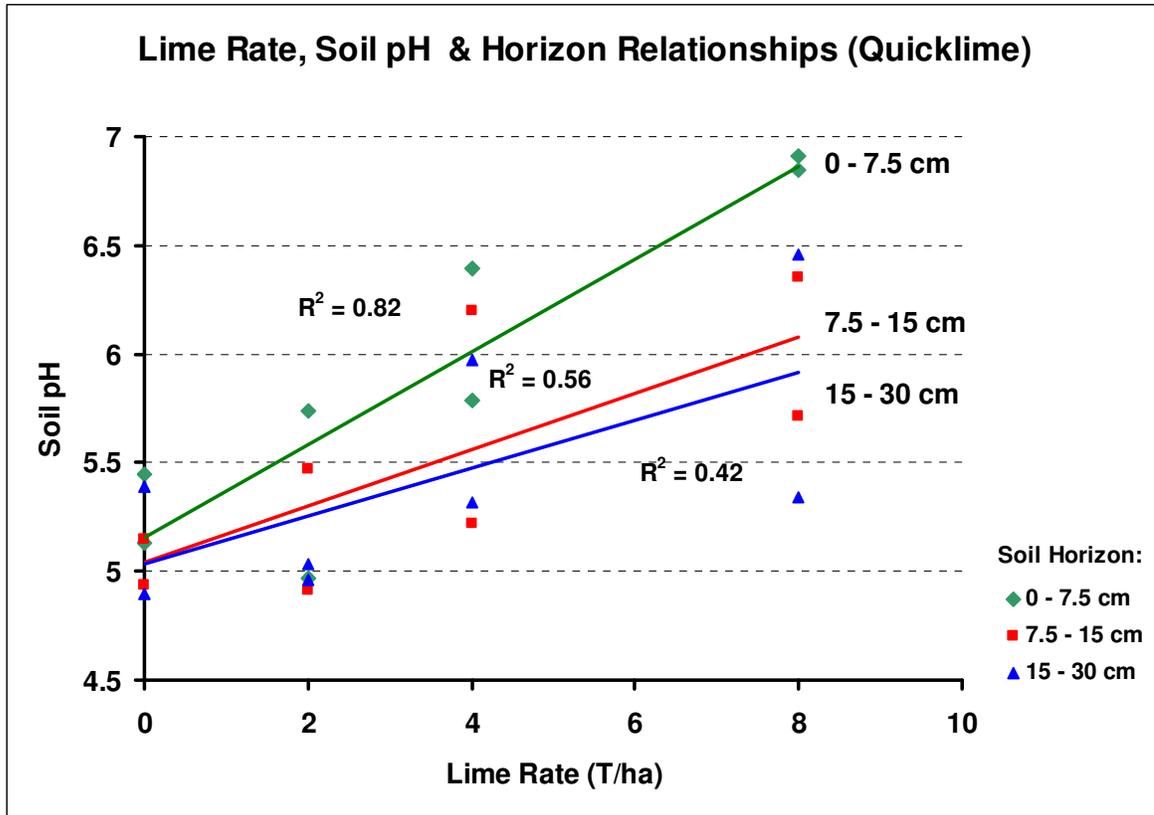
Soil Depth	Lime Rate (T / ha)	Aglime		Quicklime	
		Soil pH	Soil Al	Soil pH	Soil Al
0 – 7.5 cm	0	5.40	0.85	5.45	0.9
	2	6.00 (↑0.60)	0.1 (↓0.75)	5.74 (↑0.29)	0.2 (↓0.7)
	4	5.91 (↑0.51)	0.15 (↓0.7)	6.09 (↑0.64)	0.1 (↓0.8)
	8	6.27 (↑0.87)	0.1 (↓0.75)	6.88 (↑1.43)	0.1 (↓0.8)
7.5 – 15 cm	0	5.33	1.3	5.15	1.4
	2	5.93 (↑0.60)	1.0 (↓0.3)	5.19 (↑0.04)	2.1 (↑0.7)
	4	5.60 (↑0.27)	0.55 (↓0.75)	5.71 (↑0.56)	1.7 (↑0.3)
	8	5.87 (↑0.54)	0.3 (↓1.0)	6.03 (↑0.88)	0.55 (↓0.85)
15 – 30 cm	0	5.28	2.0	5.15	1.7
	2	5.49 (↑0.21)	1.2 (↓0.8)	5.00 (↓0.15)	2.1 (↑0.4)
	4	5.38 (↑0.05)	1.4 (↓0.6)	5.65 (↑0.50)	1.2 (↓0.5)
	8	5.62 (↑0.29)	1.3 (↓0.7)	5.90 (↑0.75)	0.9 (↓0.8)

