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Dryland Pastures Update - Timaru

5 September 2014

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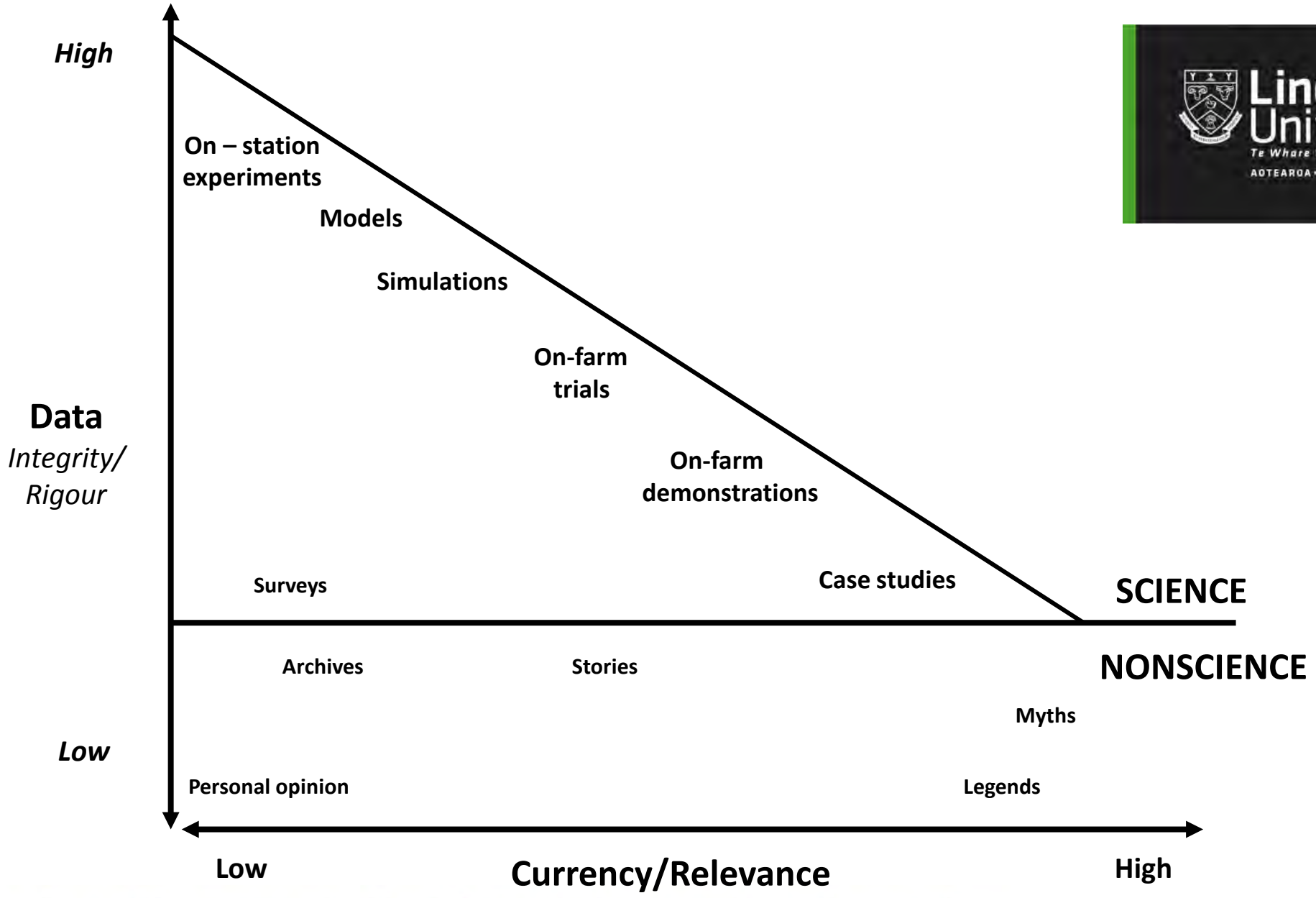


Source: Modified from Carberry 2001, based on Bonoma 1985 and Crookston 1994

Topics

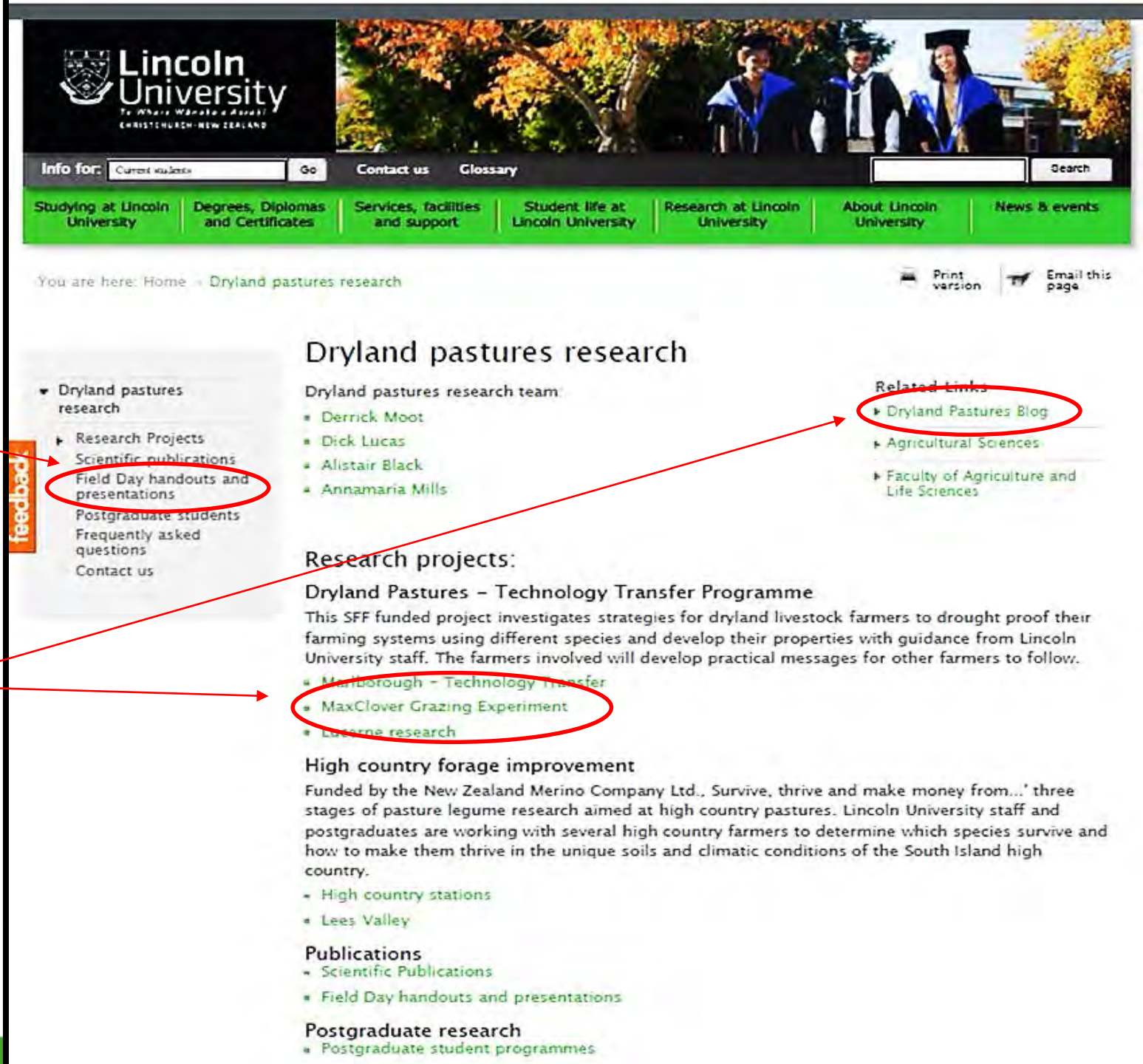
- MaxClover photo diary
- Perennial ryegrass
- White clover
- Annual clovers
- Lucerne establishment
- Lucerne grazing management
- Current research projects

The website…

Info on:

- Current projects
- Field day presentations
- Scientific publications
- FAQs
- Postgraduate study
- Photo Diary
- Direct link to BLOG

www.lincoln.ac.nz/dryland



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Dry matter yield and botanical composition of the 'MaxClover' grazing experiment at Lincoln University, Canterbury, New Zealand

PHOTO DIARY - 2002/03 to 2010/11

Funded by:
beef+lamb new zealand

Prepared by: DJ Moot; A Mills; RJ Lucas; KM Pollock; M Smith
Lincoln University DryLAND Pastures Research Team

General information

The ‘MaxClover’ Grazing Experiment was established at Lincoln University, Canterbury in Feb 2002.

There were six paddocks of each of the six pasture types. This gave 36 individual plots of 0.05 ha each.

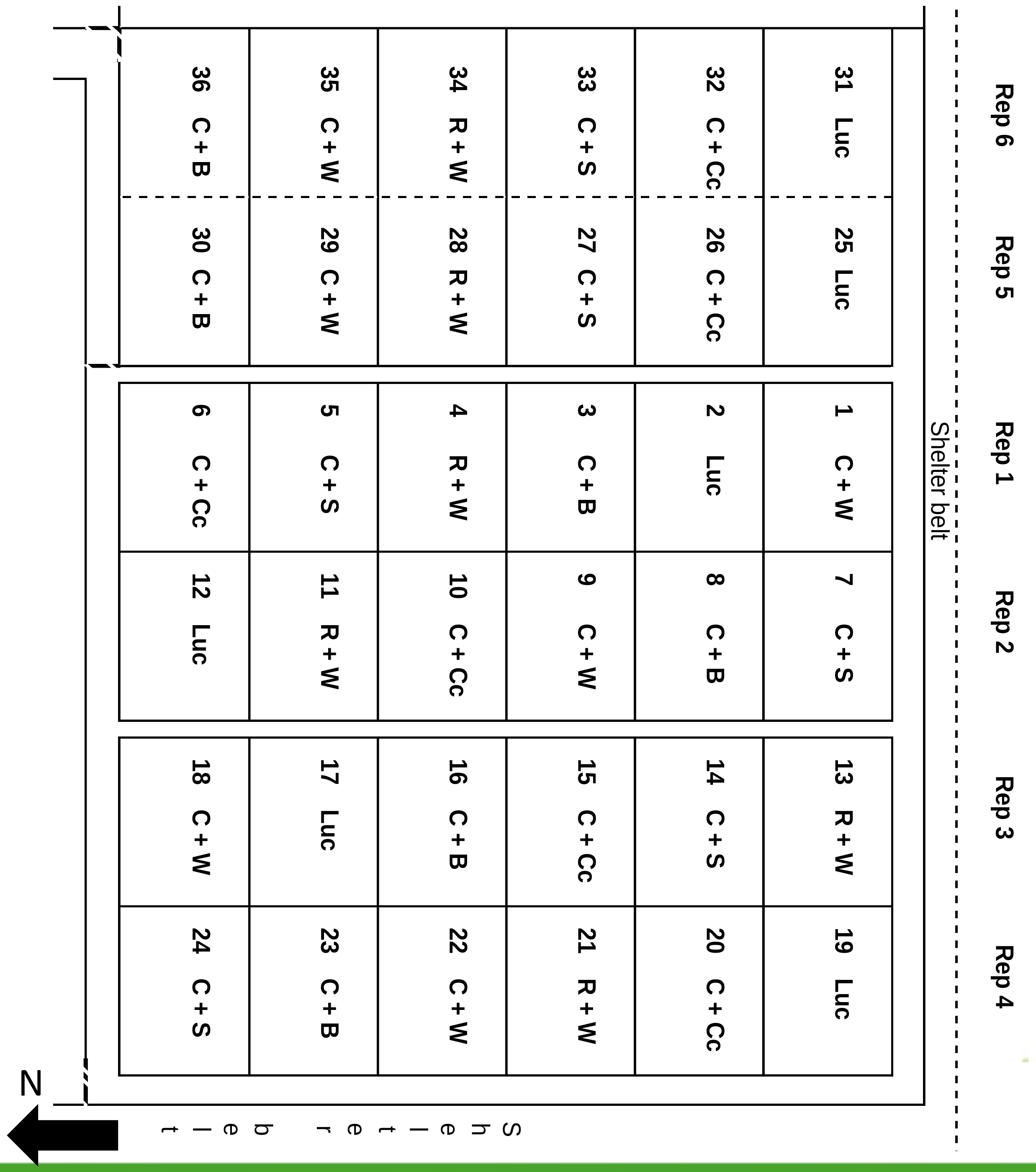
Measurements of yield and botanical composition began in Sept 2002 and continued until June 2011.

No nitrogen fertiliser or irrigation was applied to any pasture over the nine years. Other nutrients (S, P) and lime were applied in response to annual soil tests.

Annual soil test results can be found on the ‘MaxClover’ page at www.lincoln.ac.nz/dryland

No irrigation was applied. Annual rainfall ranged from 490 to 770 mm and the mean is about 630 mm/yr at this location.

Rainfall is variable and unpredictable, particularly from September to March when potential evapotranspiration exceeds rainfall leading to the development of soil moisture deficits.



Dryland
4 clovers + cocksfoot
v R/W v Luc
(Reps 1 - 4 sown Feb, 2002)
(Reps 5 & 6 sown autumn, 2003)

B Bolta balansa clover (3.5 kg/ha)
C Vision cocksfoot (4kg/ha, reps 1-4) (2kg/ha, reps 5 & 6)
Cc Endura caucasian clover (5.9 kg/ha)
Luc Kaituna lucerne (5.7 kg/ha)
R Aries AR1 ryegrass (10 kg/ha)
S Denmark sub clover (10 kg/ha)
W Demand white clover (3 kg/ha)

Plot sizes

Dimensions	Area
22 x 23m	0.05 ha

Notes:
Plot numbers (1-36) are indicated for each plot.

The plan (not to scale) has been rotated so it has the same orientation as the aerial photo on the next page.

The ‘MaxClover’ Grazing experiment in paddock H19 at Lincoln University

Grazing management

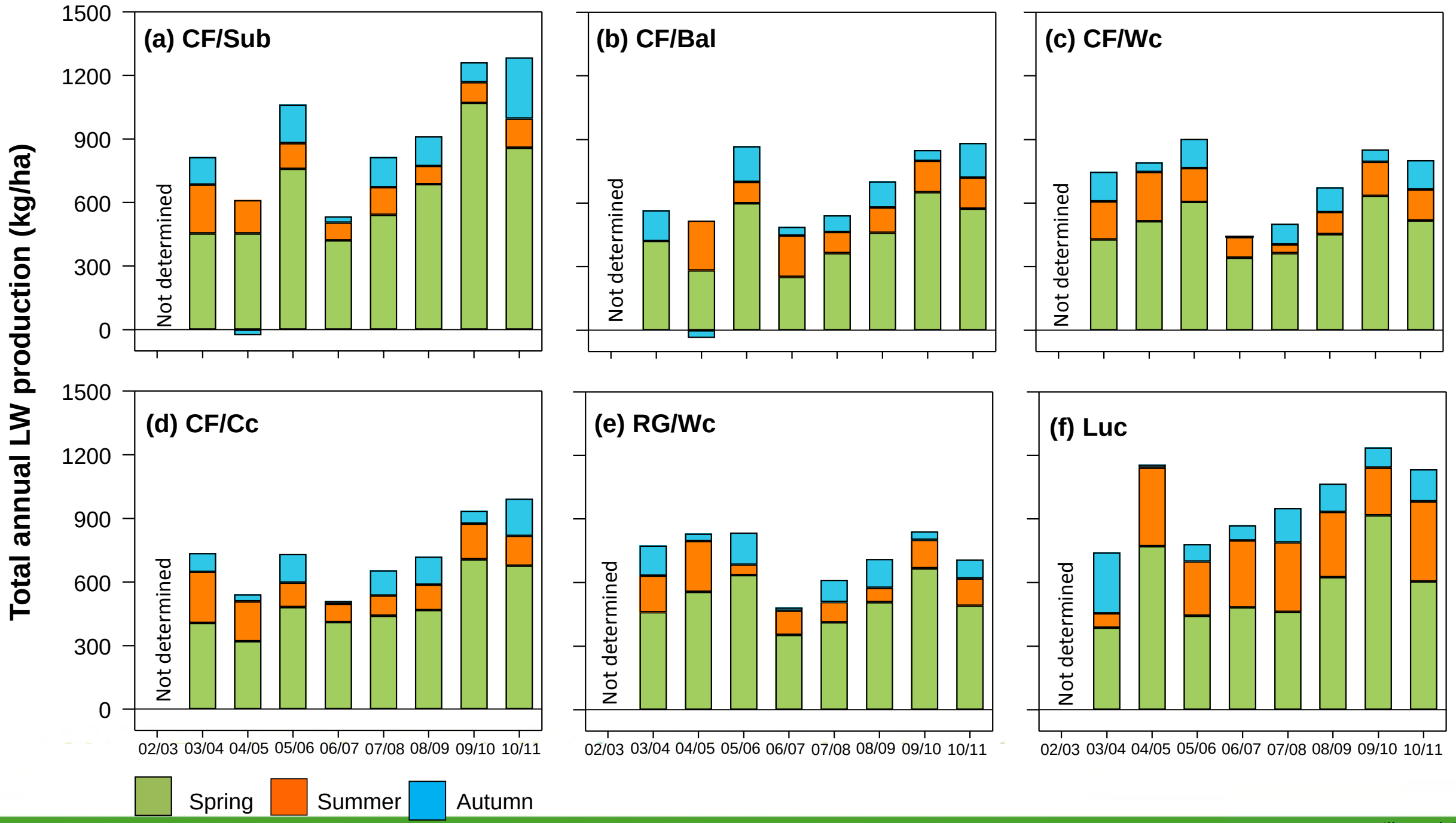
Lucerne was always rotationally grazed.

Grass-based pastures underwent a period of set stocking, short (2-paddock) or intermediate (3-paddock) rotational grazing in early spring before being rotationally grazed in a six paddock rotation until insufficient feed supply led to destocking of the pastures (drought or low winter temperatures).

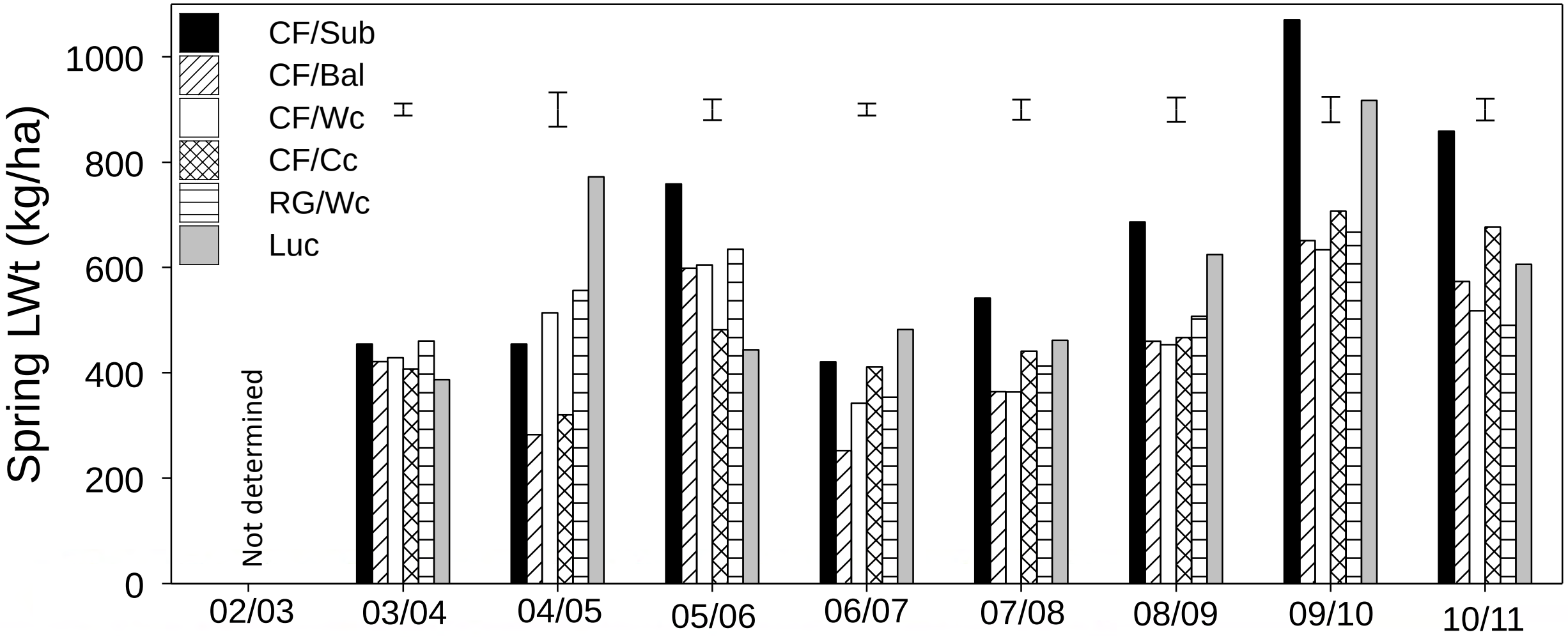
Pastures were generally destocked in winter when there was insufficient feed. This simulated a commercial farm system when sheep would be removed to graze winter forage crops or a smaller area of the farm set aside for winter grazing.

For pastures with annual clovers (sub or balansa) stock were removed to allow re-seeding. The timing differed as pastures were closed sequentially as the rotation progressed.

When necessary, ewes were used to hard graze annual clover pastures in early autumn to open the sward in preparation for the germination of annual clover seedlings after autumn rains.

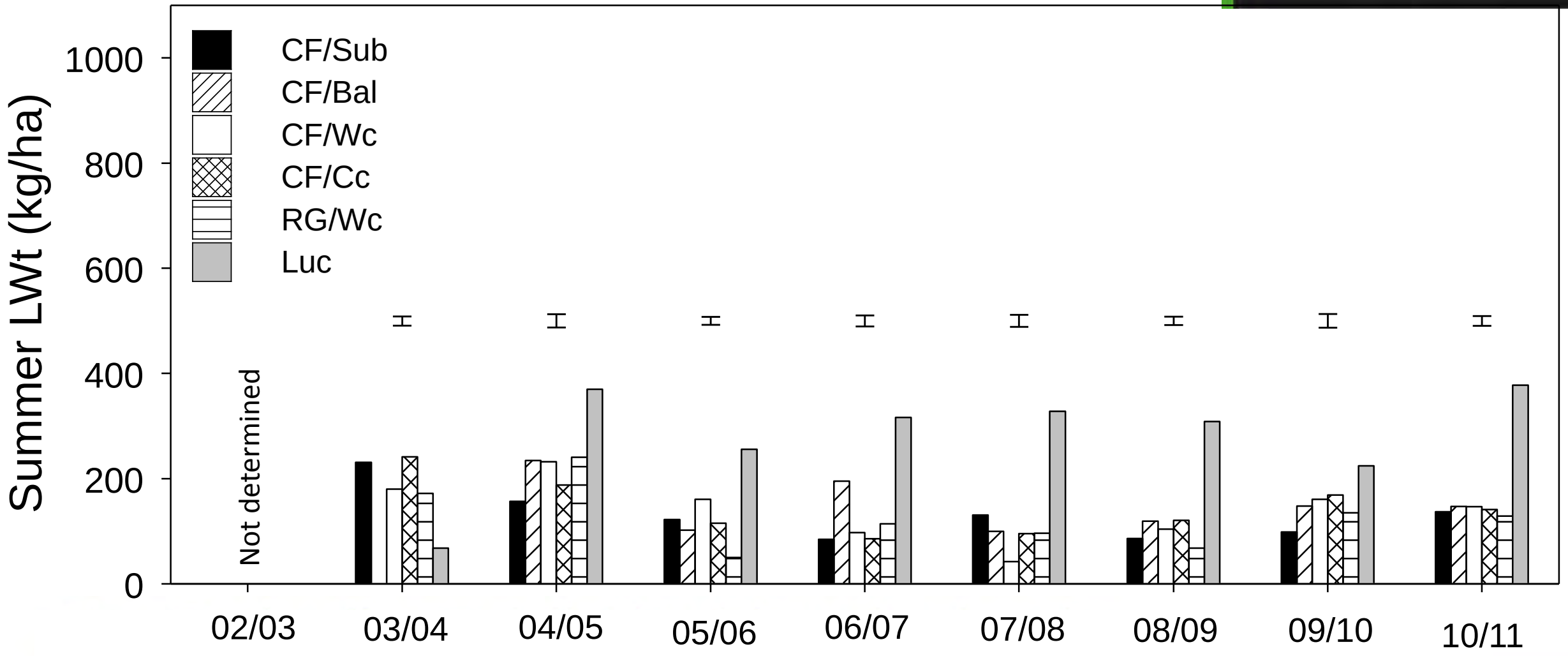

Total annual LW production (kg/ha)
(a) CF/Sub
(b) CF/Bal
(c) CF/Wc
(d) CF/Cc
(e) RG/Wc
(f) Luc
Not determined
0
300
600
900
1200
1500
02/03 03/04 04/05 05/06 06/07 07/08 08/09 09/10 10/11
Spring
Summer
Autumn

Total spring LWt production



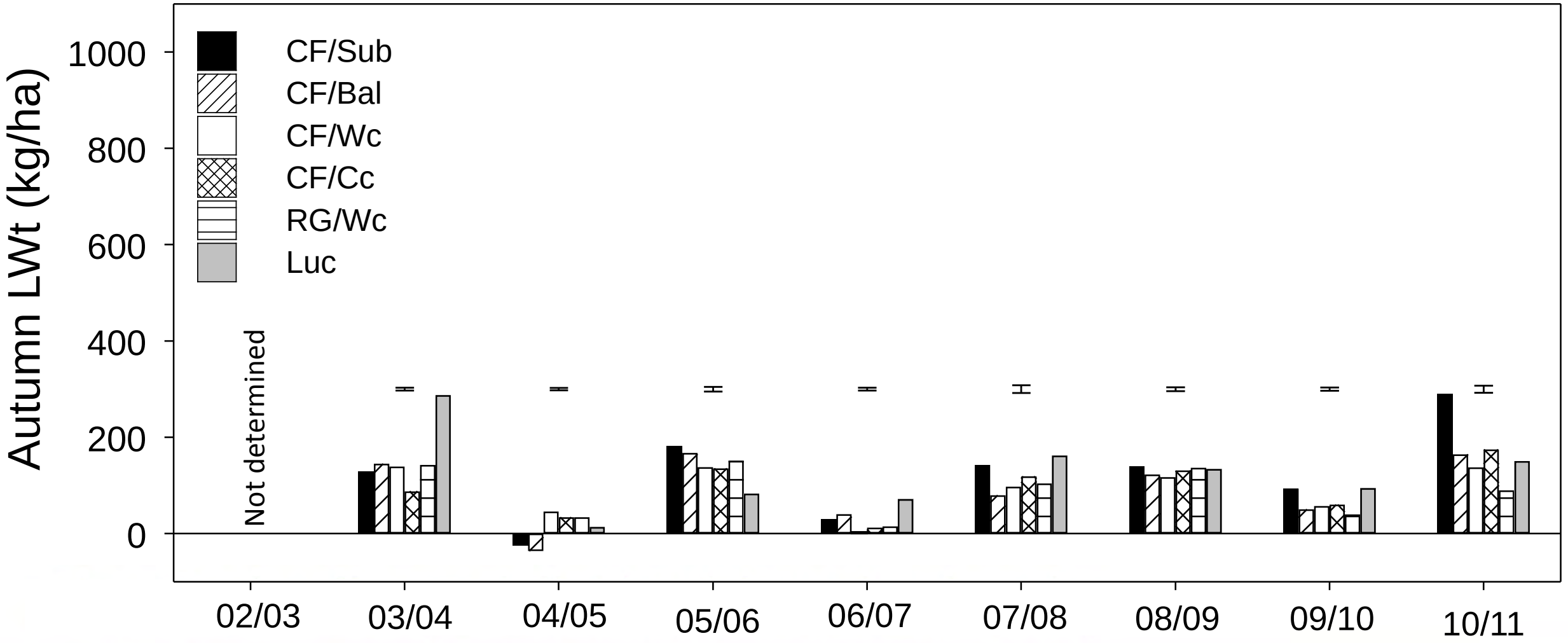
Mills *et al*. 2014b

Total summer LWt production



Mills *et al*. 2014b

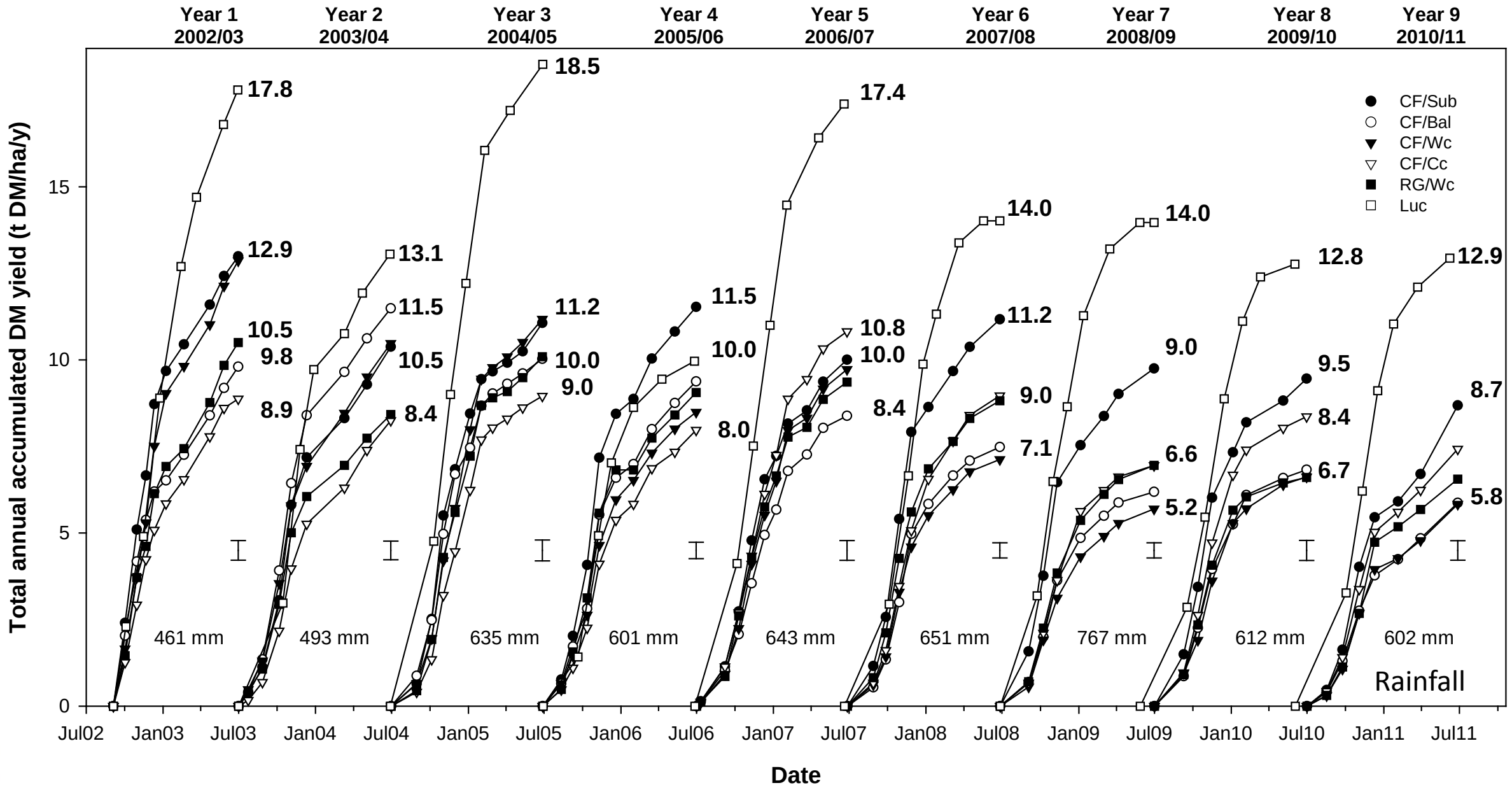
Total autumn LWt production



Yield and composition of six dryland pastures over nine growth seasons

- Lucerne produced more DM than all grass based pastures in most years.
- Its tap-root enabled access to water from lower soil layers but it also used water more efficiently than the grass based pastures - especially in spring.
- CF/Sub clover was the highest yielding grass based pastures in Years 6-9.
- Yields of all pastures declined over time.

Figure 1. Total annual accumulated dry matter production

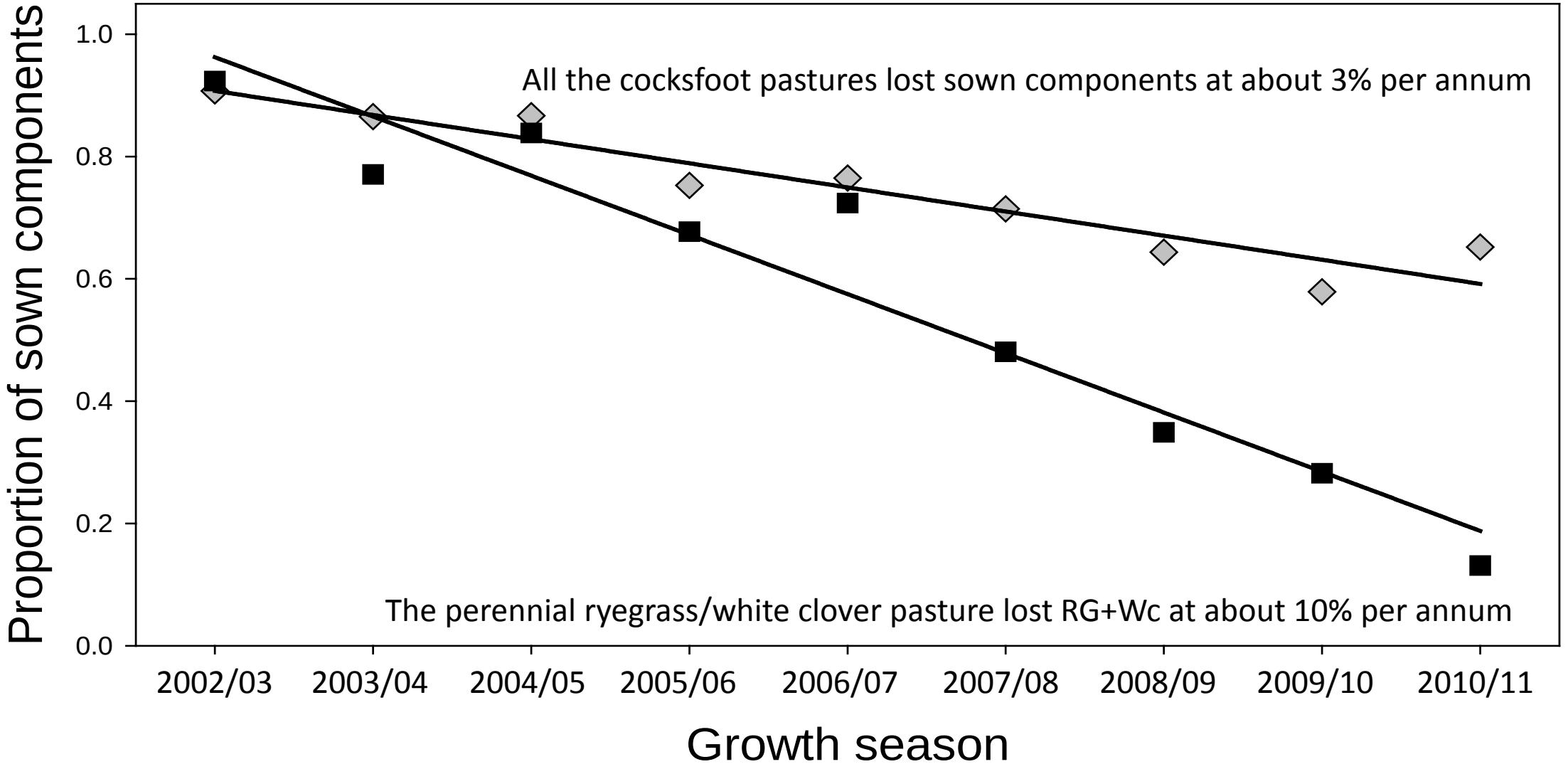


Source: Moot 2012

Summary of yields in Figure 1

- RG/Wc yield declined from 10.5 to 6.6 t/ha in Year 9.
- Lucerne yield was over 17 t/ha in 3 years and 12.9 t/ha in Year 9.
- CF/Sub yield declined from 12 t/ha to 8.7 t/ha in Year 9.
- CF/Wc, CF/Cc, CF/Bal yields were lower than CF/Sub in most years.

Figure 2. Change in the proportion of originally sown pasture components (grass + clover) over time



Source: Mills *et al*., 2014a

Summary of Figure 2

- After 9 years about 10% of the RG/Wc pasture was from originally sown species compared with about 60% in the cocksfoot based pastures. Lucerne (not shown) was about 85% pure due to winter weed control.
- In Years 1-3 the RG/Wc pastures maintained a high proportion of ryegrass and white clover. Most experiments only run for 3 years – this long-term experiment shows how this pasture deteriorated from Year 4 to Year 9.
- By Year 5-6 only about half the yield in RG/Wc pastures is from the sown species. Ideally pasture renewal would be recommended at this point.
- By Year 9 only about 10% of the 6.6 t DM/ha that was produced was from RG or Wc.
- For cocksfoot, sown pasture species decreased by about 3% per year. This meant after 9 years about 60% of the total yield produced by the four cocksfoot based pastures was from the originally sown pasture species.
- Cocksfoot was persistent but pasture vigour had declined. These pastures did not require renovation but had the potential for increased production. We recommend overdrilling in autumn with 10 kg/ha sub clover plus 1 kg/ha white clover to increase clover content and nitrogen fertility which would stimulate production from the existing cocksfoot component.

Perennial ryegrass/white clover pastures

White clover in flower – Lees Valley, Canterbury.
Photo: Dr K.M. Pollock

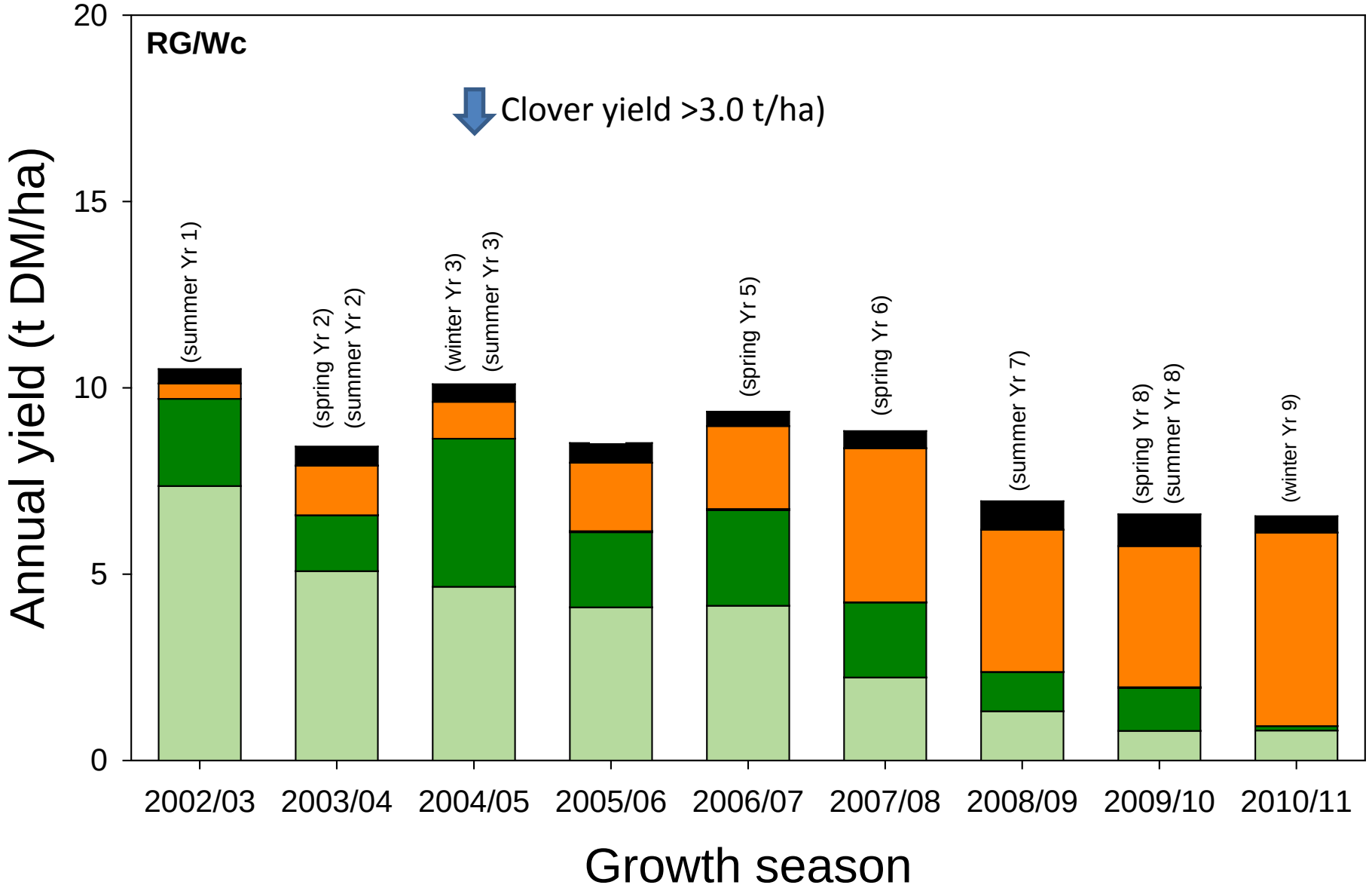
- This section details the changes in yield and composition of the grazed perennial ryegrass/white clover pastures.
- Photos are included to show the condition of the pastures over time.

Perennial ryegrass/white clover pastures

Introduction…

- Perennial ryegrass and white clover pastures have formed the basis of New Zealand's successful grass fed pastoral agriculture systems since white clover breeding began in the 1920's. There is substantial investment in breeding new white clover and perennial ryegrass cultivars relative to other permanent pasture species.
- It's ability to produce high yields of quality feed led to its recommendation as the primary pasture for pastoral areas throughout New Zealand.
- The mix is easily managed and performs well in suitable environments.
- However, it fails to thrive and persist in dryland drought prone areas.
- White clover loses its taproot at about 18 months after sowing and relies on a fibrous adventitious root system.

Figure 3. RG/Wc – Annual Botanical composition



Sown grass
Sown legume
Unsown grasses & dicot weeds
Dead

The amount of unsown grasses (*Poa annua*, goose grass, Vulpia, barley grass etc) and dicot weeds (dandelion, catsear, hawkbit, yarrow, dock) increased from 4% in Year 1 to 80% by Year 9

Text in brackets indicates presence of photos

Source: Mills *et al.*, 2014a

Yr 1 Summer (Feb 2003) RG/Wc

The pasture is about 1 year old and drill rows are still obvious.
The pasture was exposed to drought conditions with summer rainfall (80 mm) only about half of what would fall in an average year.

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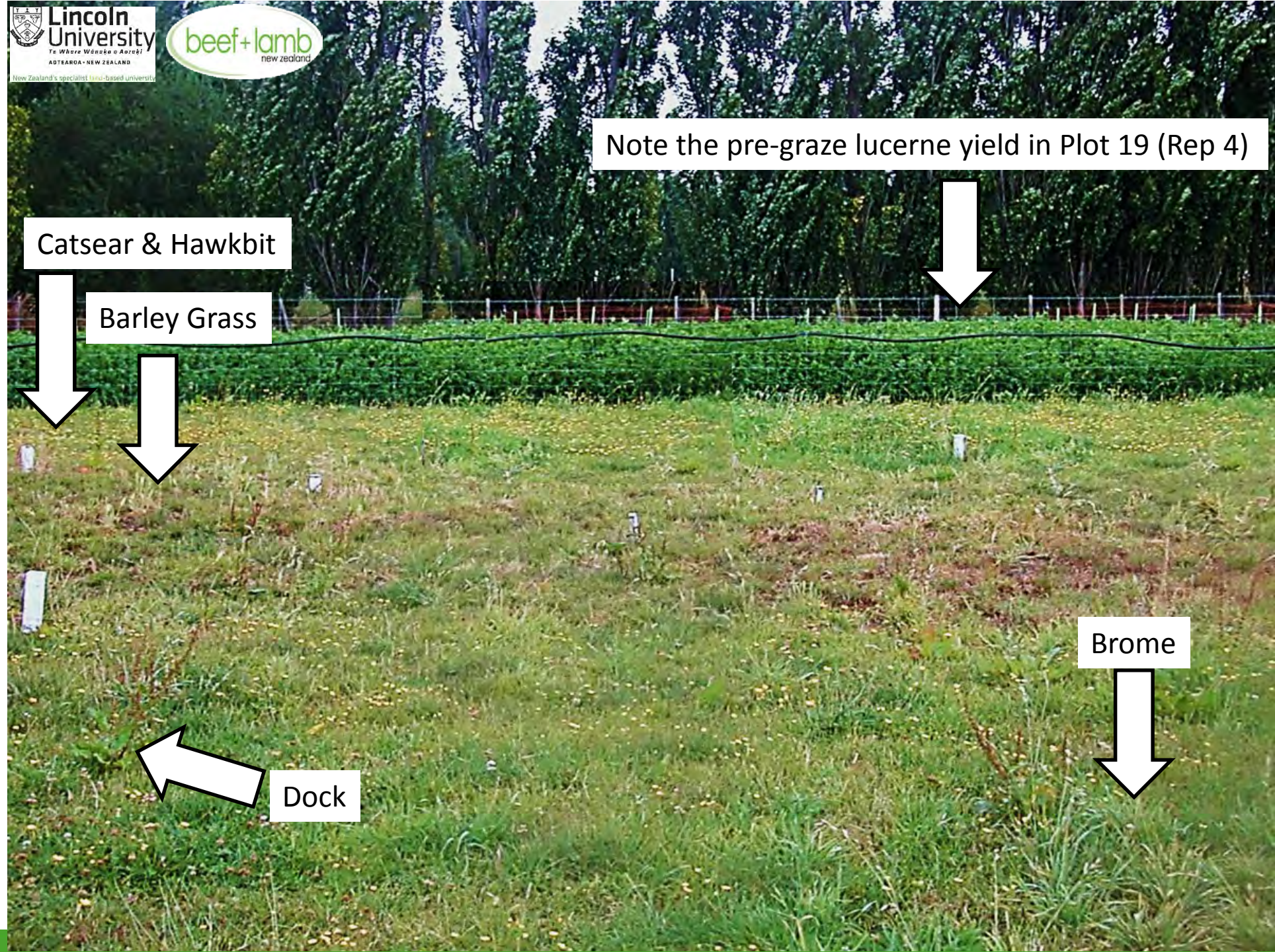
Yr 3 Summer (Feb 2005) RG/Wc

This shows a comparison of RG/Wc in Plot 13 in foreground with the pre-graze lucerne in Plot 19 Luc in background.

At this point perennial weed species have already started to invade the RG/Wc pasture even though annual rainfall was about average and summer rainfall almost 29% about average (180 mm).

The wet summer benefitted the white clover which has its main production period in the warmer summer months.



Yr 5 Spring (Nov 2006) RG/Wc

Two months later the perennial ryegrass has gone reproductive with seedheads visible or reproductive stems elongating.

The pasture is pale green and looks visibly N deficient with a build up of dead material in the base.

Yr 7 Summer (Jan 2009) RG/Wc

This was taken in Plot 21 about 1 month later than the previous photo.

Summer rainfall was about 30% above average and green material is visible beneath the dead reproductive stems.

Few of these appear to be from perennial ryegrass. Yellow flowers of the perennial flatweed catsear (arrows) can be seen throughout the pasture.

Yr 8 Spring (Sept 2009) RG/Wc

By spring of Year 8 the perennial rhizomatous weed yarrow is present.

This is now problematic for pasture renewal because, if cultivated, chunks of the yarrow root can form individual new plants and contaminate newly sown crops or pastures.

In this case the extent of the invasion and the type of weeds present mean the renewal phase may need to be extended to ensure adequate weed control before a new pasture can be established.

Ryegrass is not visible.

Yr 8 Summer (Dec 2009) RG/Wc

Summer rainfall was about 30% below average and the sheep grazing in the background continue to avoid the less palatable dying seedheads of the invading grasses.

There is no evidence of perennial ryegrass seedheads in this image.

Much of the green material is goose grass, *Vulpia* and *Poa annua.*

Yr 9 Winter (Jun 2011) RG/Wc

This is what a RG/Wc clover pasture looks like at the end of nine years in a grazed experiment in a periodically water stressed environment.

There is no evidence of any perennial ryegrass and few white clover leaves.

The majority of the unsown grasses will remain palatable to grazing stock – until they become reproductive or die.

However, stock grazing these pastures (or wind dispersal) could hasten the deterioration of other pastures on a farm by transferring the seeds of these species into other pastures on farm during the course of a rotation.

Cocksfoot/Subterranean clover pastures

This section describes the production and persistence of the CF/Sub pastures from Year 1 (2002/03) to Year 9 (2010/11) through a combination of measured data and photos.

Sub clover…

An annual clover, sub germinates from seed in autumn before growing slowly through winter. Its main production period is Sept-Oct before it flowers, sets seed then buries it and dies. This mechanism is known as **drought avoidance**. The plant survives by avoiding the drought period and regenerating from buried seed in open areas of the pasture following autumn rains.

When the plant dies **nitrogen** is released into the soil as the plant material breaks down and this becomes available to the cocksfoot. Nitrogen is also directly transferred to the other pasture components in urine returns from grazing stock. Sub clover fixes about 25 kg N per ton of clover DM produced – the higher the clover yield the more N enters the system to alleviate N deficiency symptoms in the grass.

To maintain sub clover in the pasture an early close up at 3-4 year intervals will allow the maximum amount of seed to set and replenish the seed bank.

'Antas' sub clover leaf – Mt Benger, North Canterbury
Photo: RJ Lucas

Cocksfoot/Subterranean clover pastures

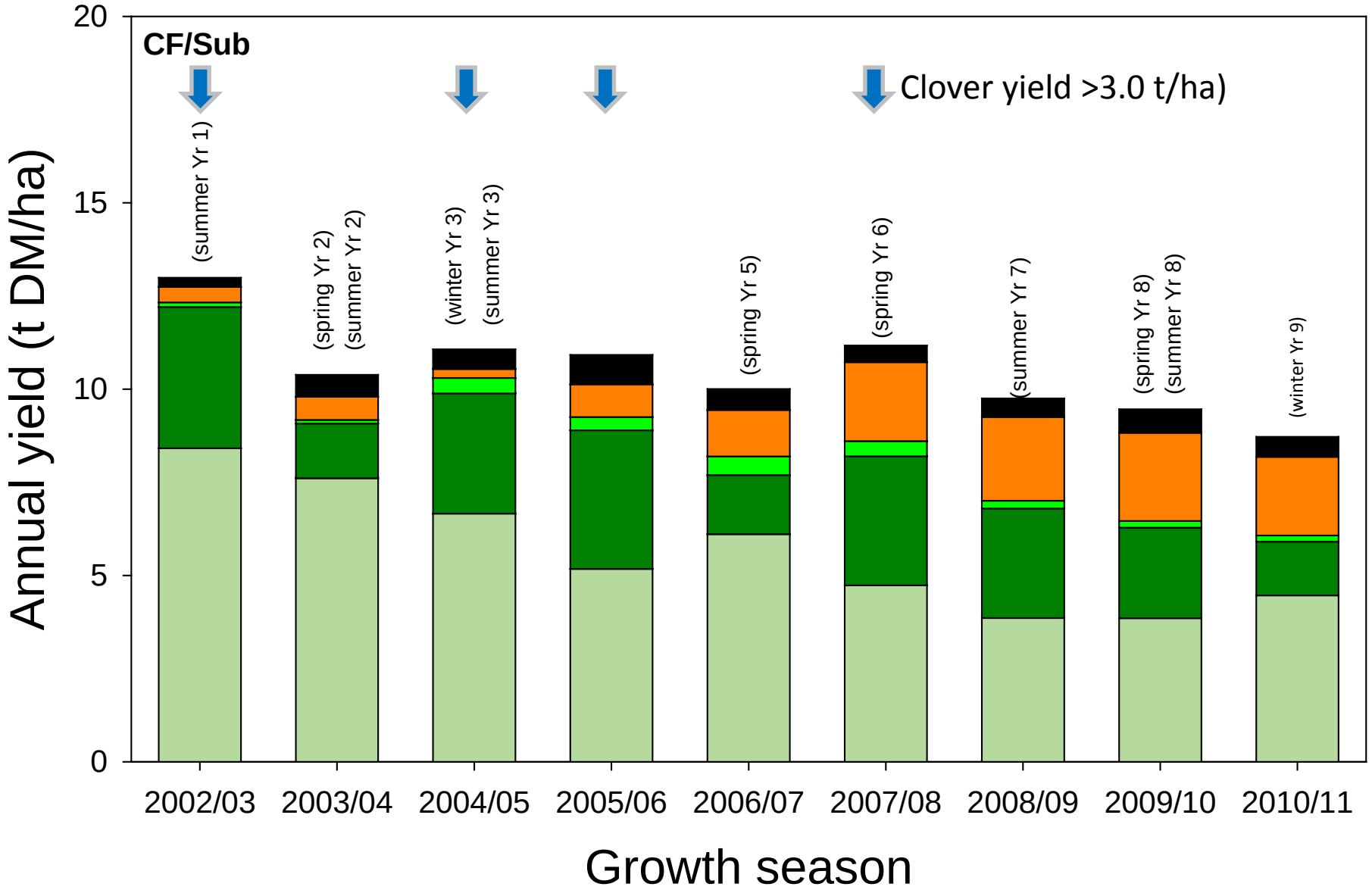
Total yields ranged from 13.0 t/ha (Year 1) to 8.7 t/ha (Year 9).