**Soil test results:**

Date	pH	Olsen P	Ca	Mg	K	Na	S
8/08/2007	5.7	12	4	8	11	<2	8

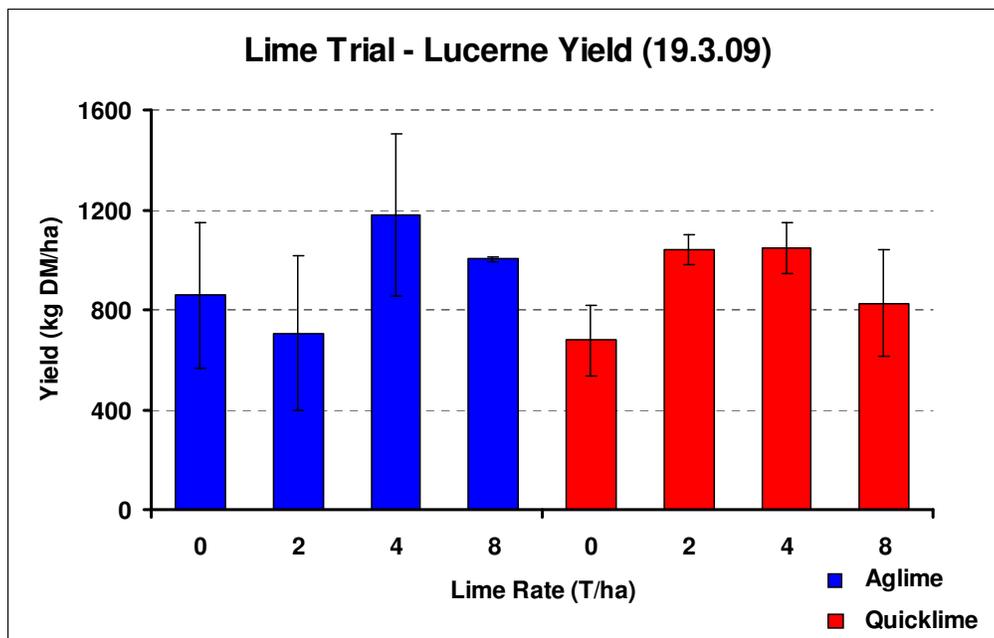


Lucerne x lime experiment showing soil variation



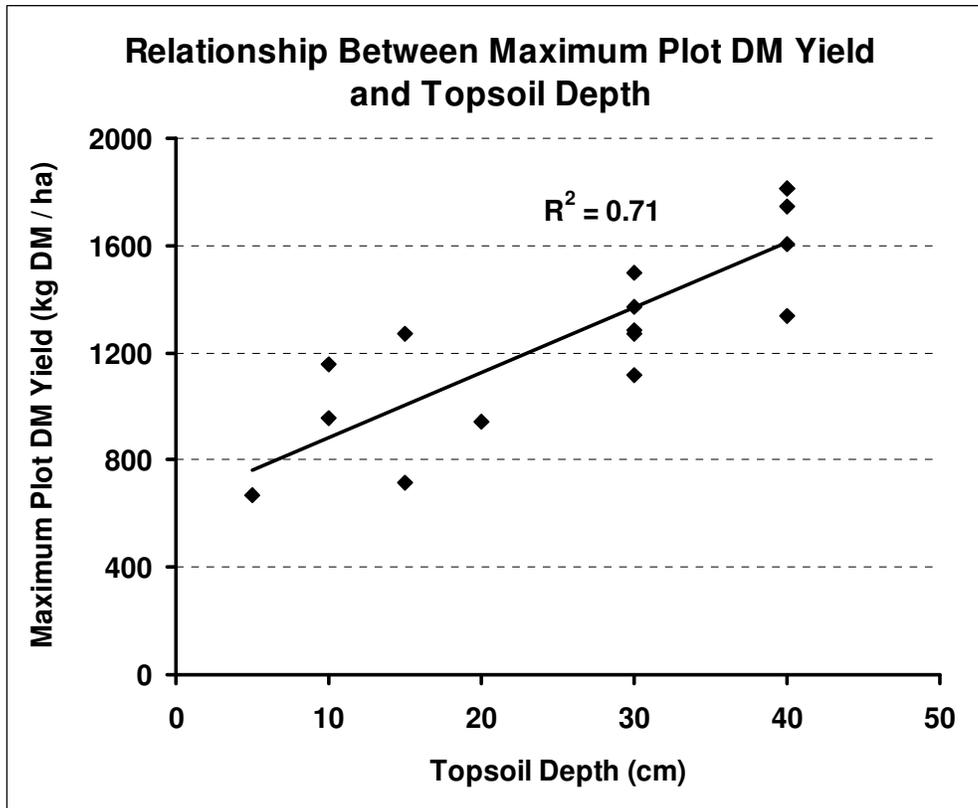
### ***Lime and Lucerne Yield***

- Current DM cover (yield) is low, and soil moisture limited.
- Effect of lime / liming rate on yield is unclear at present, and is probably confounded by other factors.



### ***What key factors are currently influencing yield at this site?***

- A preliminary survey indicated that topsoil depth (depth to gravel) is extremely variable at this site, over small distances (1 – 2 m).
- Current lucerne yield seems most strongly related to topsoil depth / depth to gravel, and therefore the plant-available water storage of the soil.
- Yields do not appear to be related to soil pH and Al levels so far. However, this is an establishing crop, and any effect of pH and Al may become apparent over the next 12 months.



### ***Conclusions to date***

- Soil pH was strongly related to levels of soil plant-available Aluminium.
- Liming increased soil pH and reduced soil plant-available Aluminium.
- Liming was most effective at the soil surface and less effective at depth (15 – 30 cm).
- Higher rates of lime appeared more effective, though data was variable. No difference in effectiveness between Aglime and Quicklime was detected.
- Soil pH / Al levels did not relate well to lucerne yields to date. Extreme variability in depth of topsoil (micro-topography) and hence plant-available water storage have influenced yields. More data is required to explain this result.

## Pasture yields around Lees Valley

**Table 10.** Annual yield (t DM/ha/y) from January 2008 to December 2008 around Lees Valley.

Location	Yield (t DM/ha/y)
Island Hill (flat) pasture	4.6
Wharfedale Lucerne	7.4
Snowdale pasture	7.8
Mt Pember pasture	5.6

- Most readings are taken between 21-28 day rotation.