By Year 9, 67% of the total yield was from the originally sown species.

In four of the nine years the sub clover yield was >3.0 t/ha (blue arrows).

Source: Mills *et al*., 2014a

Figure 4. CF/Sub – Annual Botanical composition



This was the highest yielding of the grass pastures over 9 years.

About 90% of the sub clover yield was produced in the spring period to produce high quality lactation feed.

Sub clover was the best of the companion clovers and managed to persist and survive in a mixture with cocksfoot.

Summary of Figure 4

- The CF/Sub pasture was the most productive and persistent of the grass-based pastures monitored over nine years.

- As with all pastures the total yield declined over time. However, the persistence of the cocksfoot and sub clover meant there was no need to renew the pastures at the end of the experiment.

- These pastures could be overdrilled with 10 kg/ha sub clover plus 1 kg/ha white clover into a hard grazed pasture in autumn. This would stimulate total pasture production by increasing clover content and subsequent N transfer to the cocksfoot component. We recommend 5 kg/ha each of a mid and late flowering sub clover in this environment to allow for year-to-year variation in rainfall. White clover can contribute when summer rainfall allows.

- Previous research by Ates *et al*. (2010) at Ashley Dene has shown overdrilling into grass dominant dryland pastures with sub clover can increase DM production by 40% annually and costs are reduced because full renovation is not necessary. (http://www.grassland.org.nz/publications/nzgrassland_publication_14.pdf)

Yr 2 Summer (Jan 2004) CF/Sub

In the driest summer, a bit of cocksfoot remains green in the CF/Sub pasture compared with the RG/Wc pasture where only a bit of white clover remained green at this time of year.
The quadrat is 0.1 m^2.

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Yr 3 Winter (Jul 2004) CF/Sub

Note the presence of young sub clover plants in winter (following the 2nd natural reseeding – seed produced in the first year has softened enough to germinate following autumn rains).

Sub clover has expanded from the drill rows and has begun to exploit the areas between drill rows.

Total sub clover yield from these plants was >3.2 t DM/ha in Year 3.

Yr 6 Spring (Nov 2007) CF/Sub

A close up of the pasture in the previous photo.

Yr 8 Spring (Sept 2009) CF/Sub

CF/Sub pasture in Plot 5.

In Yr 8 the 2.4 t/ha of yield contributed by sub clover was more than double the clover yield produced from any other grass based pasture.

For the spring period (to 16 Nov 2009) about 40% of the DM yield on offer was sub clover.

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Yr 8 Summer (Dec 2009) CF/Sub

Bare ground is visible following the end of the sub clover lifecycle.

A few barley grass seedheads are visible but it remains a minor component of the pasture compared with the level of invasion observed in the RG/Wc pastures of the same age.

It is important to **hard graze prior to autumn rainfall** to open these bare ground patches for small germinating clover seedlings. Rank, leafy grass pastures will shade out small establishing clover plants and they will not survive.

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Yr 9 Winter (Jun 2011) CF/Sub

This is a CF/Sub clover pasture nine years after establishment.

Cocksfoot remains a major component of the pasture and sub clover can be seen in the base of the sward.

In six of the nine years sub clover contributed 26-32% of all DM produced on an annual basis.

Overdrilling with sub clover in autumn will rejuvenate the pastures and increase total annual production.

Lucerne monocultures

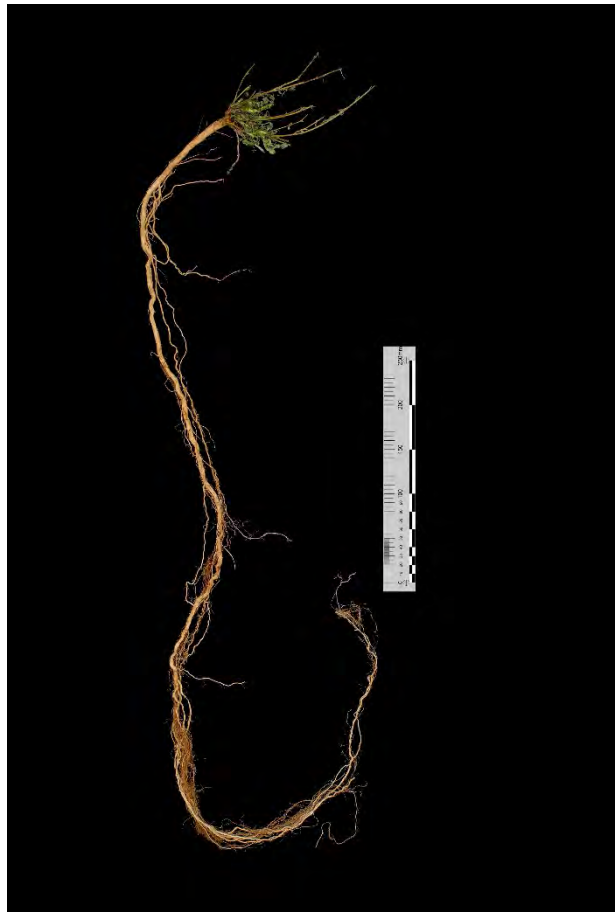
Yield data and photos are used to document the performance of the lucerne monocultures in this section.

Lucerne…

Lucerne is a taprooted, summer active, perennial legume. Its benefit in summer dry regions comes from its deep taproot which allows it to extract water from lower in the soil than grass based pasture species. This allows growth to continue for longer as drought conditions develop.

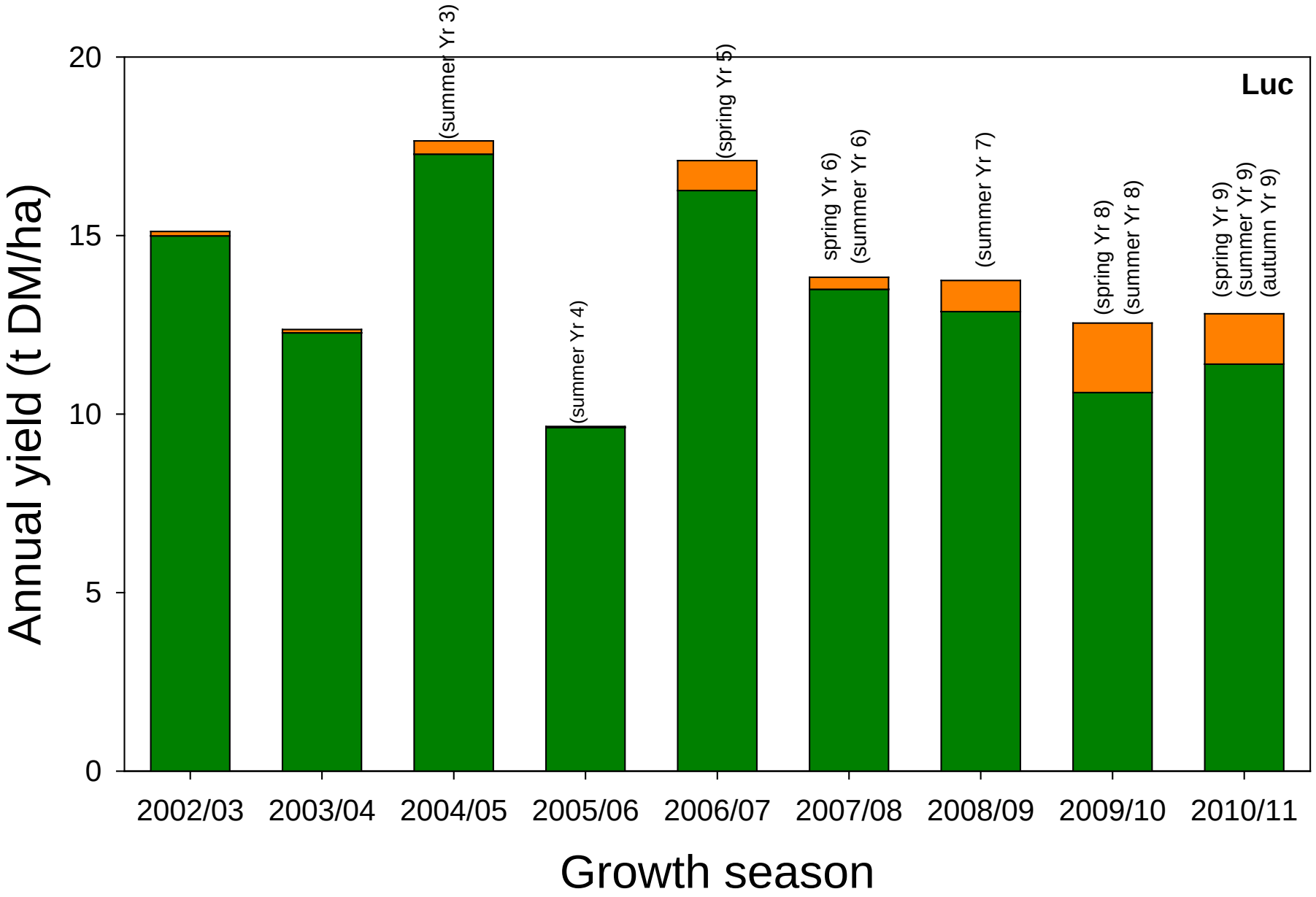
Spring growth is more than expected because carbohydrates stored in the roots are remobilised to boost above ground yields. However, to maintain a productive and persistent stand lucerne must be allowed to flower once after the longest day. It is this environmental trigger which changes the partitioning priority of the plant and carbohydrates are preferentially directed back in the roots to replenish the reserves. Failure to replenish the reserves means there are less reserves for growth in the following spring. A lucerne stand can be destroyed within two years if not managed correctly.

Lucerne was rotationally grazed throughout active growth over nine years and weed control applied in winter when required. Spring grazing was initiated when lucerne in the first paddock reached 20 cm in height.



Lucerne plant with roots – 18 months after sowing
Photo: D. Hollander

Luc – Annual Botanical composition



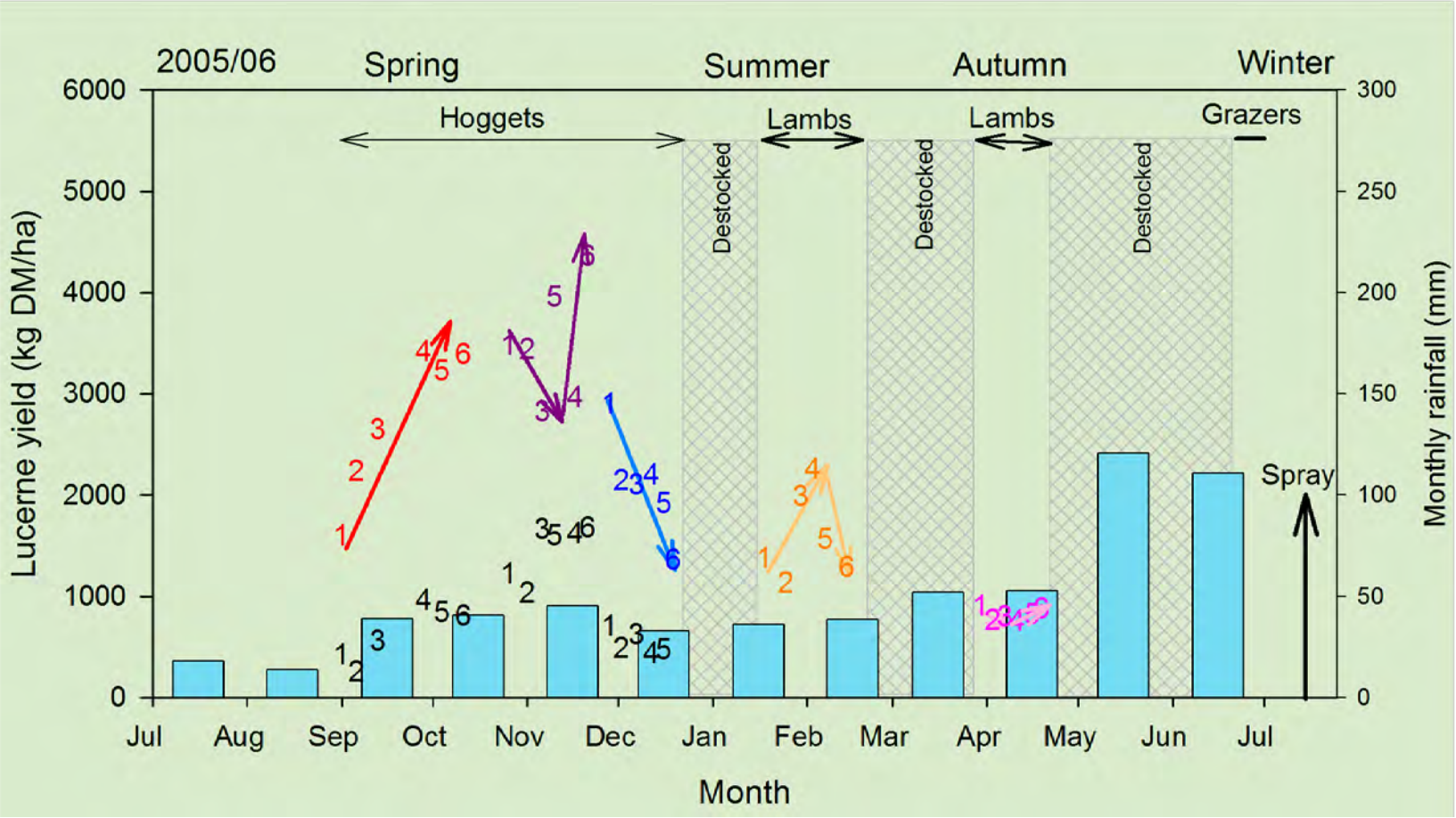
Sown legume
Unsown grasses & dicot weeds
Dead

Lucerne monocultures produced more feed than the grass pastures in most years.

The benefit was mainly seen in summer when lucerne growth continued because it could access soil water from deeper in the soil. Annually, lucerne had higher animal LWt gains per head and per hectare in most years.

Lucerne was treated as a monoculture and winter herbicides were applied to control invading weeds when necessary.

Rotational grazing of lucerne



This shows the pre-grazing yields in the six paddocks (1-6) throughout five grazing rotations in 2005/06 (Year 4).

In the first rotation (red) the yield in paddock 1 was about 1.5 t/ha when grazing started. Growth continued in paddocks 2-6 and increased ahead of the grazing mob to reach about 3.3 t/ha prior to the start of grazing in paddocks 4-6.

In the second rotation (purple) paddocks 3 and 4 had lower production as water stress developed but rainfall allowed paddocks 5 and 6 to recover.

Rotation 3 (blue) was compromised by water stress. In summer a change in partitioning meant above ground yield was reduced as the plant replenished root reserves.

Yields were lowest in Rotation 5 (pink) due to the seasonal decline in temperature.

(Numbers in black are the post-grazing residuals.)

Moot & Smith 2011

Yr 5 Spring (Sept 2006) Luc

In Year 5 total annual lucerne yield was 17.3 t DM/ha compared with grass pastures which yielded 8.4 (CF/Bal) to 10.4 t DM/ha (CF/Sub and CF/Cc pastures).

Yr 7 Summer (Jan 2007) Luc

Also Jan 2007 but later in than the previous photo. This shows Plot 19 (Rep 4) in the foreground during grazing in late Jan 2007 is in the foreground.

Note the destocked, reproductive, drought stressed grass based pastures beyond the lucerne.

Yr 8 Spring (Sept 2009) Luc

First spring grazing with ewes and twin lambs at foot.

Lucerne yield was 12.8 t DM/ha compared with the 6.7 (CF/Wc) to 9.5 t DM/ha (CF/Sub) produced by the grass based pastures.

Rainfall for the Jul-Nov period was 195 mm and almost 30% below average. Summer rainfall was also below average in Year 8.

Yr 8 Summer (Dec 2009) Luc

The lucerne sward has opened up as individual lucerne plants have died over time.

The main perennial weeds invading the lucerne were dandelion and hawkbit and the annual shepherds purse.

Some grass weeds have also established in the lucerne.

Yr 9 Autumn (Mar 2011) Luc

Lucerne in Plot 25 (Rep 5) in full flower to recharge root system. This feed would not be recommended for flushing or mating livestock due to the increase in coumestrol content in reproductive lucerne.

However, non breeding stock will still benefit from eating lucerne which is likely to be of higher quality than other drought stress pastures available on a dryland property at this time.

For this lucerne stand we would now recommend overdrilling with brome or cocksfoot to create a runout mix suitable for grazing with ewes and lambs in early spring.

Conclusions from MaxClover after nine years

- Animal LWG was associated with more dry matter production in spring.
- Lucerne produced more DM than all grass based pastures in most years.
- Its tap-root enabled access to water from lower soil layers but it also used water more efficiently than the grass based pastures - especially in spring.
- CF/Sub clover was the highest yielding grass based pastures in Years 6-9.
- Yields of all pastures declined over time.

MaxClover Publications (to June 2014)

Journal & Conference papers

Brown, H. E., Moot, D. J., Lucas, R. J. and Smith, M. 2006. Sub clover, cocksfoot and lucerne combine to improve dryland stock production. *Proceedings of the New Zealand Grassland Association*, **68**, 109-115.

Lucas, R. J., Smith, M. C., Jarvis, P., Mills, A. and Moot, D. J. 2010. Nitrogen fixation by subterranean and white clovers in dryland cocksfoot pastures. *Proceedings of the New Zealand Grassland Association*, **72**, 141-146.

Mills, A., Lucas, R. J. and Moot, D. J. 2014. 'MaxClover' Grazing Experiment: I. Annual yields, botanical composition and growth rates of six dryland pastures over nine years. *Grass and Forage Science*, ***In Press***. (DOI: 10.1111/gfs.12132)

Mills, A., Lucas, R. J. and Moot, D. J. 2014. 'MaxClover' Grazing Experiment: 2. Annual and seasonal sheep liveweight production from six grazed dryland pastures over eight growth seasons. New Zealand Journal of Agricultural Science, *Submitted for review.*

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Mills, A., Smith, M. C., Lucas, R. J. and Moot, D. J. 2008. Dryland pasture yields and botanical composition over five years under sheep grazing in Canterbury. *Proceedings of the New Zealand Grassland Association*, **70**, 37-44.

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Moot, D. J. and Smith, M. 2011. Practical Lucerne Management Guide. 9 pp. http://www.lincoln.ac.nz/Documents/Dryland-Pasture-Research/presentations/Lucerne-management-guide-Col.pdf.

Teixeira, E. I., Moot, D. J. and Mickelbart, M. V. 2007. Seasonal patterns of root C and N reserves of lucerne crops (*Medicago sativa* L.) grown in a temperate climate were affected by defoliation regime. *European Journal of Agronomy*, **26**, 10-20.

Tonmukaykul, N., Moot, D. J. and Mills, A. 2009. Spring water use efficiency of six dryland pastures in Canterbury. *Proceedings of the Agronomy Society of New Zealand*, **39**, 81-94.

MaxClover Publications (cont.)

(to June 2014)

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Thesis/Dissertations

- Ates, S. 2009. *Productivity, botanical composition and insect population of seven dryland pasture species in Canterbury after eight years.* PhD thesis, Lincoln University, Canterbury. 189 pp.
- Buckley, C. 2002. Sociability of four clover species during pasture establishment. B.Ag.Sci (Hons) dissertation, Lincoln University, Canterbury. 103 pp.
- Monks, D.P. 2009. *The vegetative and reproductive development of balansa clover.* PhD thesis, Lincoln University, Canterbury. 164 pp.
- Morris, N.J. 2010. *Productivity, botanical composition and insect population of seven dryland pasture species in Canterbury after eight years.* M.Ag.Sci thesis, Lincoln University, Canterbury. 93 pp.
- Sangster-Ward, J. 2003. The timing of autumn rain affects cool season performance of clover species grown with cocksfoot. B.Sci. dissertation, Lincoln University, Canterbury, 90 pp.
- Tonmukayakul, N. *Water use efficiency of six dryland pastures in Canterbury. M.Ag.Sci. Thesis, Lincoln University, Canterbury. 73 pp.*

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Timaru
5th September 2014

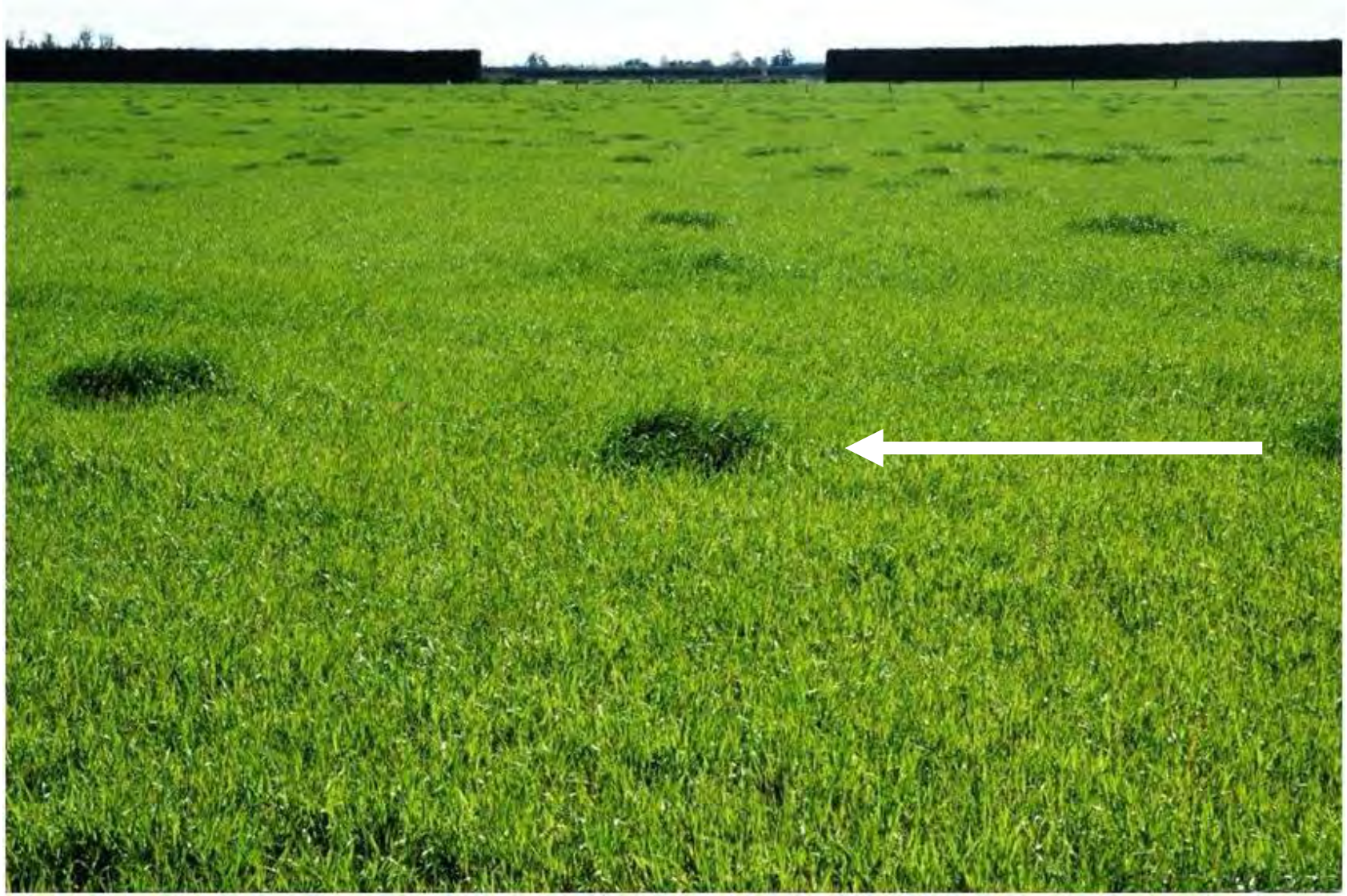
Pasture (legume) establishment

Dr Derrick Moot
Professor of Plant Science

Water and nitrogen = ryegrass

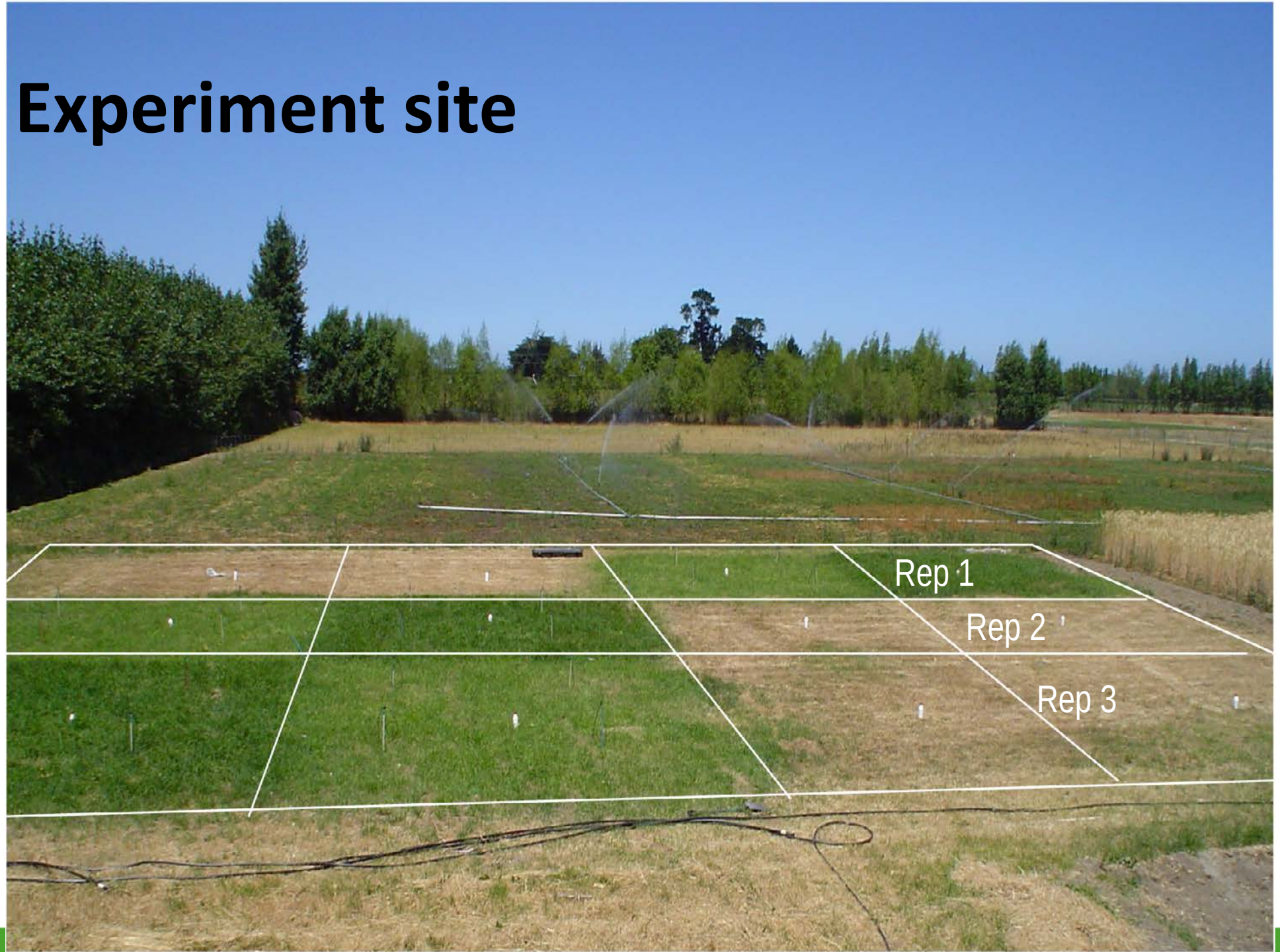
Photo: Dr WR Scott
Lincoln University

Nitrogen deficient pasture

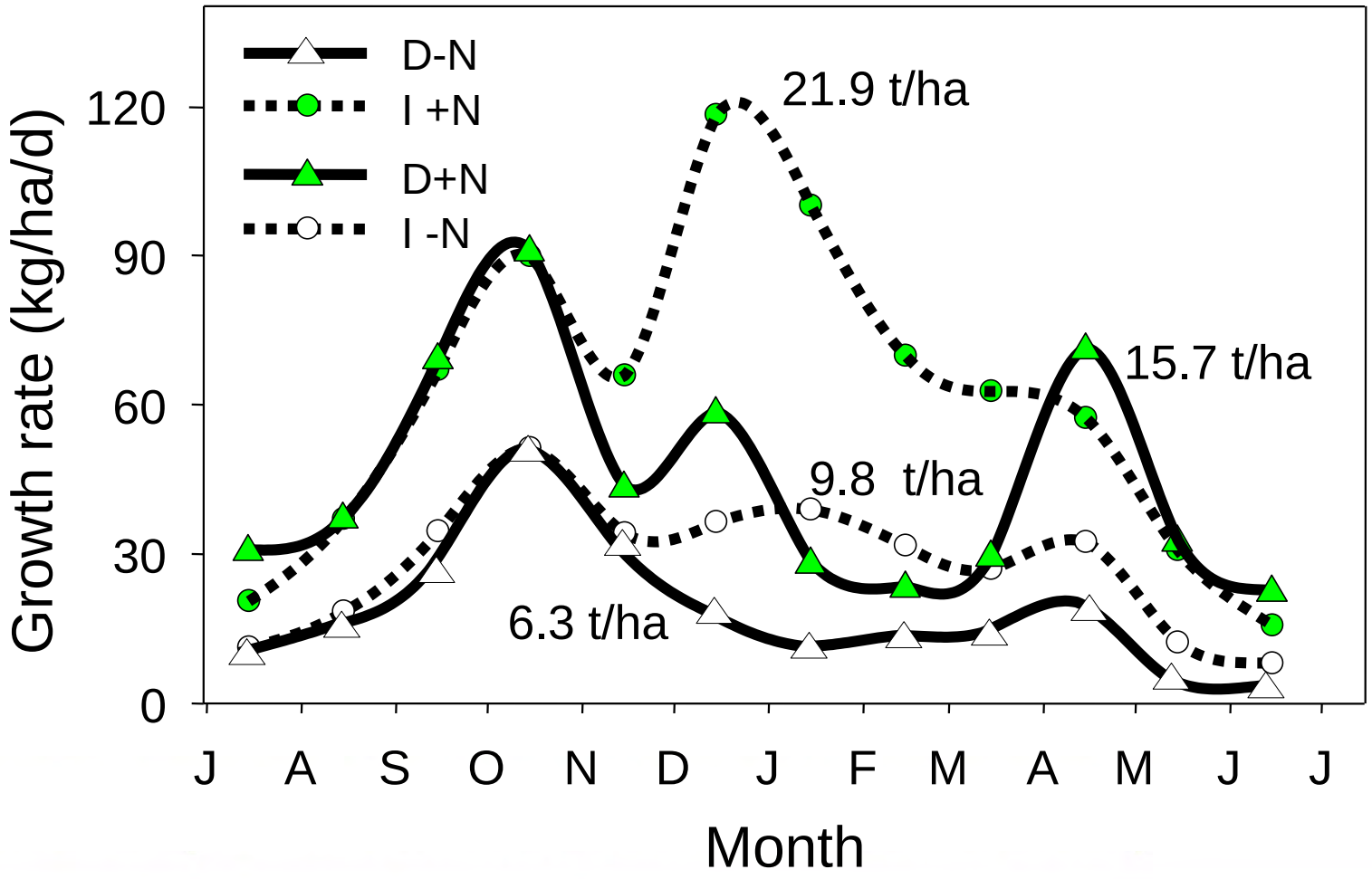


1000 kg N/ha

Experiment site



Growth rates (2 year means)



Mills *et al.* 2006

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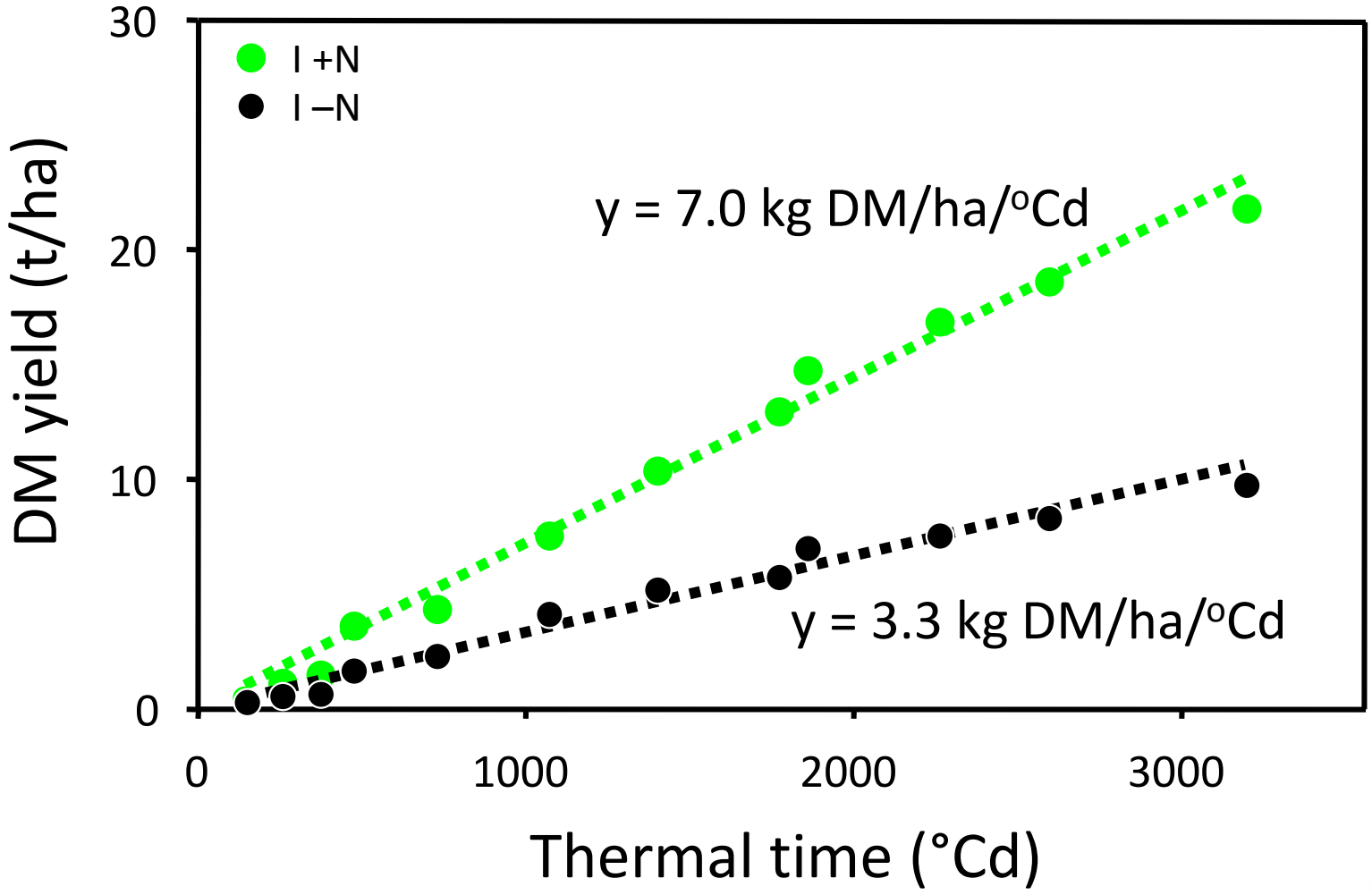
Winter

⇒ temperature response

The Nitrogen gap



21.9 t/ha

9.8 t/ha

Mills *et al*. 2006; 2009

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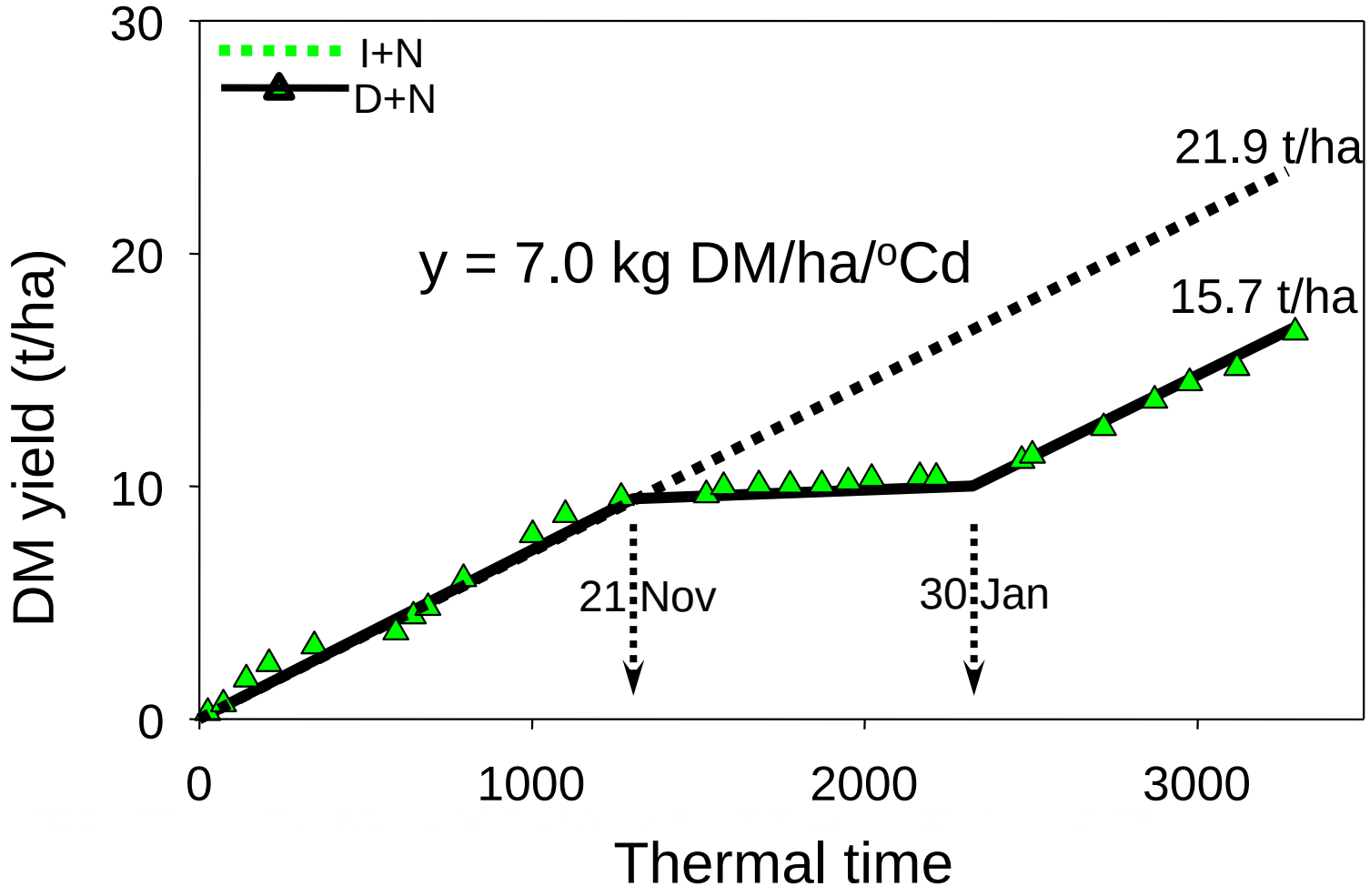
Summer

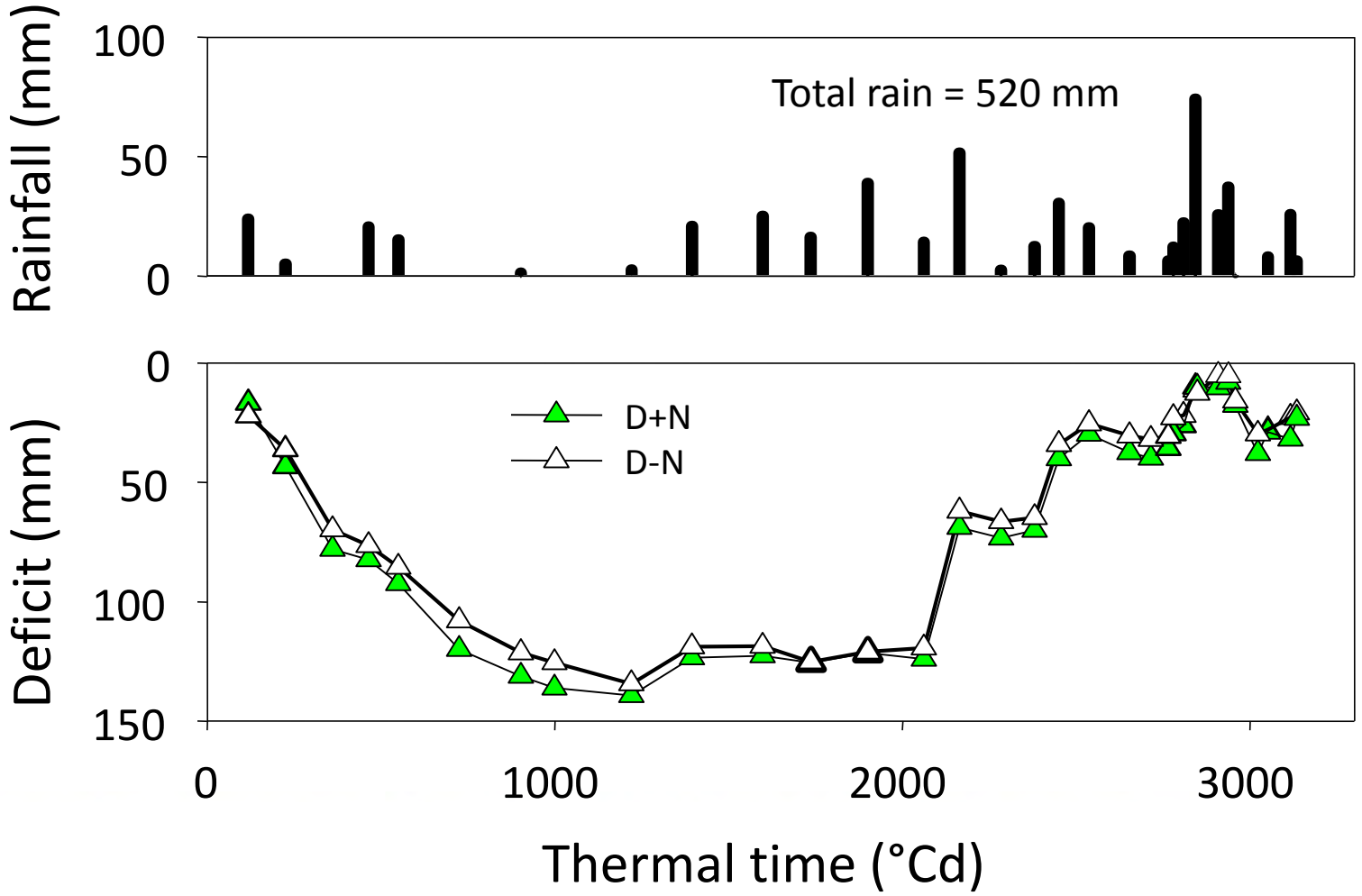
⇒ moisture response

Water stress effect on yield



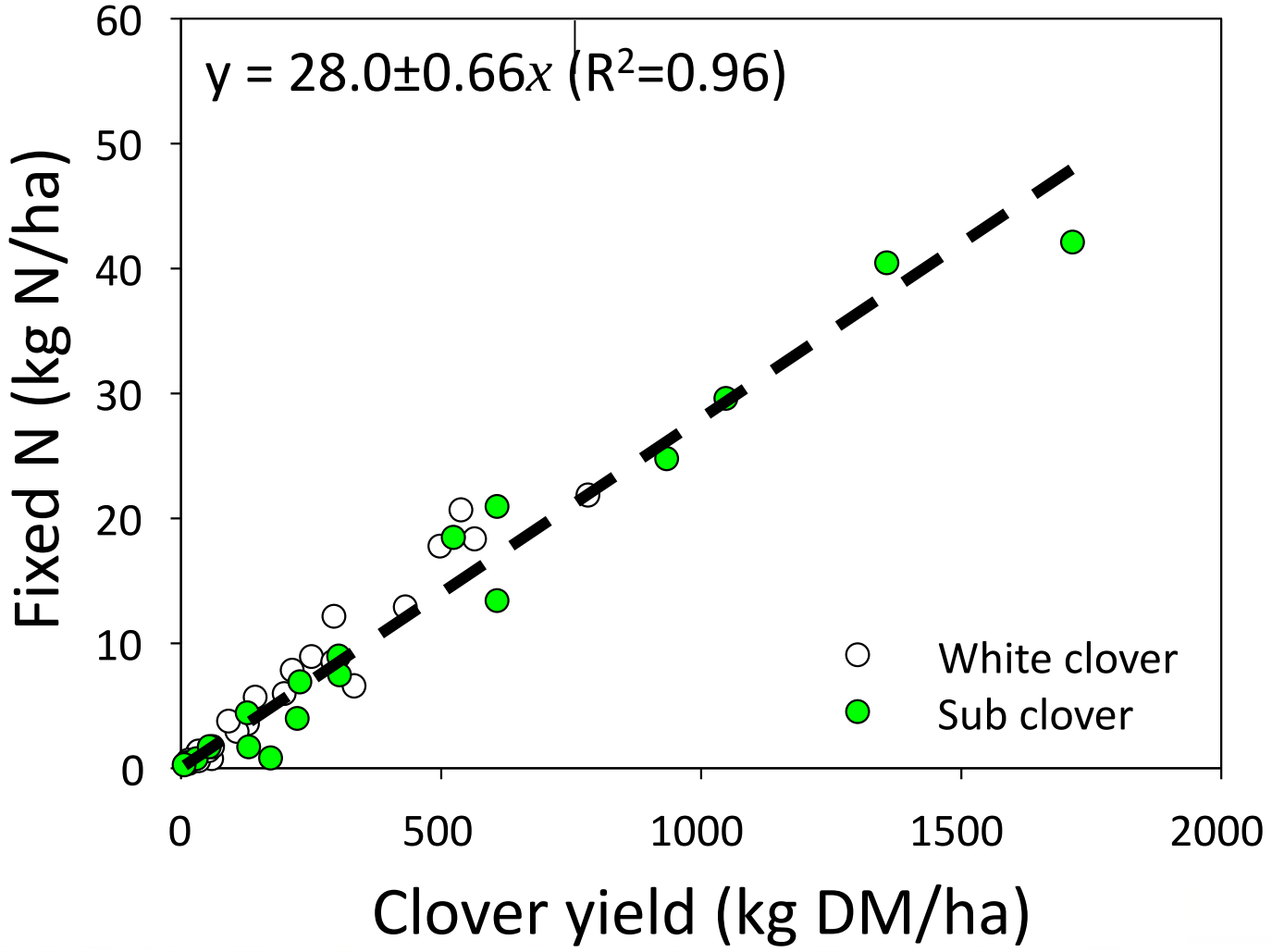
Mills *et al.* 2006

Soil moisture deficit 2003/04



Nitrogen fixation
25 kg N/t DM

Biological N fixation



Lucas *et al.* 2010

Nitrogen fertiliser use

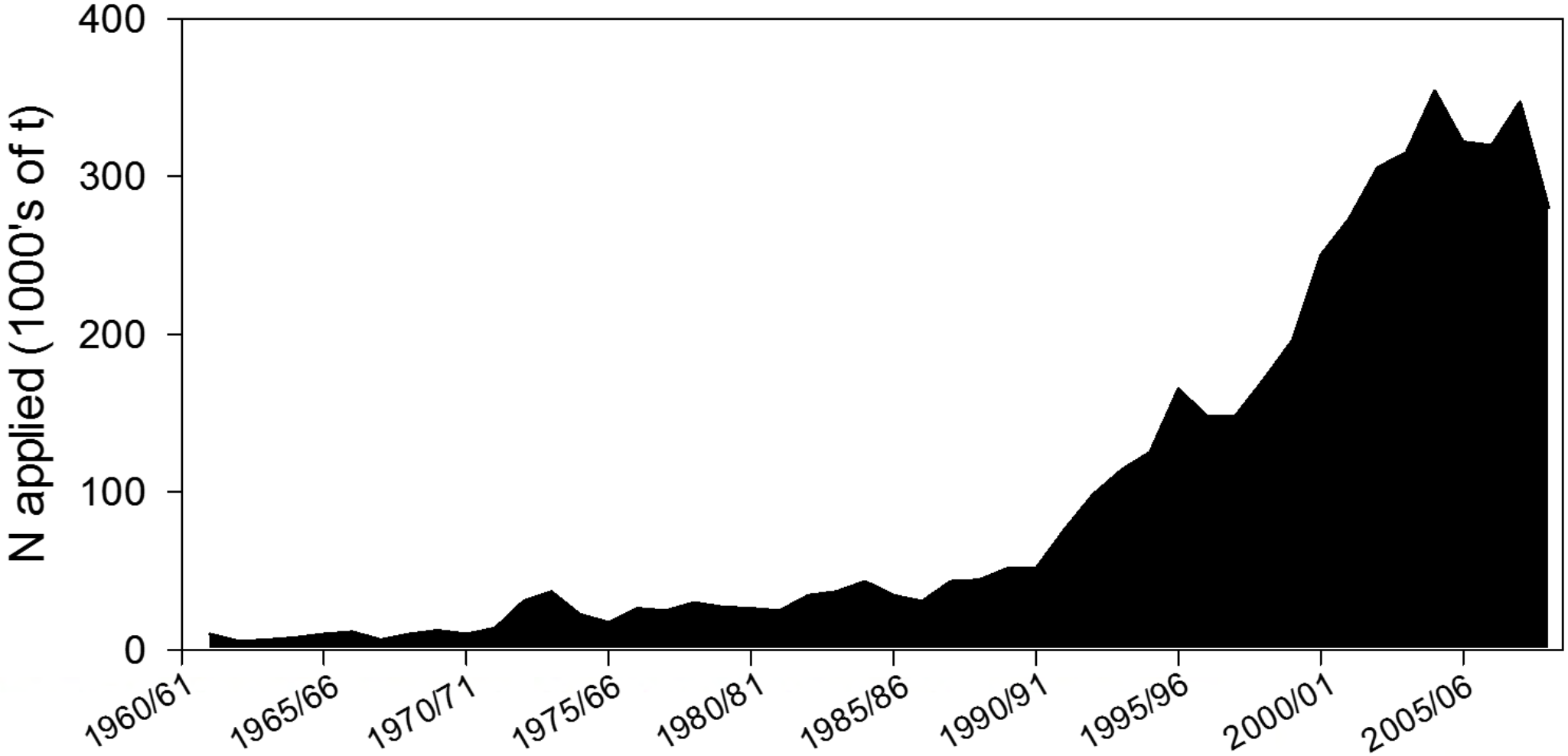


Photo: A Black

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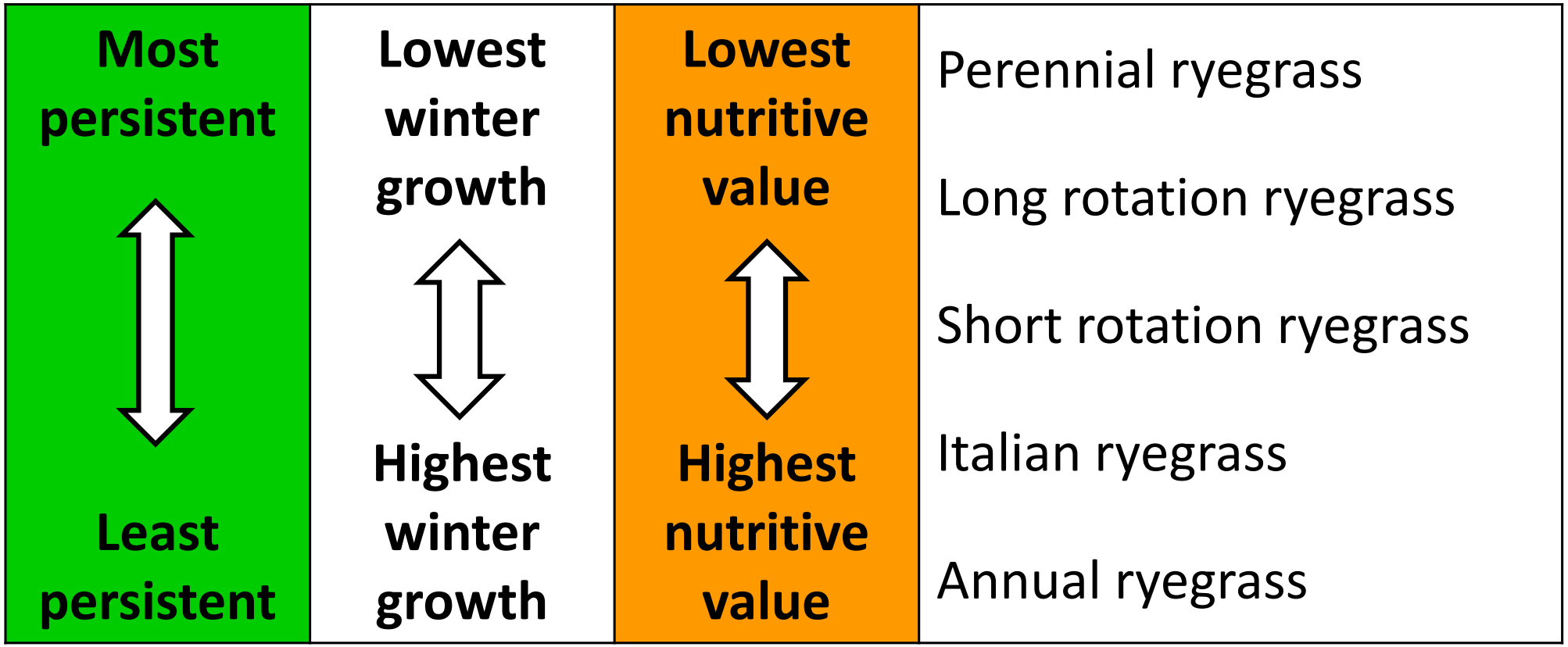
The ryegrass continuum