## Lees Valley weather summary

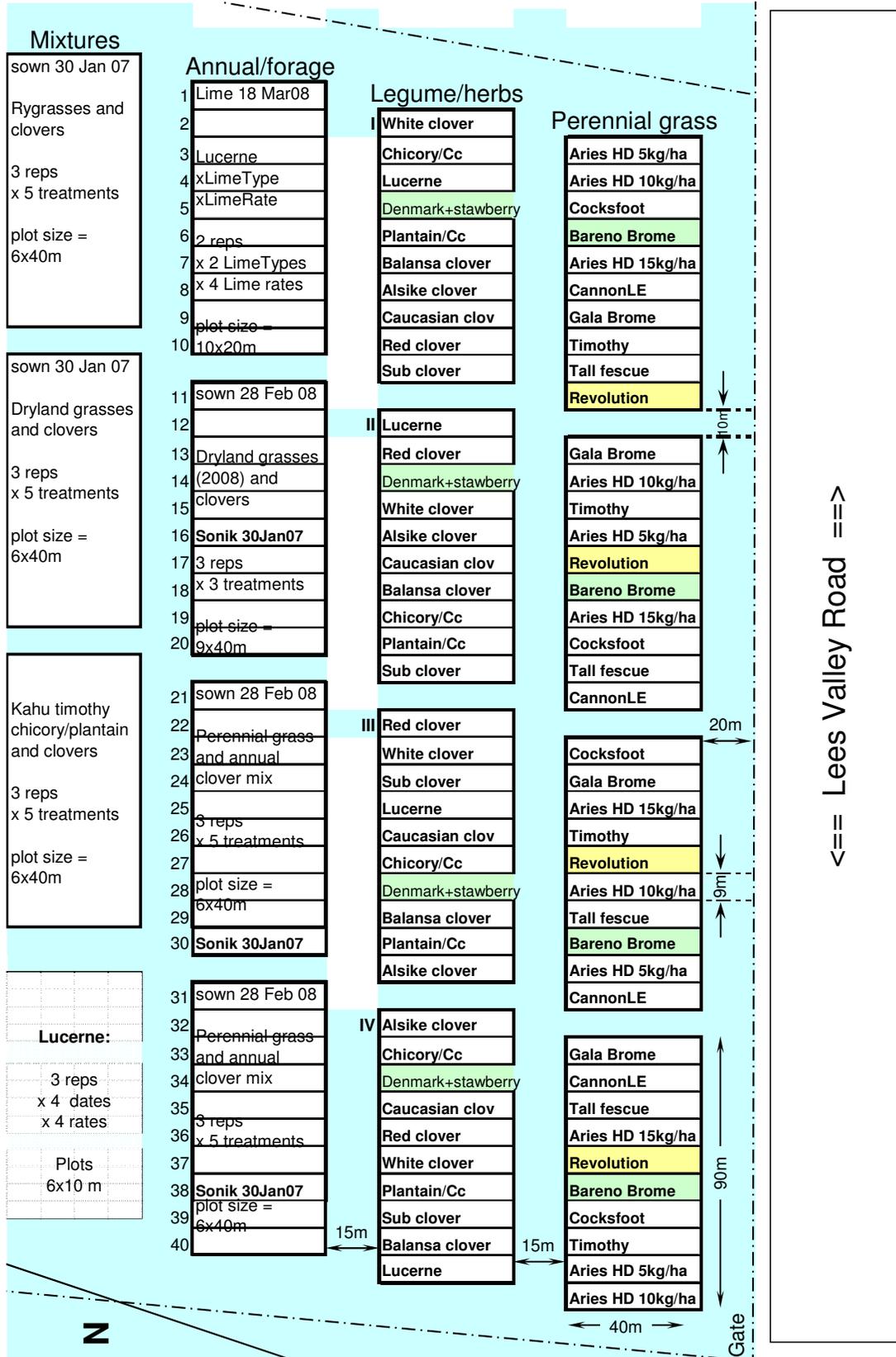
Data are summarized below and compared with data from Darfield and the ECAN rain records from near Island Hill across the valley (due North from trial site, on the Ashley River).

Month	Air temp. (°C)		Soil temp. (°C)		Rainfall (mm)	
	Lees	Darfield	Lees	Lees	Lees(ECAN)	Darfield
Nov07	11.8	13.4	13.7	23.2	35.5	25.8
Dec07	14.7	16	16.6	28.0	55.0	69
Jan08	17.0	18.3	19.7	18.8	37.0	14.2
Feb08	15.2	16.9	17.9	98.0	167.0	125.2
Mar08	13.5	16.1	14.7	21.4	25.5	16.8
Apr08	9.8	12.6	11.4	25.6	46.5	46.2
May08	2.8	7.9	6.3	17.2	26.5	29.4
Jun08	3.4	7.8	4.4	83.0	133.5	87
Jul08	3.2	6.6	3.6	128.5	206.0	148.4
Aug08	3.8	6.8	5.0	80.8	130.0	126.4
Sep08	8.6	11.1	8.6	46.3	75.0	54.8
Oct08	9.5	12.1	11.3	40.8	54.0	24.4
Nov08	13.5	12.6	15.1	16.0	21.2	12.6
Dec08	14.4	75.2	17.1	68.0	117.2	75.2
Jan09	17.3	21.2	19.4	30.0	52.2	21.2
Feb09	13.9	91.8	17.5	74.2	105.8	91.8
Mar09	12.3	14.4	15.0	11.5	18.0	14.4
<b>Means /totals</b>	<b>10.9</b>	<b>21.2</b>	<b>12.8</b>	<b>811</b>	<b>1306</b>	<b>983</b>

Coloured cells indicate data estimated from ECAN rainfall data.

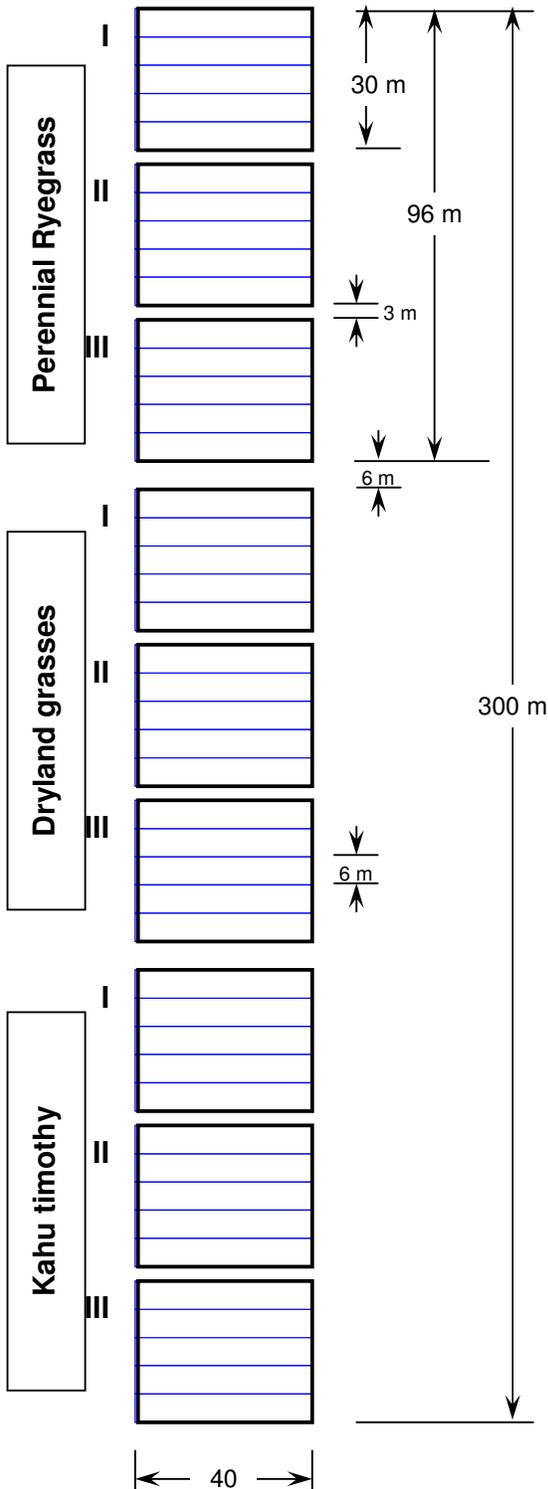
Darfield data are courtesy of NIWA and ECAN rainfall data are from Environment Canterbury. Rainfall updates from the ECAN network are available by phone or their web page @ <http://www.ecan.govt.nz/Our+Environment/Water/Rainfall/>