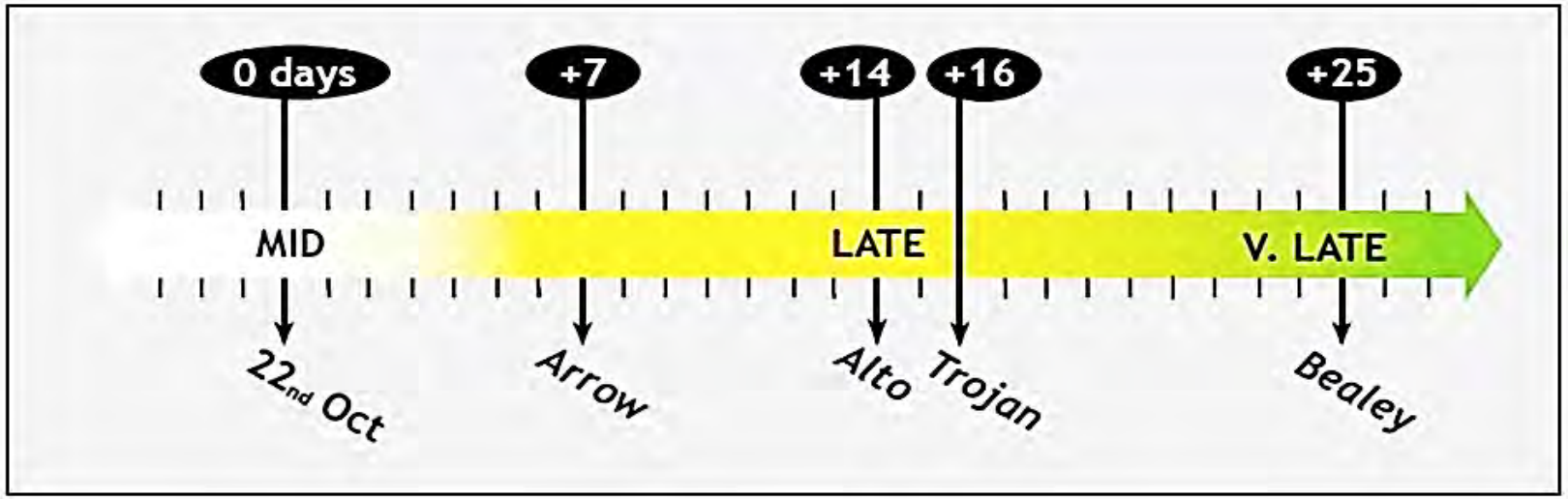
Ryegrass endophyte strains

Endophyte strain	Peramine	Lolitrem B	Ergovaline	Janthitrems
Standard	High	High	High	-
Without	-	-	-	-
Endo5	High	-	Low	-
AR1	High	-	-	-
NEA2 or NEA	Low	Low*	Low-medium*	-
AR37	-	-	-	High

- = none produced; * depends on the specific endophyte strain(s), and ratio of strains, in the mix

Heading date

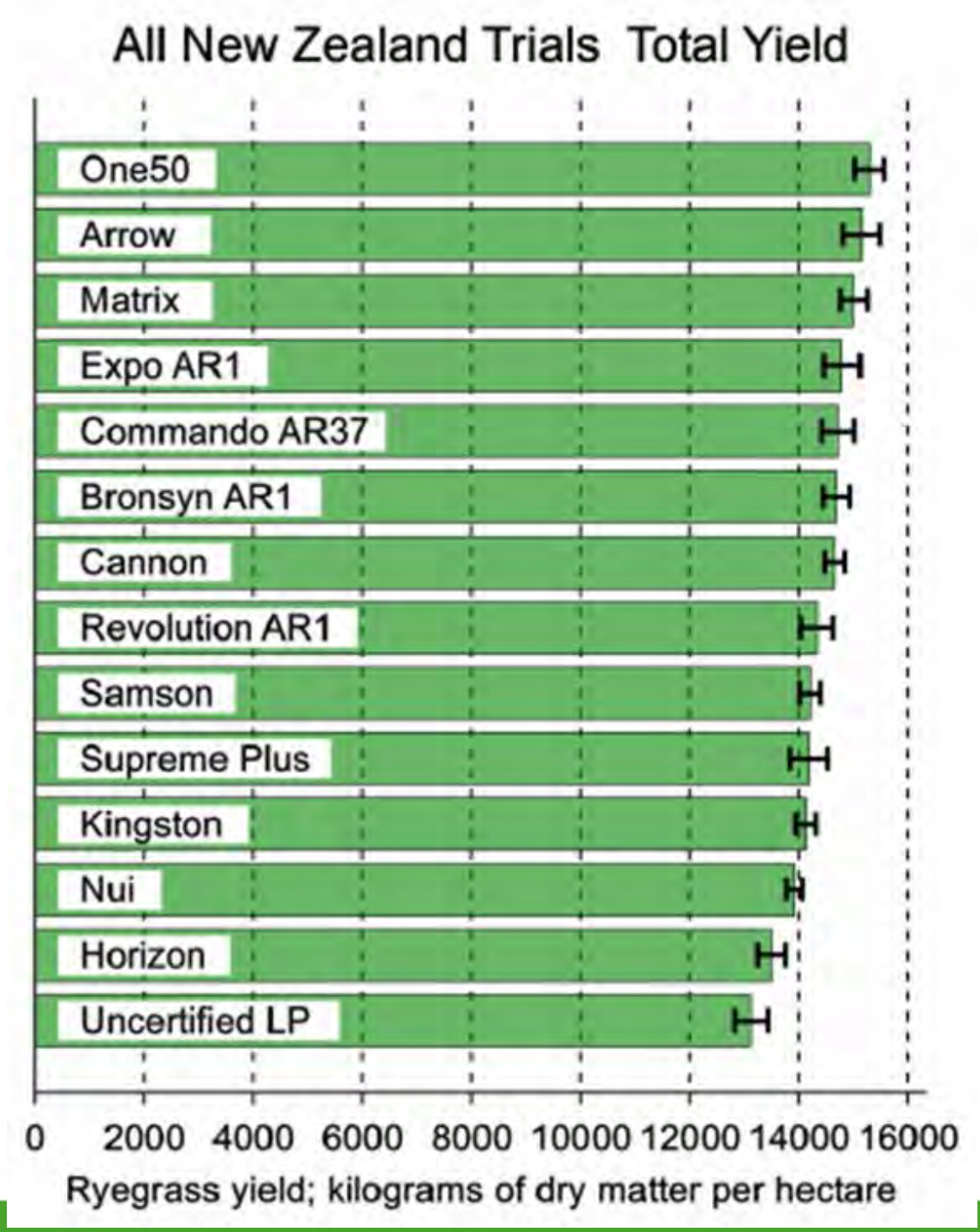
- Heading = flowering time in spring.
- Early heading - higher early spring growth.
- Late heading - late spring quality.



Source: www.agriseeds.co.nz

Forage variety trials

Photo: A Black



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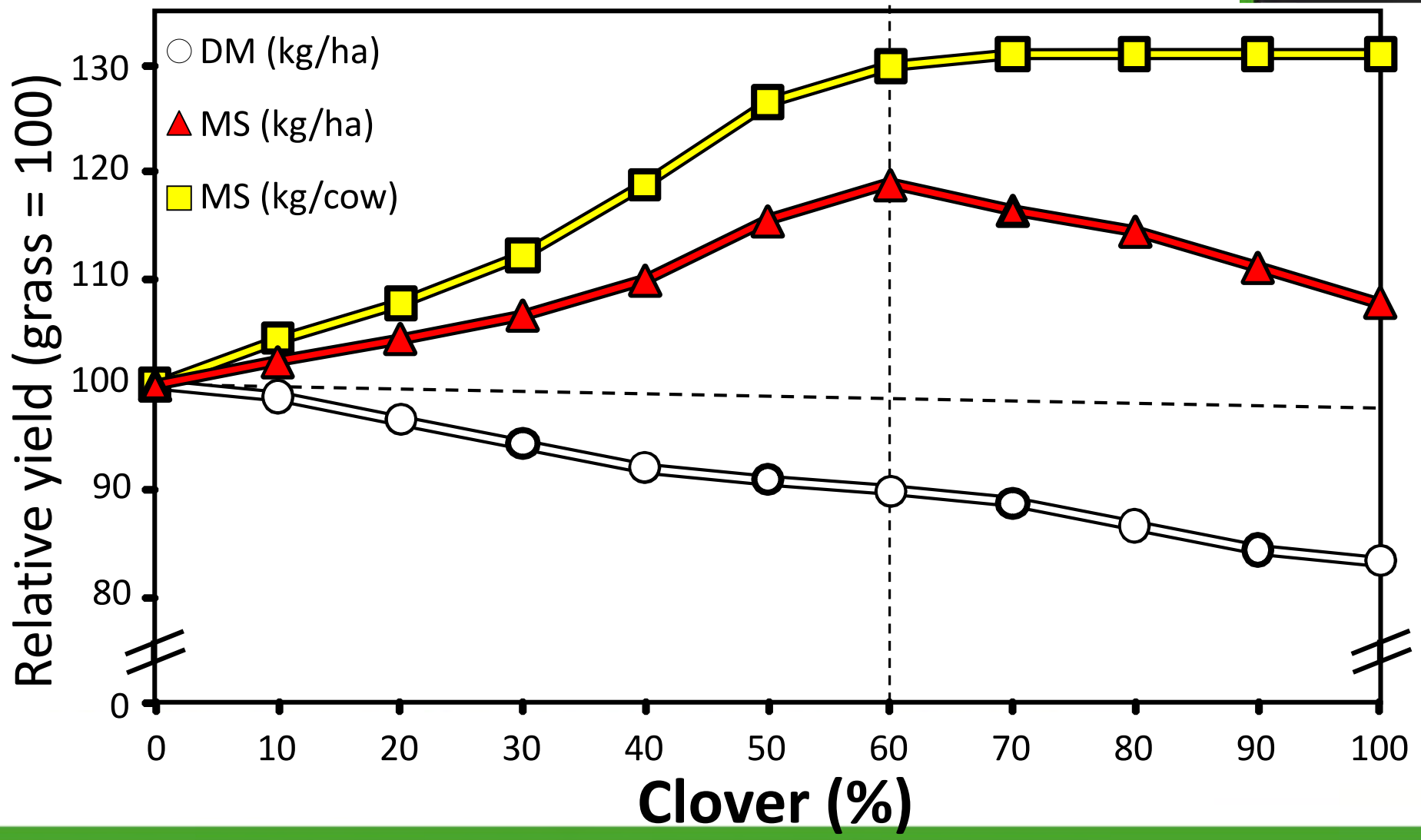
Perennial ryegrass cultivars

Source: National Forage Variety Trials (www.nzpbra.org)

Sheep prefer 70% legume, 30% grass

Photo: Jo Grigg
'Tempello' Marlborough

Clover content & milksolids production



Cosgrove, 2005 - SIDE

High feeding value pastures have;

- **high legume content**
- **high leaf content**
- **low stem content**
- **young herbage age**


40% white clover

How to get more legume??

- Grass is a WEED!!!!! (in the eyes of clover)
- Understand competition: - Grass vs. Legume
  - Grazing preference
  - N, P, S, K – grass has more roots
  - Water – deep rooted perennials
  - Light – taller legumes?
- Management: -
  - Sow legume friendly grasses at low seeding rates
  - Grow legumes alone, overdrill grasses later?
  - Use a range of legume species & cultivars
  - Avoid N fertiliser on actively growing legume pastures

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Olsen P>20

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Olsen P<6

Photos: A Black

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White clover @ 4 weeks after sowing

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Perennial ryegrass @ 4 weeks after sowing

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Italian ryegrass @ 4 weeks after sowing

White clover

- Small seed (0.63 mg)
- Rapid germination and emergence but:
- Small seedling – needs light to produce leaves

- Establishment experiment (chicory 1.5 kg/ha)

  Dates = 4/2, 26/2, 19/3, 9/4

  Rates = 0, 4, 8, 12, 16 kg/ha ryegrass

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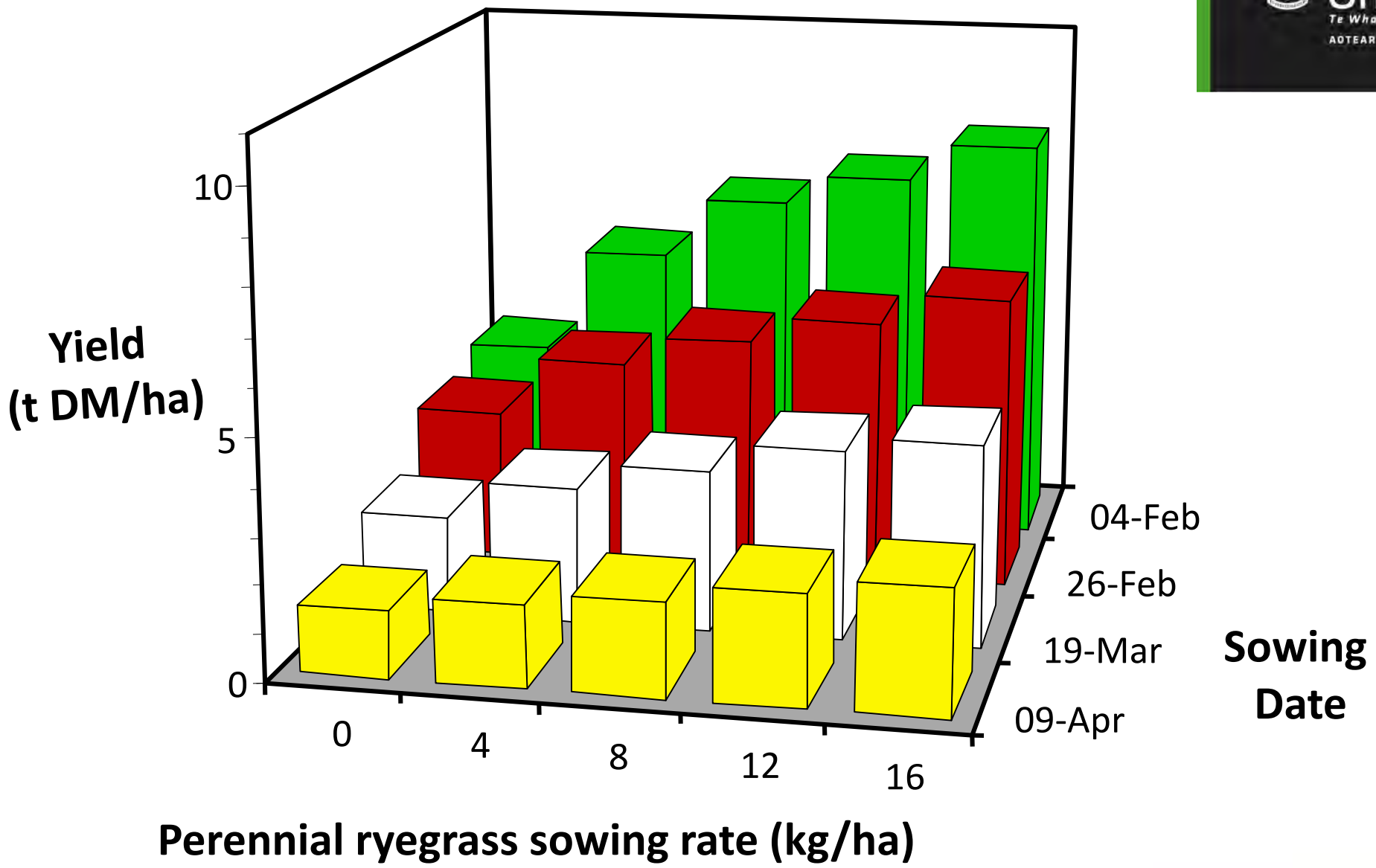
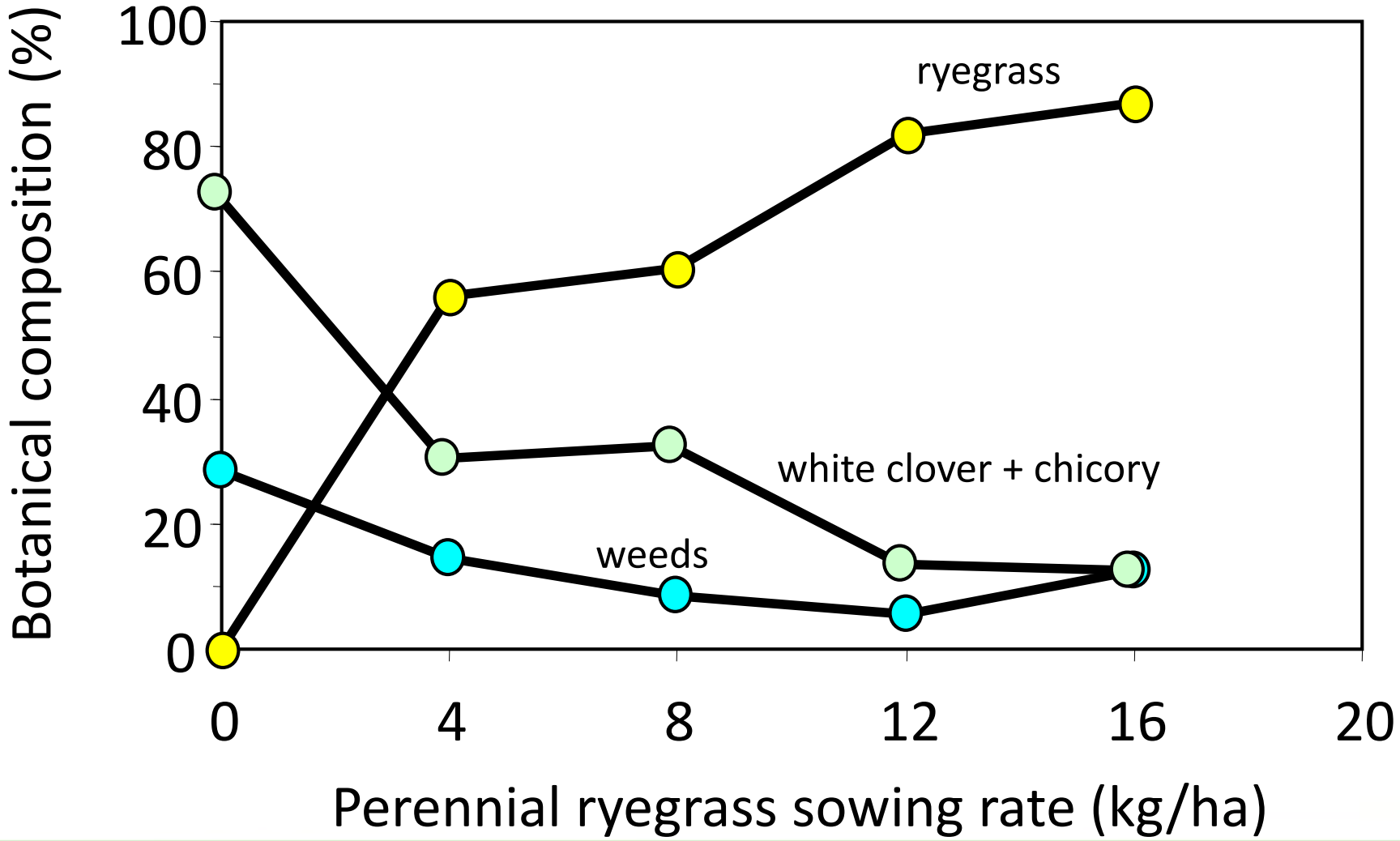
Ryegrass sowing rate

Total yield in Year 1 (25/9)

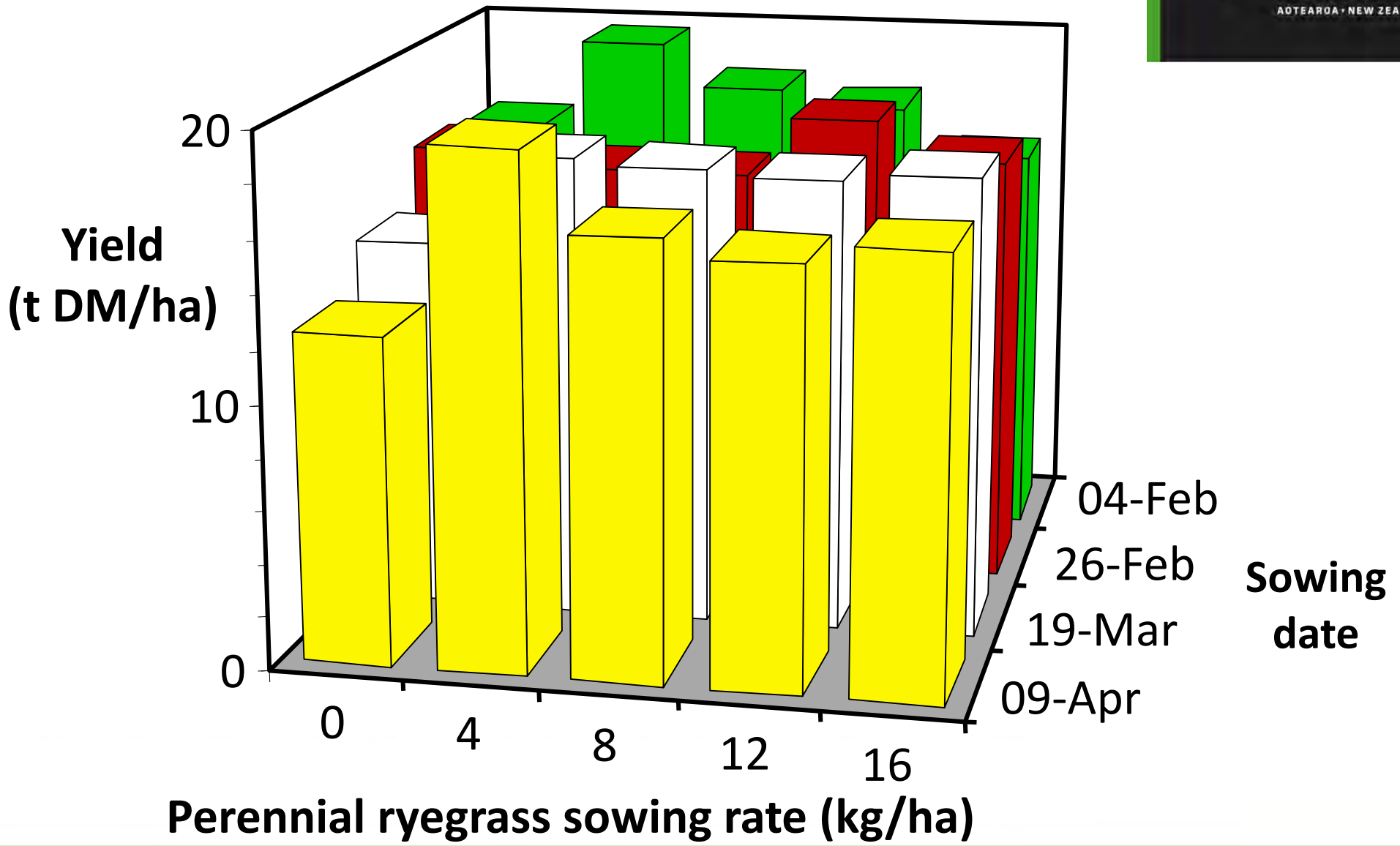


Botanical composition



Dumbleton, 1997

Total yield in Year 2



Nicholls 1998

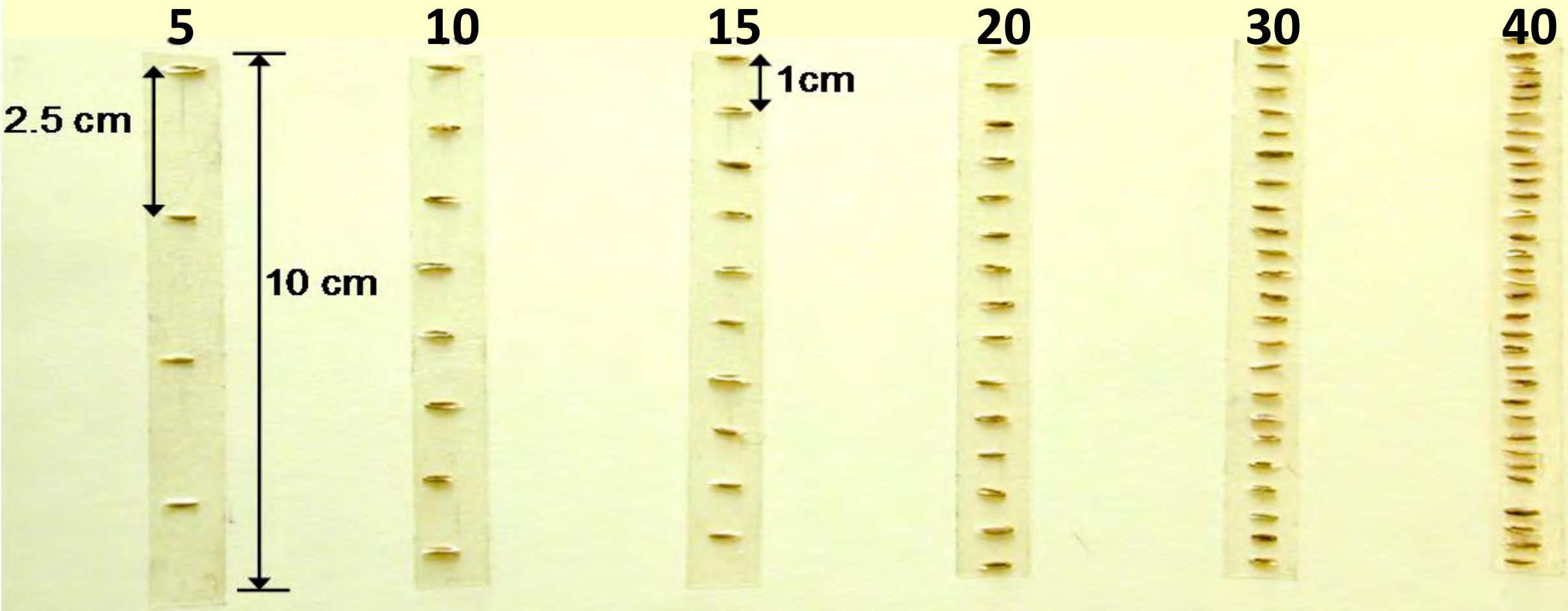
Number of seeds sown /m²

Ryegrass sowing rate	Ryegrass (seeds/m²)	White clover (3 kg/ha)	Chicory (1.5 kg/ha)	Total (seeds/m²)
0	0	420	120	540
4	200	420	120	740
8	400	420	120	940
12	600	420	120	1140
16	800	420	120	1340
20	1000	420	120	1540

Perennial Ryegrass Seed Spacings

15 cm Drill Rows

Sowing rates (kg/ha)



Summary: White clover

- Autumn sowing
  - soil temperature >14°C
- Drilled with 4-8 kg/ha ryegrass in a well prepared seed bed!
- Nutrients (P) maintained
- Manage for white clover (18 months) and each spring!
- Chicory and plantain increase complexity of weed control

Caucasian clover

- Germination and emergence = RG/Wc but:
- Slow seedling development (leaf appearance)
- Why bother?

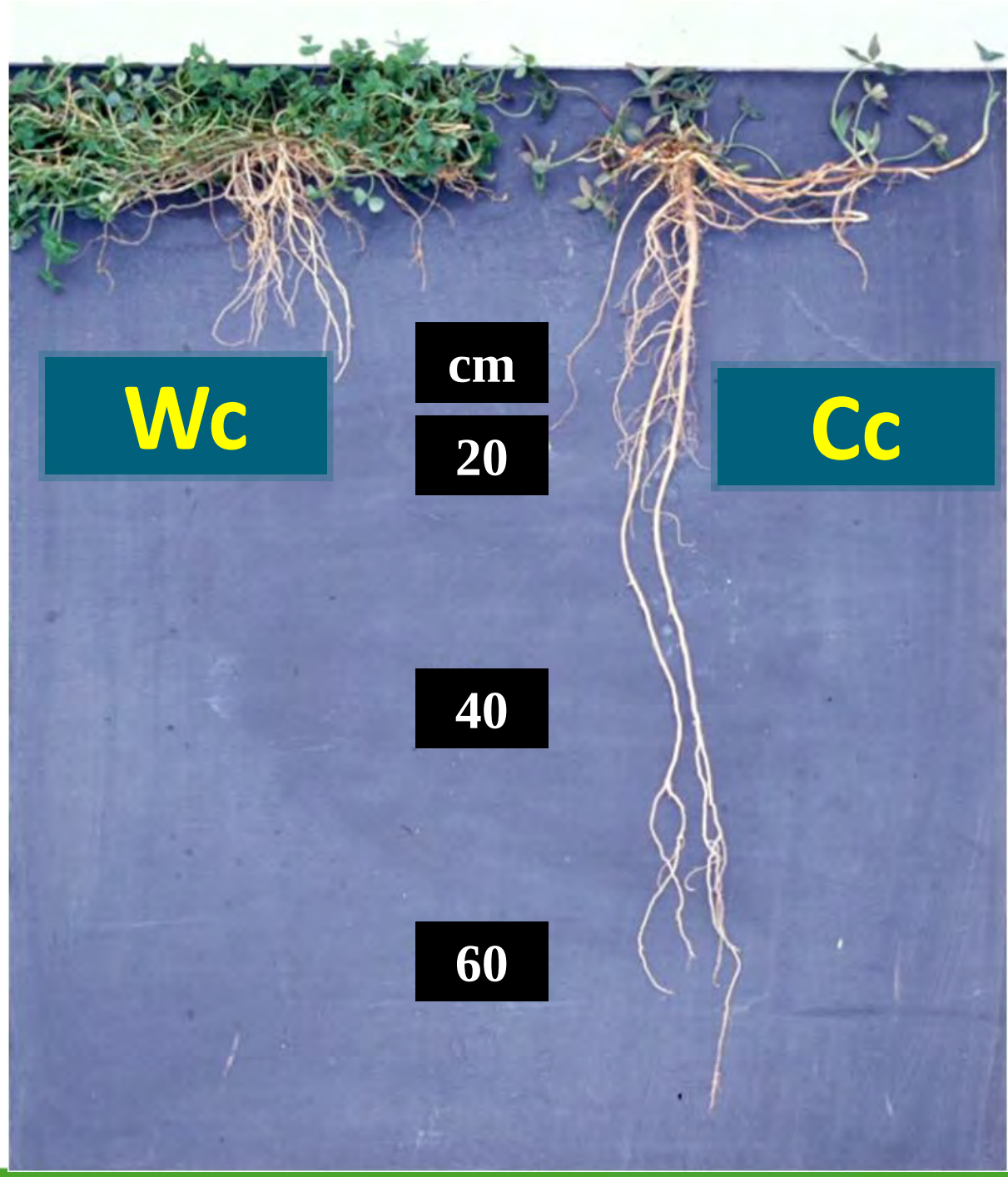
Growth in the field

20 month old white clover plants – grazed by sheep

Widdup *et al*. 2003

agresearch

2 years after sowing



Seedlings at 28 DAS

Hurst *et al*. 2000

9 year old pasture

Tall fescue/Caucasian

90% cover, 60% clover DM on offer

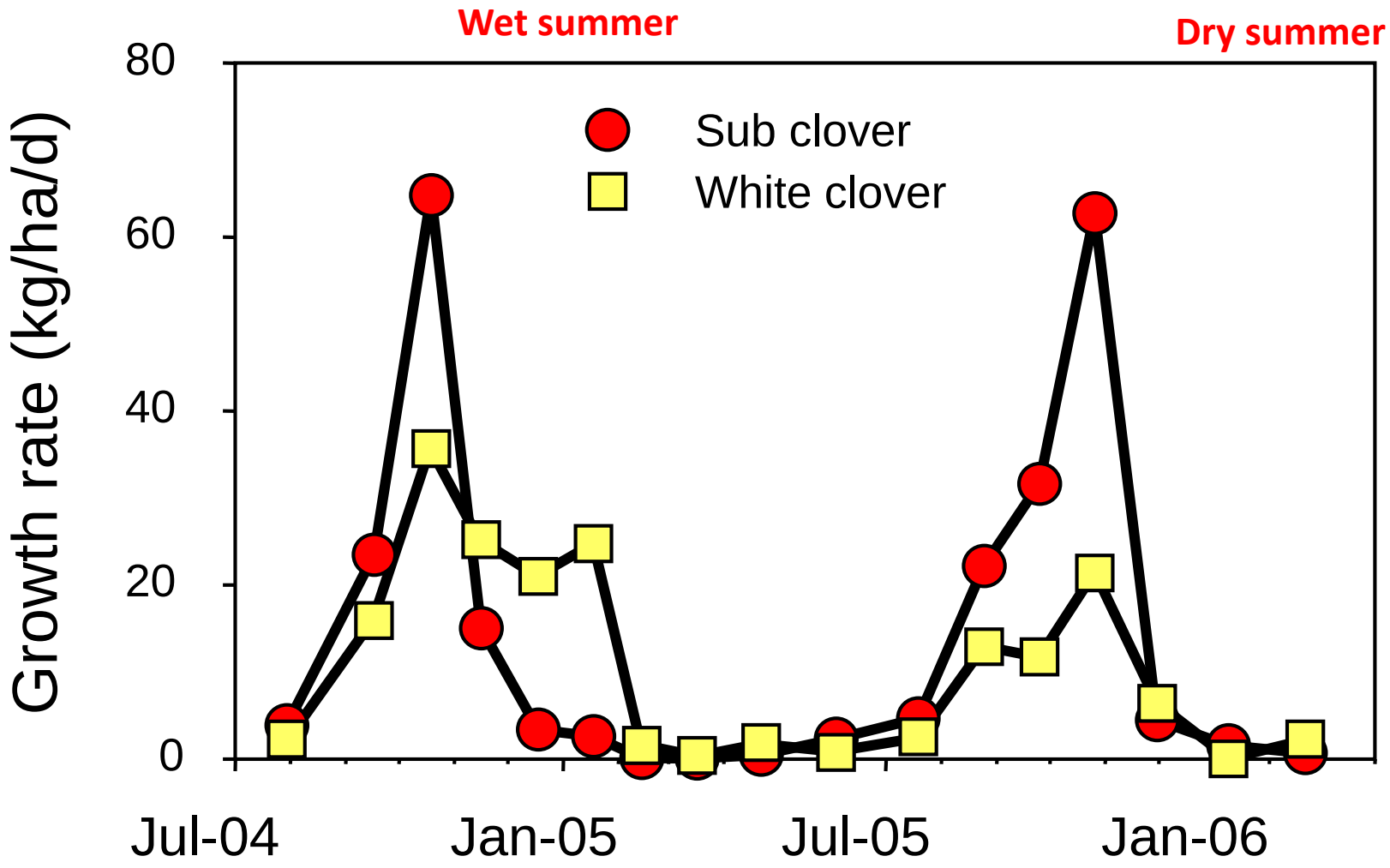

Temporal separation

Sub clover grazing management

Subterranean Clover

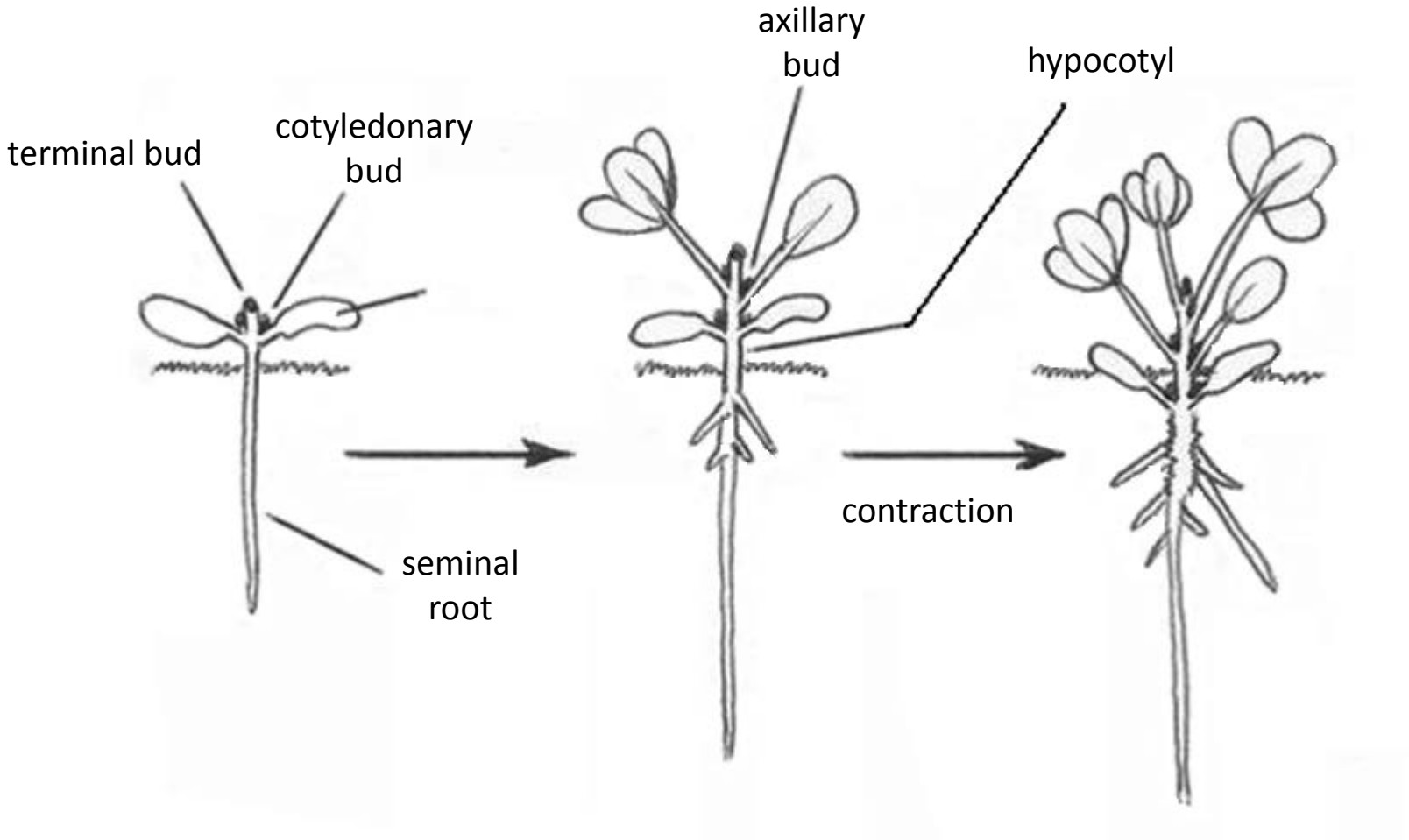
- Large seed, 10x Wc therefore 10x sowing rate
- Winter annual – autumn sow soil temp. <11°C
- Rapid but variable germination with rainfall from Jan-May
- When can seedlings be grazed in autumn?
- How to maximize summer seed set

Seasonal clover growth



Brown *et al*. 2006

Seedling Development



Thomas 2003

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- *Direct drill before rain*
- *Initial population for seed build up*

Autumn Management in later years

(200 seedlings/m^2 in pasture)

- High strikes after extended hot periods
  - bare ground for seedlings to establish in
  - high temperatures break dormancy
- January rains are often false break
  - seedlings die (March is usual)
- Amount of cover in autumn is crucial


seedling


1. 4. 2003


5. 4. 2003

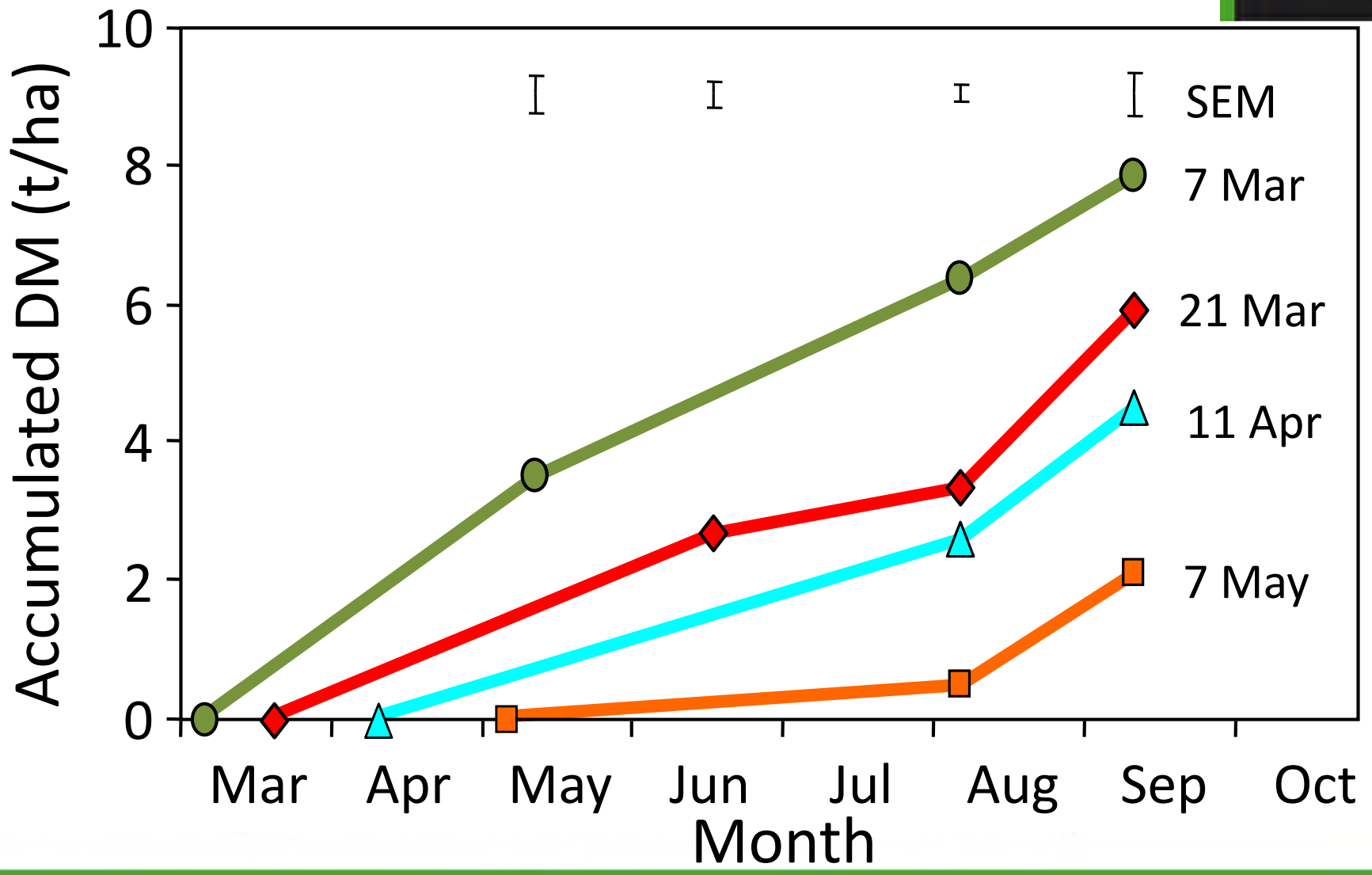

9. 4. 2003


12. 4. 2003

Seedling density is what gives us fast recovery

Costello & Costello 2003

Dry matter yields



Costello & Costello 2003

Takes several years to build seed reserves

Dryland Pasture Mix

- 8 kg/ha AR1 or AR37 Ryegrass
- 6-10 kg/ha subterranean clover
  - early and late flowering cultivars
- 1.5 kg/ha White clover
- 1 kg/ha Cocksfoot

- Hill country = 10 kg/ha sub (2 flowering dates)
- Direct drill into grass dominant swards

Tempello

David & Joanna Grigg

- Website: www.lincoln.ac.nz/dryland
- Field Day handouts and presentations page (18 June 2012)

Photo: Jo Grigg
Tempello

Tempello

- 4800 ha steep/rolling hill (2600 effective)
- 4500 sheep su
- 5200 cattle su
- Sub-clover key legume
- Any summer legume …. a bonus

Tempello - commentary

- We are a semi extensive property with the main development opportunities lying in further sub division on the hill country.
- Sub-clover is our predominant legume species on the hill country. This was first established in the 70s through aerial oversowing and top dressing. RATES for the oldies amongst us were 2 pounds white clover and 3 pounds sub clover and 20 ryegrass to the acre. Translated for those born in the modern era this is around 3 kg white clover 4.5 of sub and 24 ryegrass. This was sown with 600 kg per ha of potash super. Cultivars of sub used were Mt Barker and Woogenellup
- Our hill blocks range from Olsen P of 10 to 18 and the soil pH range is 5.5 to 6.
- Generally our sulphur levels are good ranging from 7 - 10.
- Of latter years our fertiliser focus has changed to a lime sulphur viaphos application with added trace elements to create the right balance.

Woog is by far the more dominant of the two major species of sub

Photo: Keith Pollock
Lincoln University

Woogenellup sub clover

Mt Barker is the other cultivar characterised by the red bands on the flowers

Photo: Keith Pollock
Lincoln University

Mt Barker sub clover

How do we get a high sub-clover diet?

- Clovers over sown 1970s
- A hill block gets shut up every 8-10 years in spring, to build seed bank (one block/year).
- Identify low legume blocks and try and graze before march rain, then leave until 5 trifoliate leaves.
- May have to sacrifice any early ‘false strikes’

Winter & Spring

- Thump grass/established legume in winter
- Spring: don’t graze until post-flowering mid-December
- Reap the rewards the following spring!
- On-going management includes spelling 2 months prior to lambing. Use crops.

Sub division key

These photos are from the Legume Photo Diary site at Tempello.

The rank stuff (left) is pre-grazing late summer and on the right, is pasture that was partially grazed late February setting it up for germination.

Not totally cleaned up but some cover does provide shade for young seedlings

Grass out of control. Fence!

This photo illustrates the down side of Tempello. Total suppression of any clover and consequently poor lamb growth are direct results

Weaning weights of 27 kg were achieved that spring. If we had better control things could be a lot different. That type of feed would not maintain ewes later into the summer.

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Meadowbank, Marlborough

Pete Anderson in clover

Getting to 20 ha blocks worth it

- $176 extra/ha justifies $300k spend on fencing/water? **Yes**
- Increased from 60 to 76+ tonnes lamb meat with 600 fewer ewes
- Still 8 su/ha this area
- Extra ewe grazing days
- Lamb income 2011 would have been $65k lower if no changes made

LEGUMES AT MEADOWBANK

We're in clover

Will Grigg

Website: www.lincoln.ac.nz/dryland

Field Day handouts and presentations page (20 June 2013)

BACKGROUND INFO

- 2800 ha, 2400 ha effective
- Topography
  140 ha Flat (excluding vineyard)
  250 ha Cultivable hill – developed
  40 ha Cultivable hill – yet to be developed
  800 ha Medium hill
  720 ha Steep hill
  850 ha Very steep un-topdressed
- 600 mm annual rainfall

OBJECTIVES THAT DETERMINED WHAT TO SOW

Twin lambs 17 kg+ cwt at weaning.
48 kg+ hogget mating weight.
140% + lambing.

- Good pasture production without N from bag.
- Autumn, winter, spring production our strength.
- Enough summer production to grow young capital stock.
- Efficient use of water – deep rooting species.

MEADOWBANKS CLOVER MIX

Finesse Q tall fescue	15 kg/ha
Prairie grass	8 kg/ha
‘Woogenellup’ Sub clover	6 kg/ha
‘Arrotas’ arrowleaf clover	2-3 kg/ha
‘Huia’ white clover	2 kg /ha
‘Tonic’ plantain	2 kg/ha

60 ha with winter active fescue

70 ha with Finesse Q fescue.

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Finesse Q fescue, Prairie grass, Sub and Arrowleaf clover and plantain mix November 2011

Grazing late November after letting sub clover flower and set burrs.

Grazing after shutting up for sub clover seeding.

Arrowleaf clover flowering January 2011

Close up of germinating clover seedlings on 1 May

Close up of mix in last photo.

Autumn drilling Italian ryegrass 2013 as part of the hill development.

This is destined to go into a lucerne mix in spring 2014.

- ‘Omaka’ barley six days after drilling on 6th February.
- All autumn drillings are summer fallowed by spraying out late October the year before.
- This block will be sprayed out in September and again in mid October before drilling into lucerne.

First graze of Omaka barley in April after February sowing.

- Lucerne/prairie grass/plantain mix in late January 2013.
- This was sown October 2012 and was first grazed late March 2013.
- This block of 16 ha is just about to be split into five paddocks and water troughs installed.

Lucerne, prairie and plantain mix in October 2012.
Running twin ewes and lambs at 12 ewes /ha and 1 finishing heifer or steer/ha.
The stand is 2 years old.

Lucerne/prairie mix sown Oct 2011.

We added cocksfoot @ 2 kg/ha in this block as a steeper harder face.

May 2013

WHAT'S HAPPENED TO PRODUCTION AT MEADOWBANK?

- Similar stock numbers , better fed.
- Ewe efficiency **increased 40%** since 2005

	2005	2012	Change
Ewe Lambing%	121%	142%	↑ 21%
Hogget Lambing%	60%	81%	↑ 21%
Weaning weight	28 kg/hd	34 kg/hd	↑ 21%
Return	$730/ha	$2640/ha	↑ $1910/ha (>**260%**)

Twin hogget lambs at weaning

Killed 16.1 kg at 10 weeks

Averaged 410 g/hd/day.

All hogget lambs averaged 370 g/hd/day.