# Lees Valley trial site



# Pasture mixtures: grass/clover/herbs

Base legumes of Leura sub clover (10kg coated/ha)  
and Nomad white clover (2 kg/ha)



Experiment	Rep	Plot#	Trt#	Grass/forbs
Ryegrass	1	1	1	Revolution AR1 10kg
	1	2	3	Cannon HE 10kg
	1	3	5	Revolution 10 kg & Cf (dg25)
	1	4	4	Revolution AR1 20kg
	1	5	2	Samson AR1 10kg
	2	6	3	Cannon HE 10kg
	2	7	2	Samson AR1 10kg
	2	8	5	Revolution 10 kg & Cf (dg25)
	2	9	4	Revolution AR1 20kg
	2	10	1	Revolution AR1 10kg
	3	11	2	Samson AR1 10kg
	3	12	5	Revolution 10 kg & Cf (dg25)
	3	13	4	Revolution AR1 20kg
	3	14	1	Revolution AR1 10kg
	3	15	3	Cannon HE 10kg
Dryland mix	1	16	1	Advance Tf
	1	17	5	Ella Cf
	1	18	3	Bareno brome
	1	19	4	Agriseeds dg25 Cf
	1	20	2	Advance Tf +endophyte
	2	21	1	Advance Tf
	2	22	2	Advance Tf +endophyte
	2	23	5	Ella Cf
	2	24	4	Agriseeds dg25 Cf
	2	25	3	Bareno brome
	3	26	2	Advance Tf +endophyte
	3	27	5	Ella Cf
	3	28	1	Advance Tf
	3	29	4	Agriseeds dg25 Cf
	3	30	3	Bareno brome
Timothy	1	31	4	Kahu timothy & chic/pltn
	1	32	5	Kahu timothy & red clover
	1	33	3	Kahu timothy & plantain
	1	34	1	Kahu timothy
	1	35	2	Kahu timothy & chicory
	2	36	1	Kahu timothy
	2	37	3	Kahu timothy & plantain
	2	38	5	Kahu timothy & red clover
	2	39	4	Kahu timothy & chic/pltn
	2	40	2	Kahu timothy & chicory
	3	41	2	Kahu timothy & chicory
	3	42	1	Kahu timothy
	3	43	5	Kahu timothy & red clover
	3	44	4	Kahu timothy & chic/pltn
	3	45	3	Kahu timothy & plantain

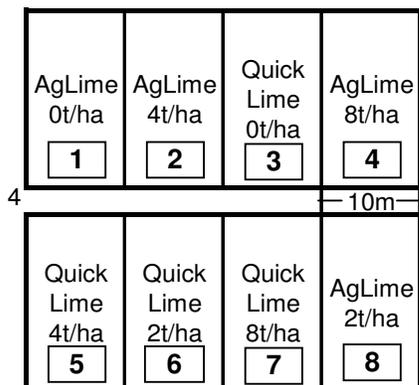
## Plot layout for pasture mixes Lees Valley, Feb 08

Experiment	Rep	Plot#	Trt#	Grass/forbs
<b>Dryland mix (2008)</b>	1	1	1	Flecha Tall Fescue (maxP)
	1	2	3	Bareno brome
Basal =	1	3	2	dg25 cocksfoot
<b>Denmark sub</b>	2	4	3	Bareno brome
<b>and Nomad wc</b>	2	5	1	Flecha Tall Fescue (maxP)
<b>Existing Sonik short rotation ryegrass plot</b>				
	2	6	2	dg25 cocksfoot
	3	7	2	dg25 cocksfoot
plot size = 9 x 40 m	3	8	3	Bareno brome
	3	9	1	Flecha Tall Fescue (maxP)
<b>Existing Ryegrass clover headland</b>				
	Rep	plot#	Grs#	Leg#
<b>Perennial grass + annual legs</b>	1	1	1	1 Arrowleaf
	1	2	1	5 Woogenlup sub
	1	3	1	3 Denmark sub
Basal =	1	4	1	6 Pawera red
<b>Nomad wc</b>	1	5	1	4 Leura sub
<b>oats</b>	1	6	1	2 Persian
<b>New headland (9x40m) Bareno brome</b>				
with main plot	1	7	2	2 Persian
<b>1= Bronsyn AR1 ryegrass</b>	1	8	2	6 Pawera red
<b>2= dg25 fine leaf cocksfoot</b>	1	9	2	1 Arrowleaf
	1	10	2	5 Woogenlup sub
	1	11	2	3 Denmark sub
plot size = 6 x 40 m	1	12	2	4 Leura sub
<b>Existing Sonik short rotation ryegrass plot</b>				
<b>Existing Ryegrass clover headland</b>				
	2	13	2	5 Woogenlup sub
	2	14	2	4 Leura sub
	2	15	2	3 Denmark sub
	2	16	2	1 Arrowleaf
	2	17	2	6 Pawera red
	2	18	2	2 Persian
<b>New headland (9x40m) Bareno brome</b>				
	2	19	1	1 Arrowleaf
	2	20	1	6 Pawera red
	2	21	1	3 Denmark sub
<b>Existing Sonik short rotation ryegrass plot</b>				
	2	22	1	5 Woogenlup sub
	2	23	1	2 Persian
	2	24	1	4 Leura sub
<b>Existing Ryegrass clover headland</b>				

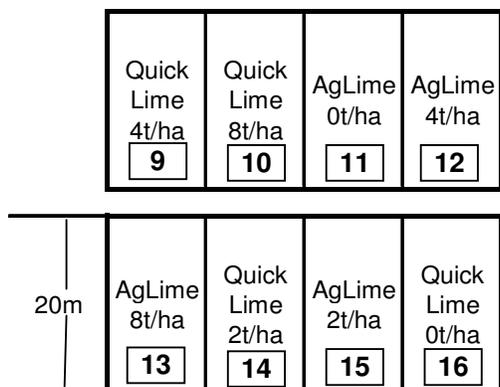
### Lucerne xLimeType xLimeRate (2008)

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



Lees Valley - Nitrogen reponse on perennial ryegrass

	75 kg N/ha	150 kg N/ha	0 kg N/ha		150 kg N/ha	75 kg N/ha	0 kg N/ha
5 kg/ha Aries HD	1	11	21	No mans land	31	41	51
10 kg/ha Aries HD	2	12	22		32	42	52
Cocksfoot	3	13	23		33	43	53
Bareno	4	14	24		34	44	54
15 kg/ha Aries HD	5	15	25		35	45	55
Cannon LE	6	REP 1			36	REP 2	
Brome	7	17	27		37	47	57
Timothy	8	18	28		38	48	58
Tall fescue	9	19	29		39	49	59
Revolution	10	20	30		40	50	60
	150 kg N/ha	0 kg N/ha	75 kg N/ha		150 kg N/ha	0 kg N/ha	75 kg N/ha
Brome	61	71	81	No mans land	91	101	111
10 kg/ha Aries HD	62	72	82		92	102	112
Timothy	63	73	83		93	103	113
5 kg/ha Aries HD	64	74	84		94	104	114
Revolution	65	REP 3			95	REP 4	
Bareno	66	76	86		96	106	116
15 kg/ha Aries HD	67	77	87		97	107	117
Cocksfoot	68	78	88		98	108	118
Tall fescue	69	79	89		99	109	119
Cannon LE	70	80	90		100	110	120

← 6.0m →

→ | 4.0m | ←

↓ 9m ↑

Photo: LU FSC



Red clover