Lucerne Establishment

Soils - deepest free draining soils
- pH 6.0
- RG/Wc fertility

Sowing - 8-10 kg/ha
- 10-25 mm
- peat inoculated 8-10 kg/ha
- *spring or autumn*
- cultivated/direct drilled (DAP)

Photo: D Hollander
Lincoln University

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Lucerne root

~8 months after sowing
> 1.5 m length

Autumn Spraying

Timing is Critical

Most important tool

Glyphosate, granstar, penetrant

Key Results

Conserve soil moisture

Kill mass root systems

Source: Kearney *et al.* 2010

Drilling seed with fertiliser
Direct drilling = seed + fertiliser

Hills Creek Station

Sown 4/11/2008

Photo taken 5/11/2010


Over 60,000 ha sown and doubling of lucerne seed sales over 10 years
“35% Rate of return on investment”

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Integrating lucerne into a high country merino system

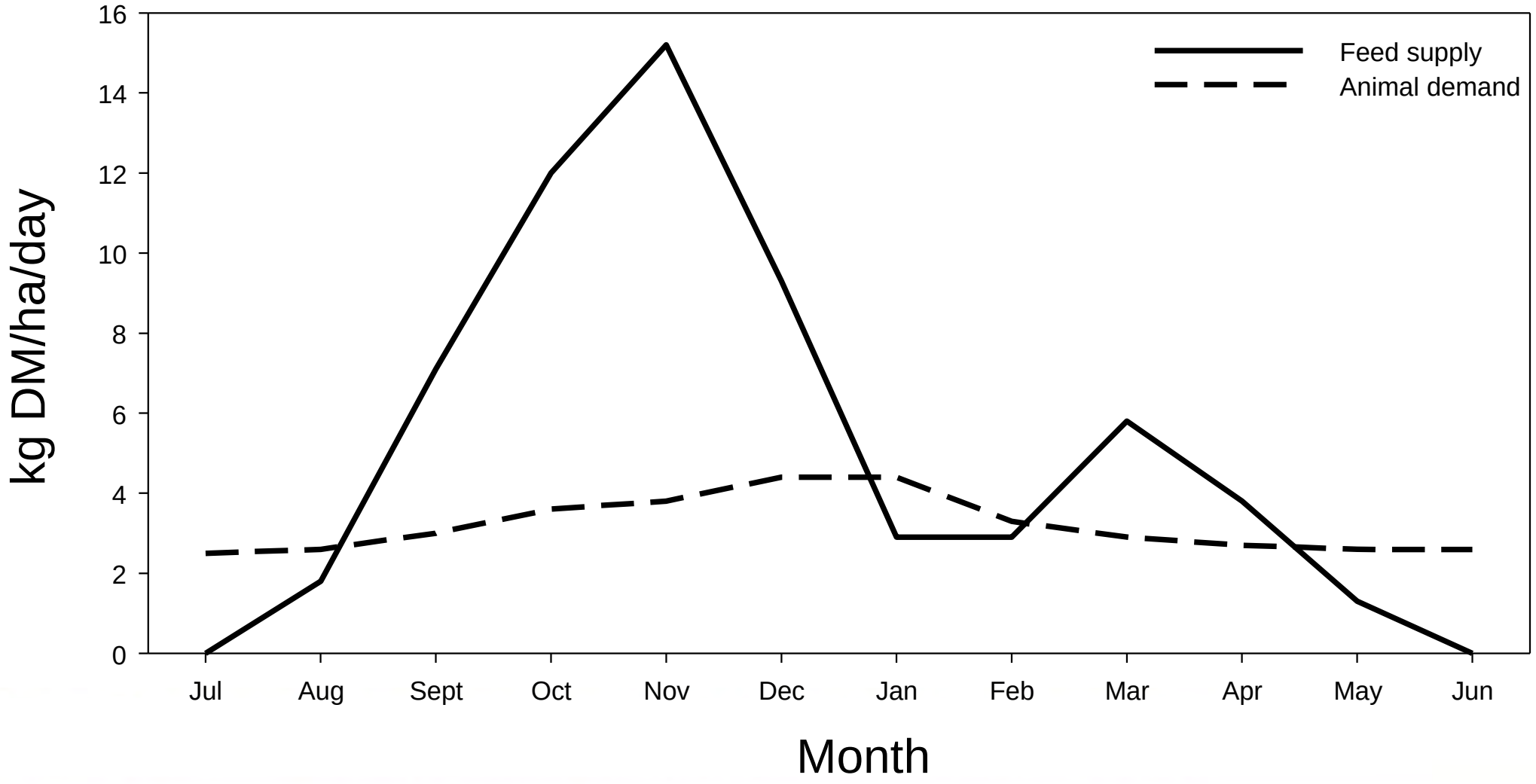
D. Anderson, L. Anderson, D.J. Moot and G.I. Ogle

New Zealand's specialist land-based university


BOG ROY
EST. 1891

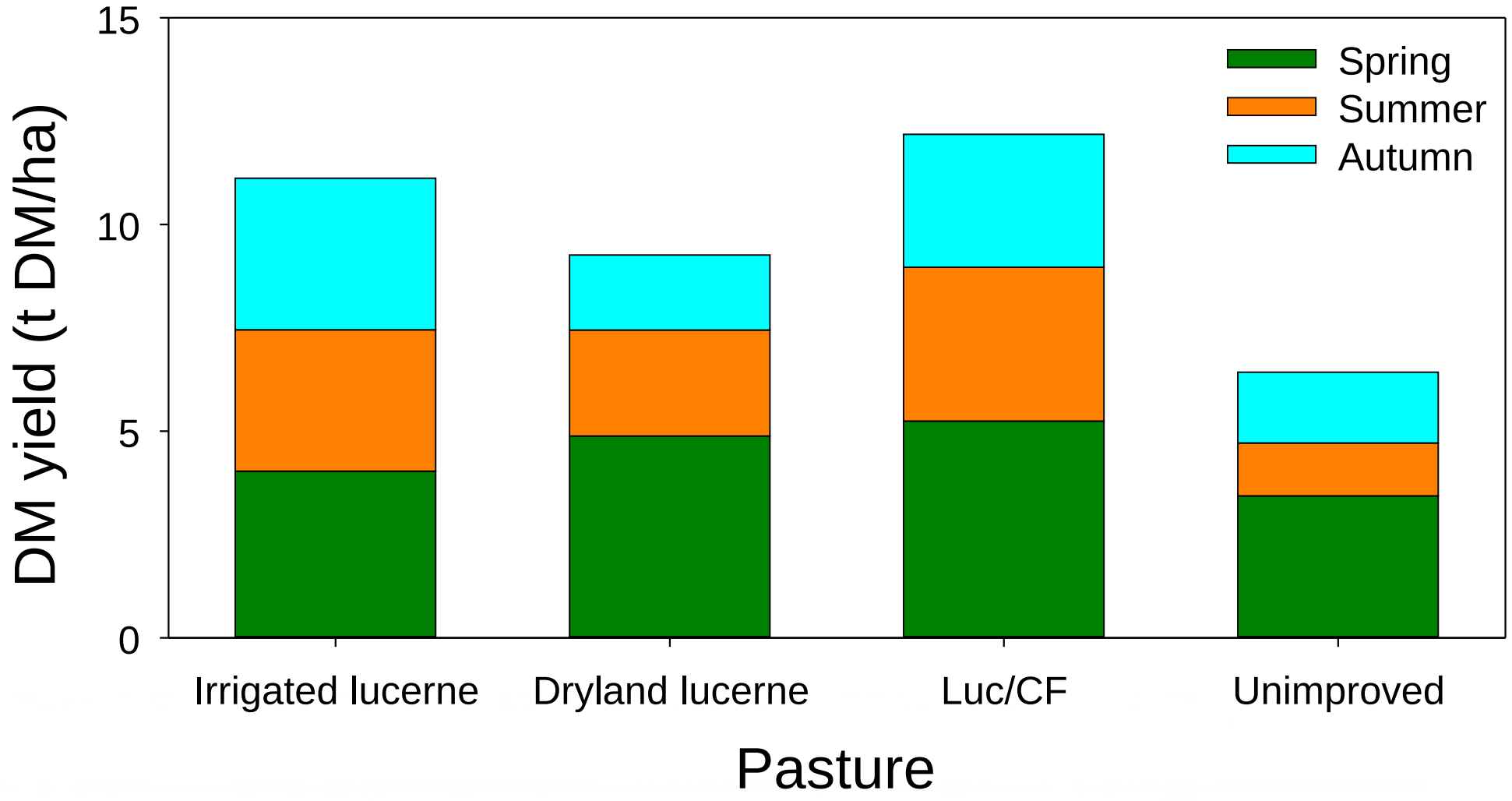
Landscape farming

Pasture supply & Animal demand



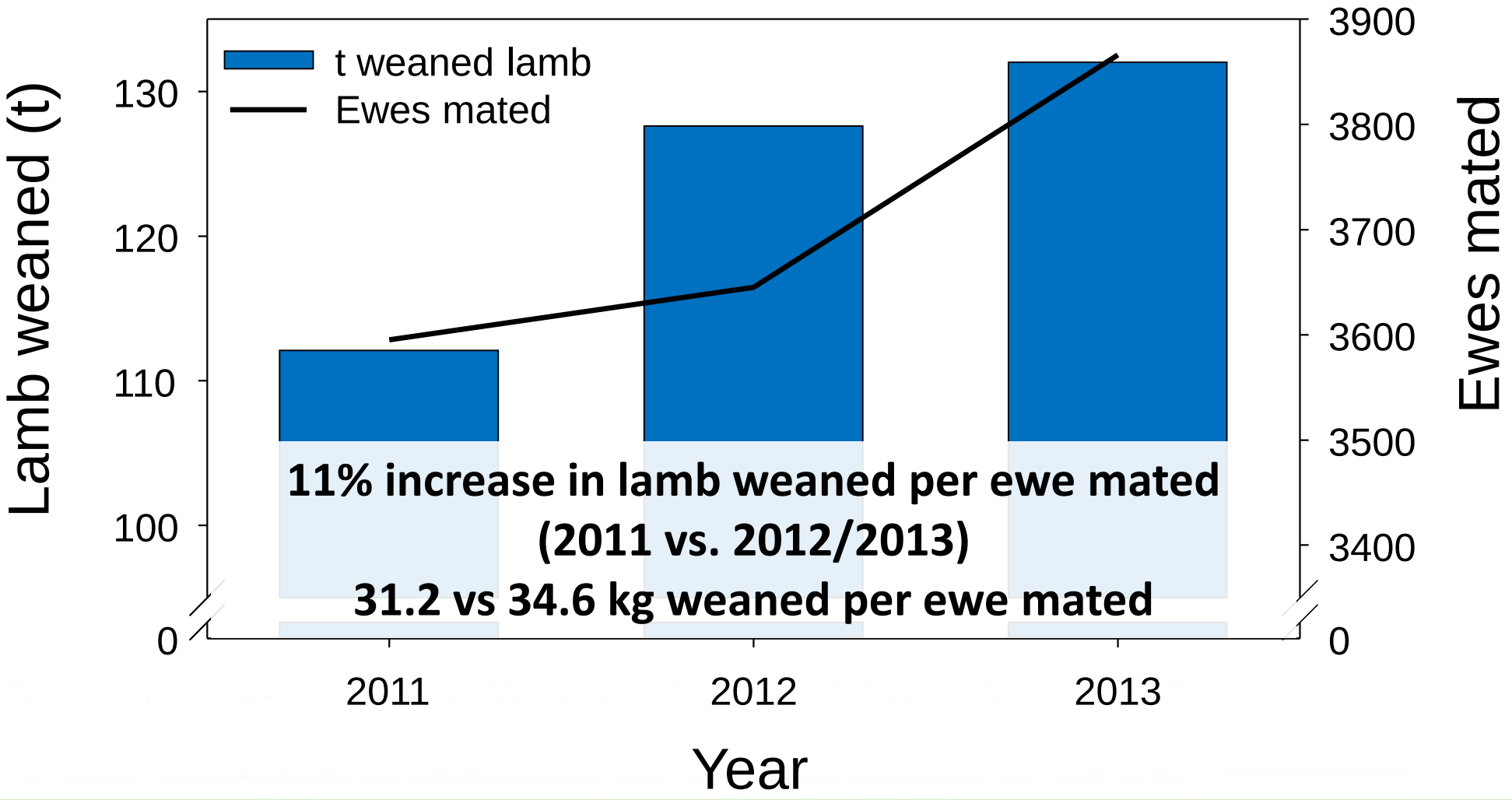
Anderson *et al*. 2014

Seasonal pasture production (3-yr average)



Anderson *et al*. 2014

Lamb weaned and Ewes mated



Anderson *et al*. 2014

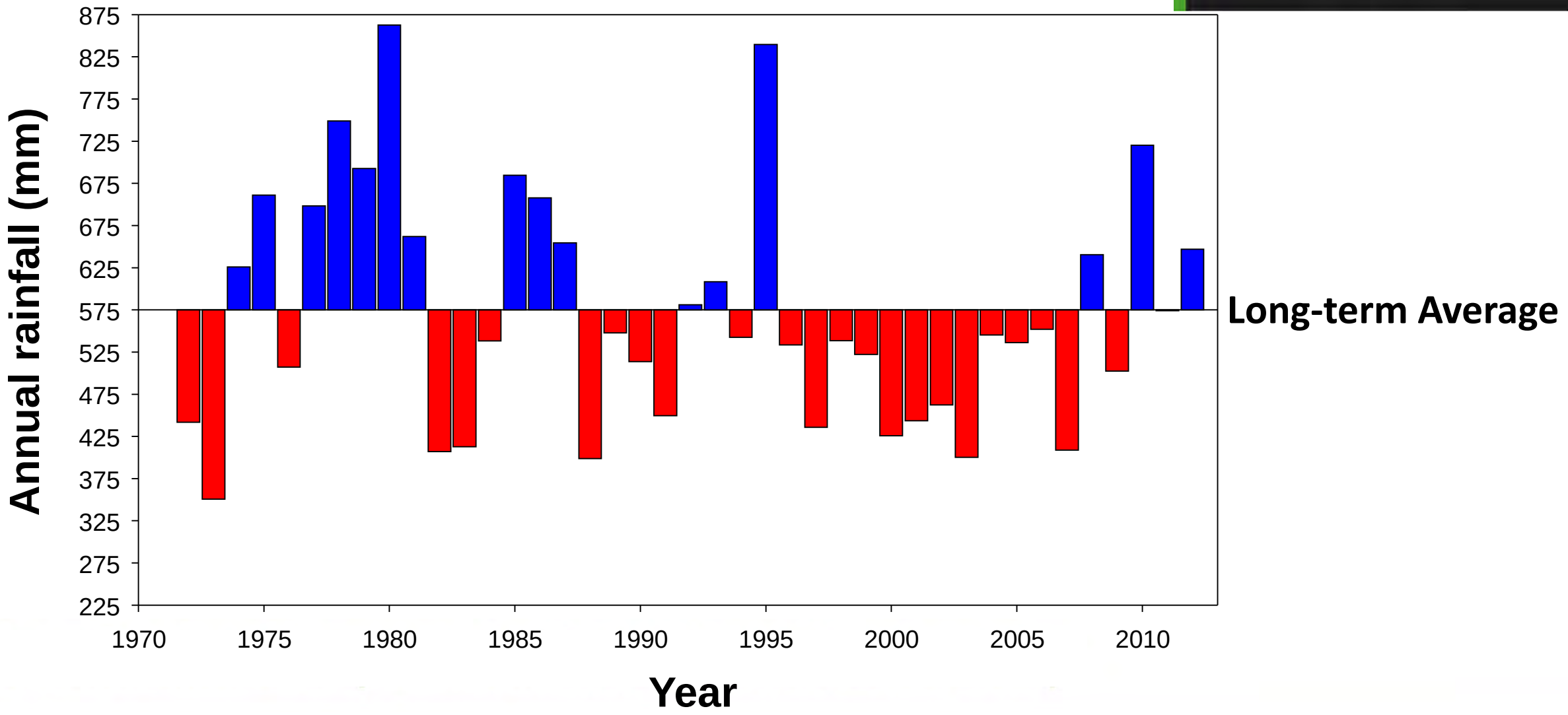
Bog Roy change in system performance

	Historic (Pre 2010)	Year 3 (target)	Year 3 (actual)	% Change
Mixed age ewes				
Tupping weight (kg)	57.0	60.0	59.5	↑ 4.3
Ewe scanning (%)	165	165	165	-
Ewe weaning (%)	115	125	130	↑ 13.0
Ewe lamb mortality (%)	30.0	25.0	21.0	↓ -30.0
Lamb weaning weight (kg)	27.0	29.0	29.0	↑ 7.4
Lamb growth rate (g/hd/day)	205	235	235	↑ 14.6

Anderson *et al*. 2014

Case study – Bonavaree farm, Marlborough
Over grazed – high erosion risk

Annual rainfall at ‘Bonavaree’



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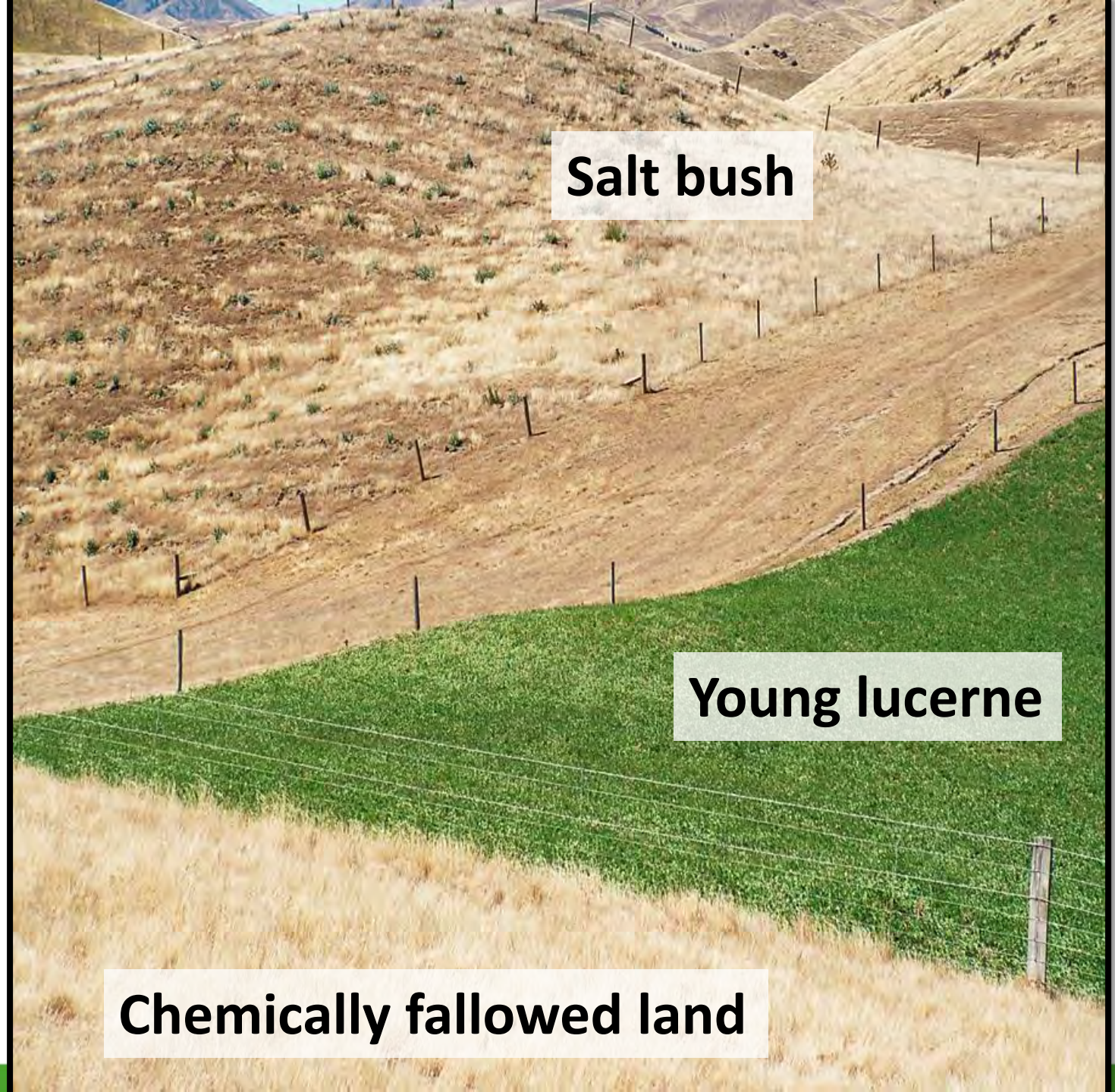

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‘Bonavaree’ production change over 10 years

	2002	2012	Change
Land area (ha)	1100	1800	↑ 64%
Sheep numbers	3724	4158	↑ 12%
Lambing (%)	117	145	↑ 24%
Lamb weights (kg)	13.3	19	↑ 43%
Lamb sold (kg)	38324	74460	↑ 94%
Wool (kg)	18317	20869	↑ 14%
Sheep:cattle	70:30	50:50	
Gross trading profit (ha)	$317	$792	↑ 149%

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"With better income we can focus on the environment and preserve it for generations to come"

Doug Avery

New Zealand's specialist land-based university

Lincoln University Current Lucerne Research Programs

- Luc/grass mixes
- Annual clovers for spring
- Lucerne oestrogens
- Lucerne Dormancy

Sowing rate and date

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Established 2007 LU – Templeton silt loam

Coated 'Grasslands Kaituna' lucerne.

Four sowing dates

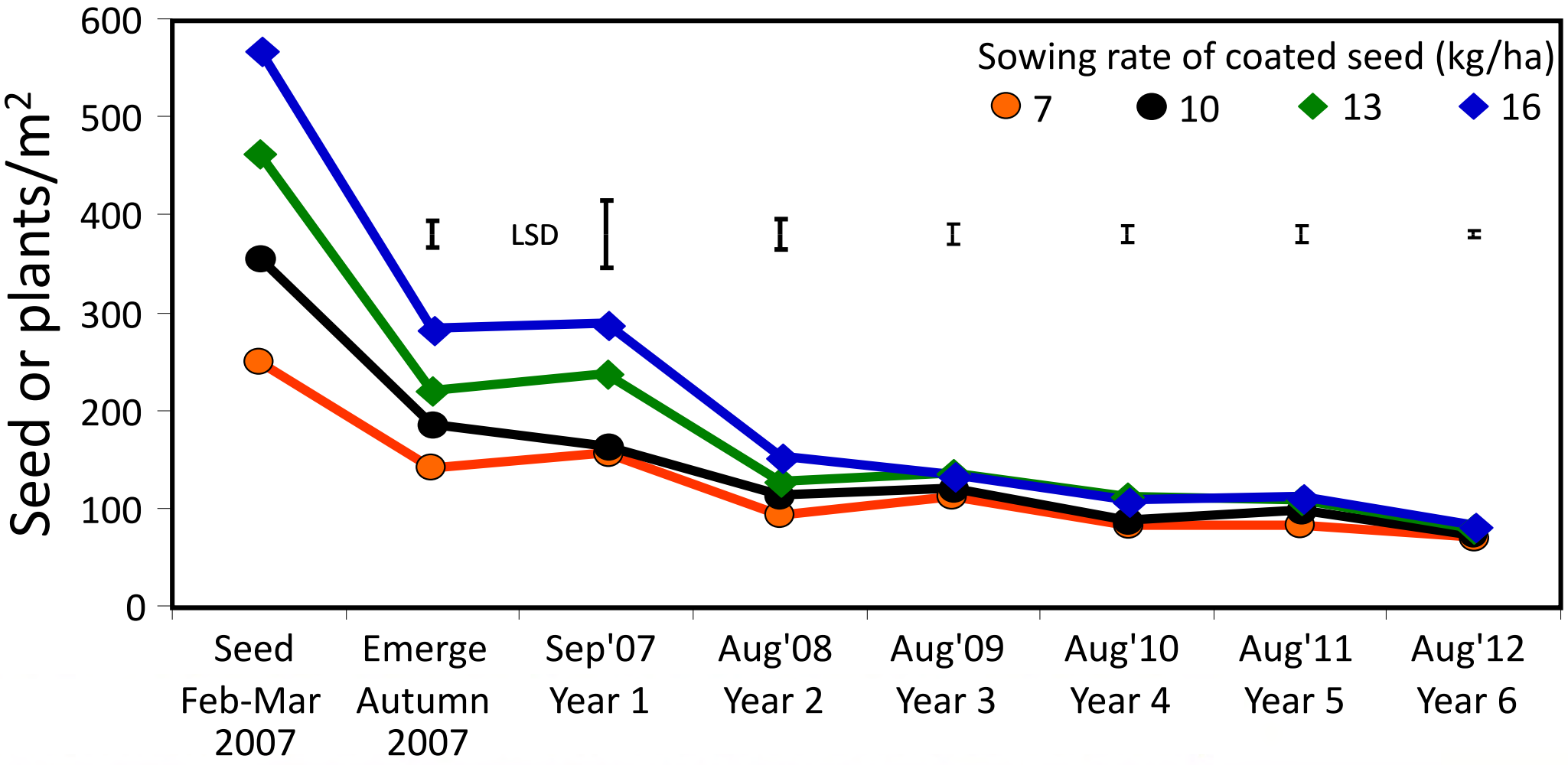
- **21 February,**
- **2 March,**
- **16 March and**
- **30 March**

Four sowing rates

- **Equivalent to bare seed @ 7, 10, 13 and 16 kg/ha**

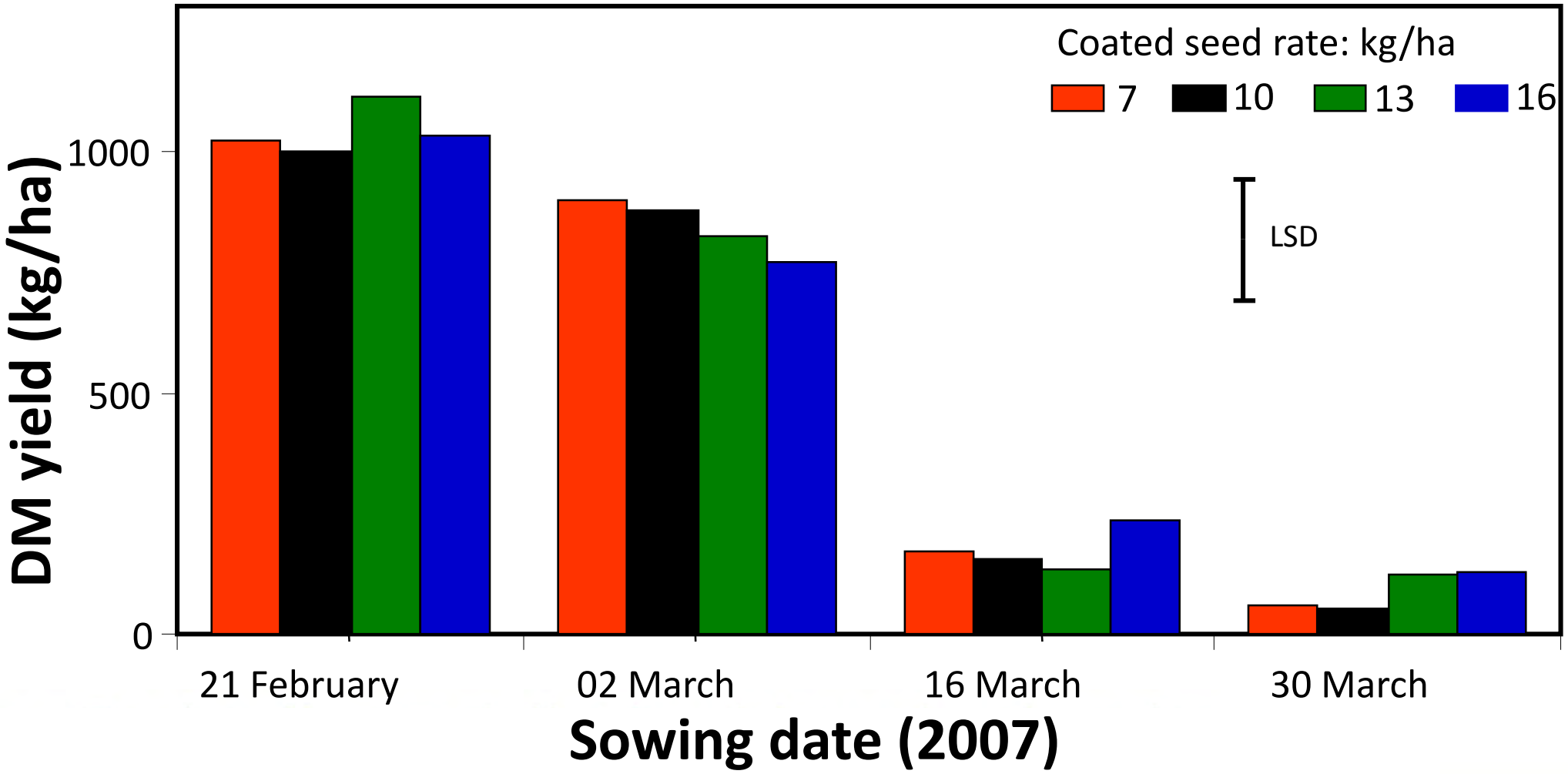
Source: Moot *et al*. 2012

Sown seed & plant population over time



Source: Moot *et al*. 2012

Seedling lucerne yield to early June



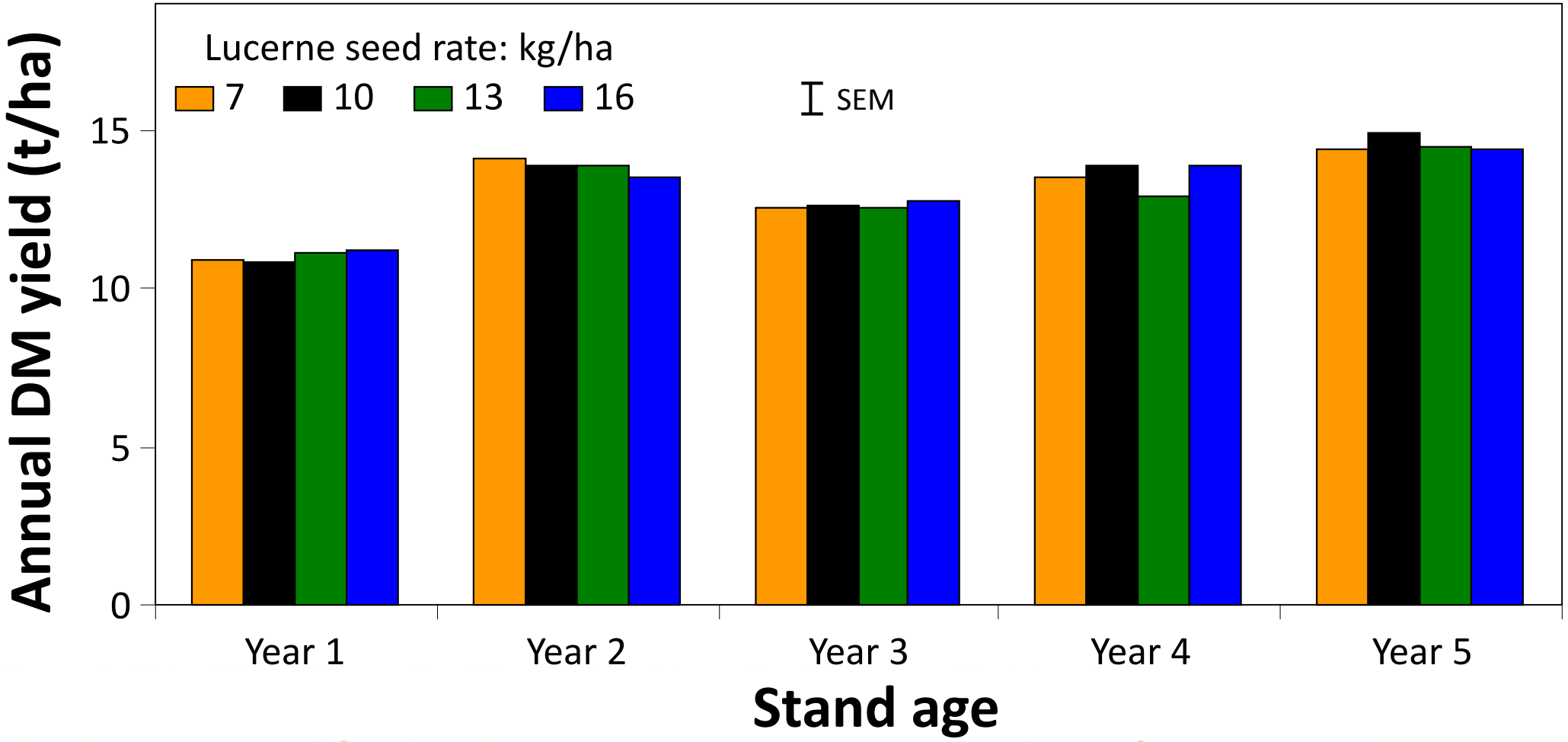
Source: Moot *et al*. 2012

Weeds present @ 09 October 2007 (Year 1)

Sown 21 Feb 2007

Sown 30 Mar 2007

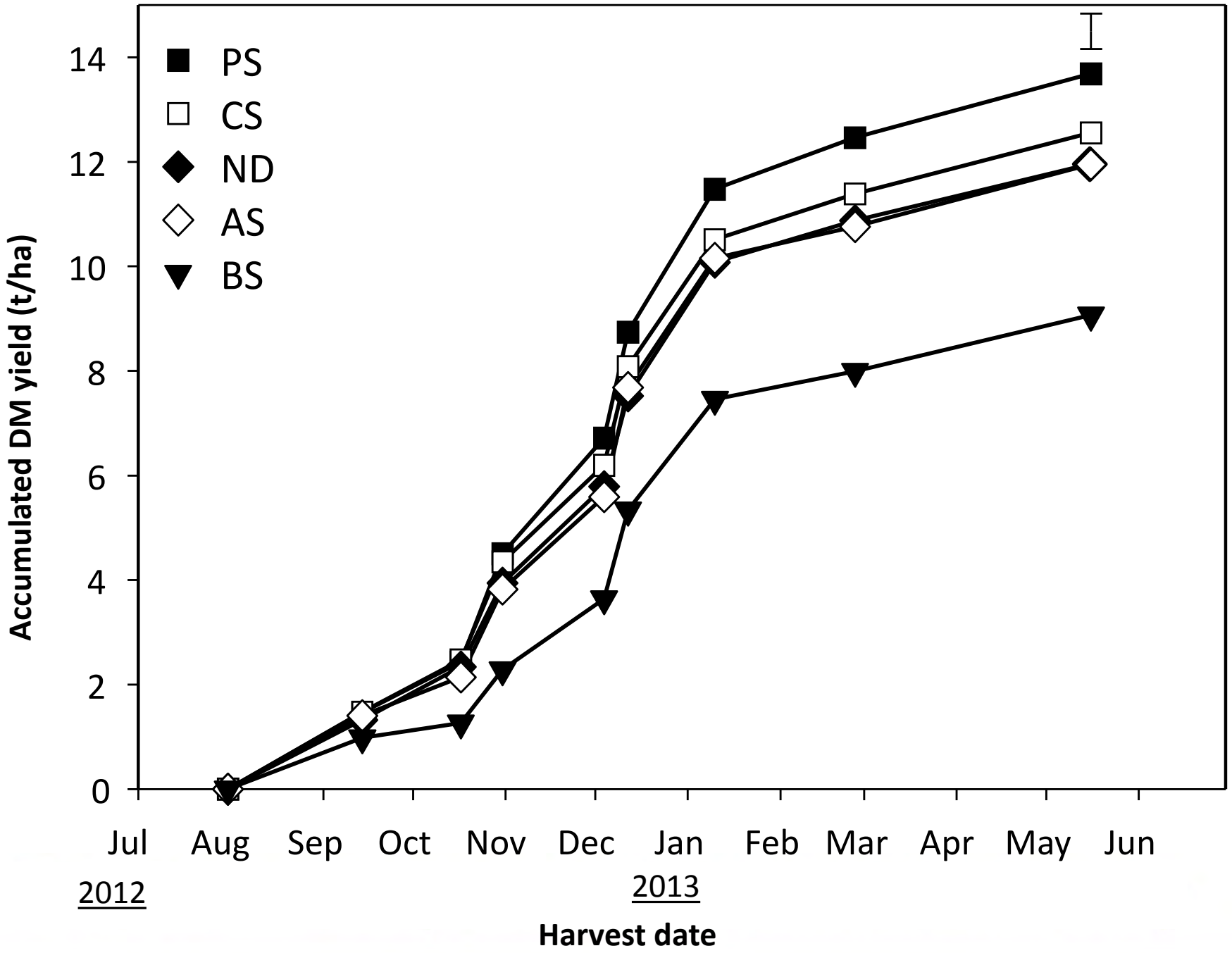
Annual yield in relation to sowing rate



Source: Moot *et al*. 2012

Inoculation Experiment

- At Lincoln University
- Dryland, variable silt loam soil
- No history of lucerne
- Split plot design with 3 replicates
- 4 sowing dates
- 4 seed inoculant technologies used
- Bare seed control also used (no rhizobia)



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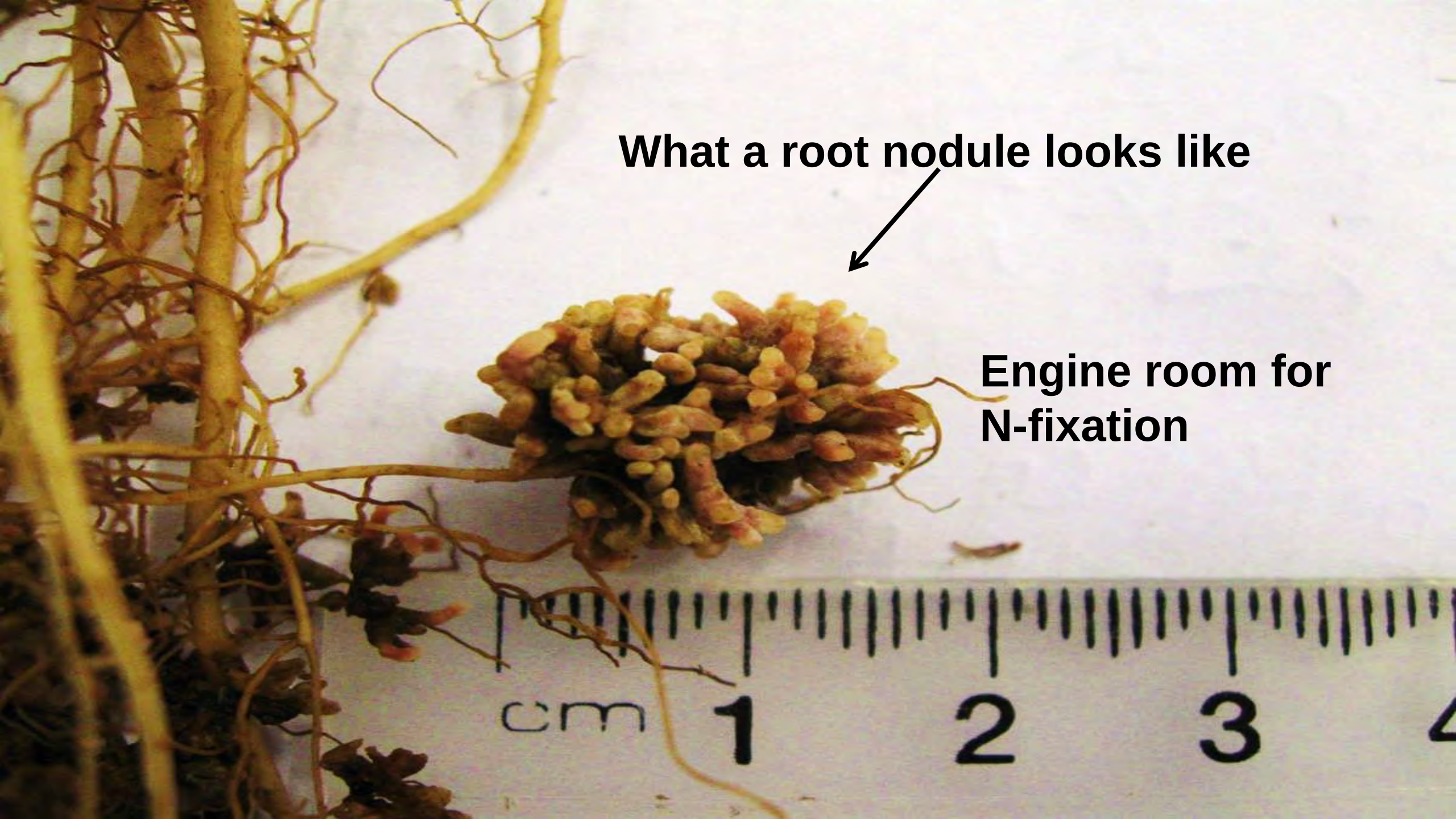
No inoculant (bare seed)


Inoculated with peat


What a root nodule looks like
Engine room for
N-fixation
cm
1
2
3

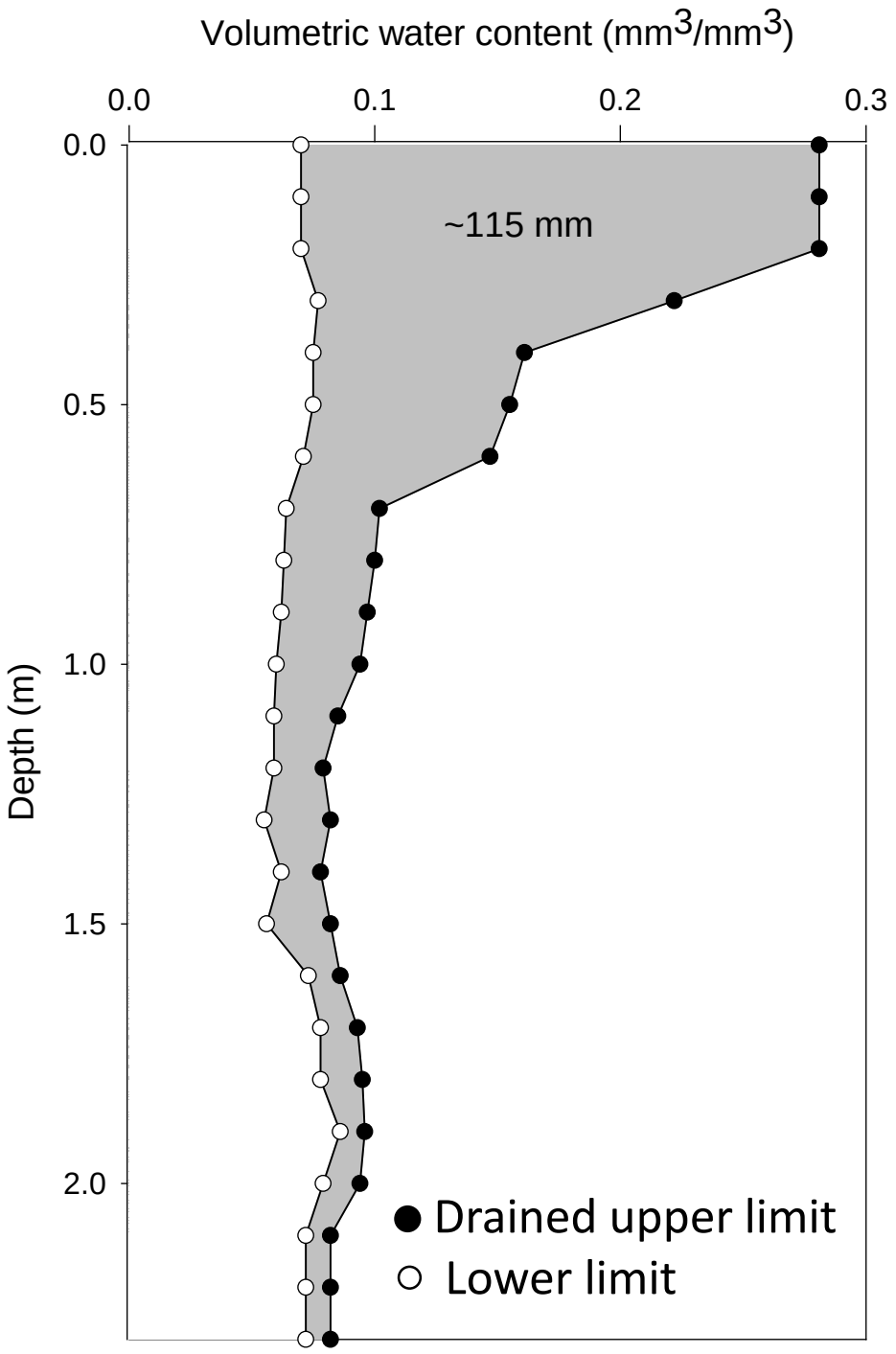
Richard Sim PhD results

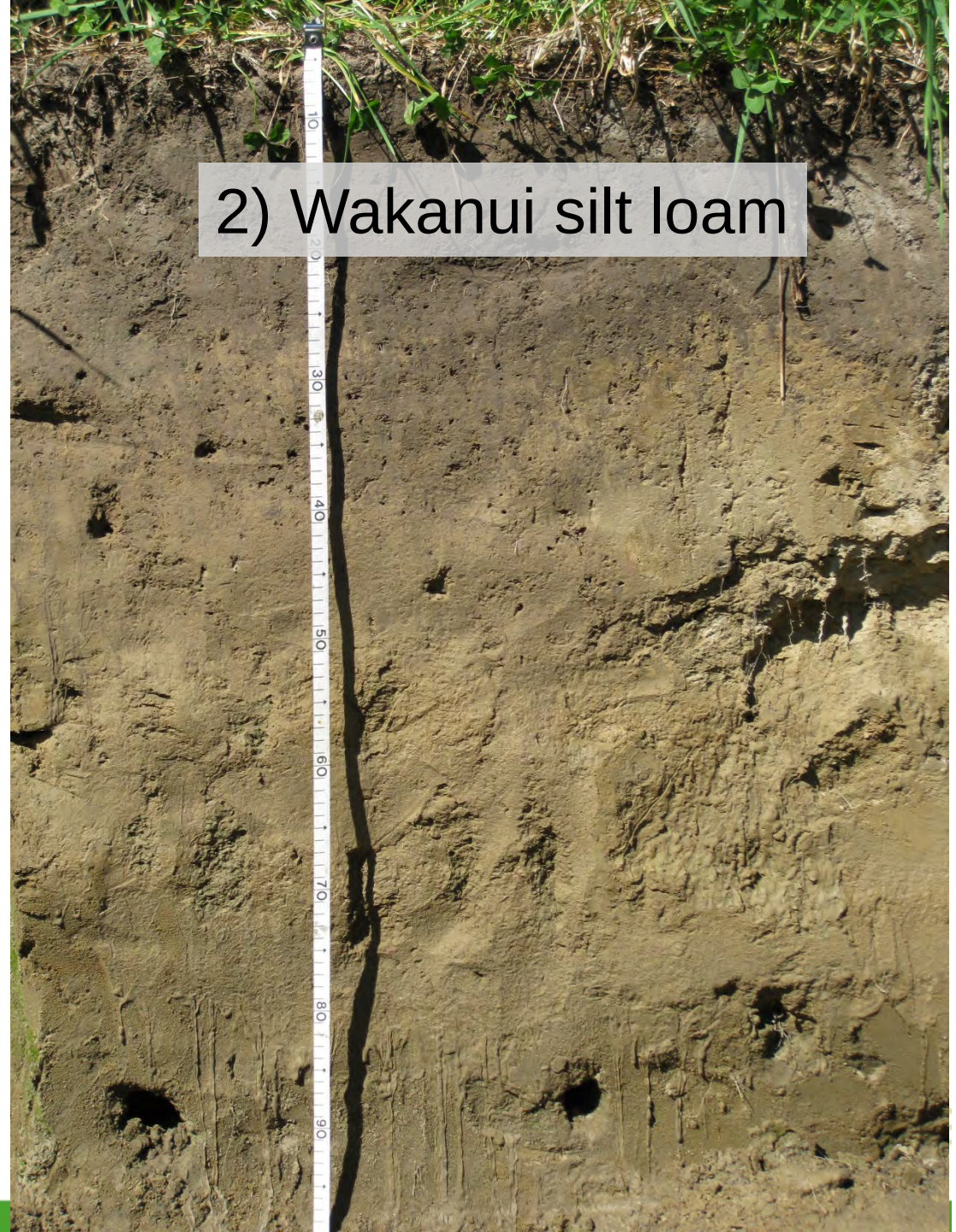
1. Soil type & sowing date
2. Seedling vs regrowth crops (yr 2)

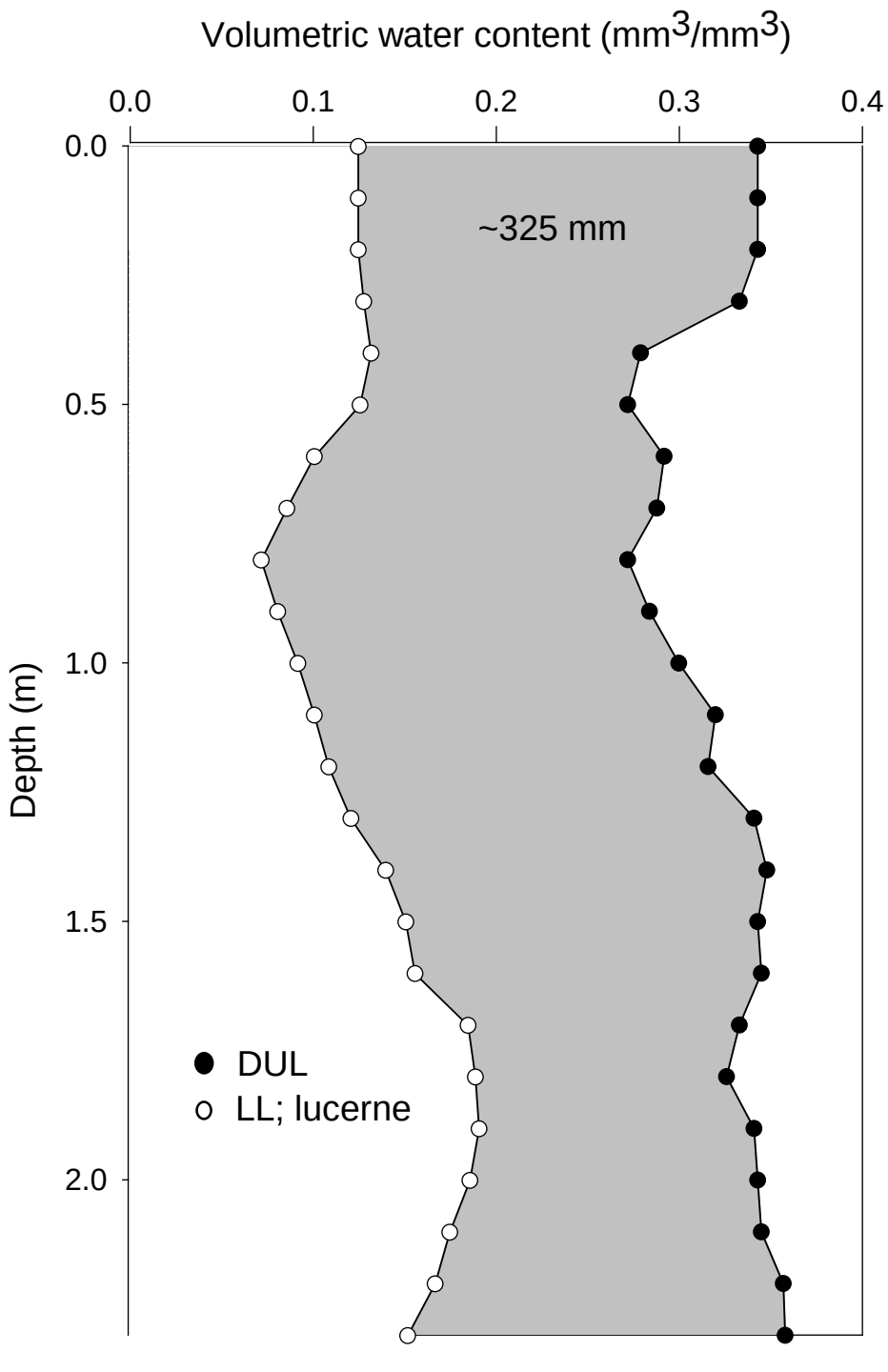
- Low soil water at Ashley Dene on stones
- High soil water at LU on silt!


Regrowth (year 2)
Seedling
Ashley Dene, January 2012

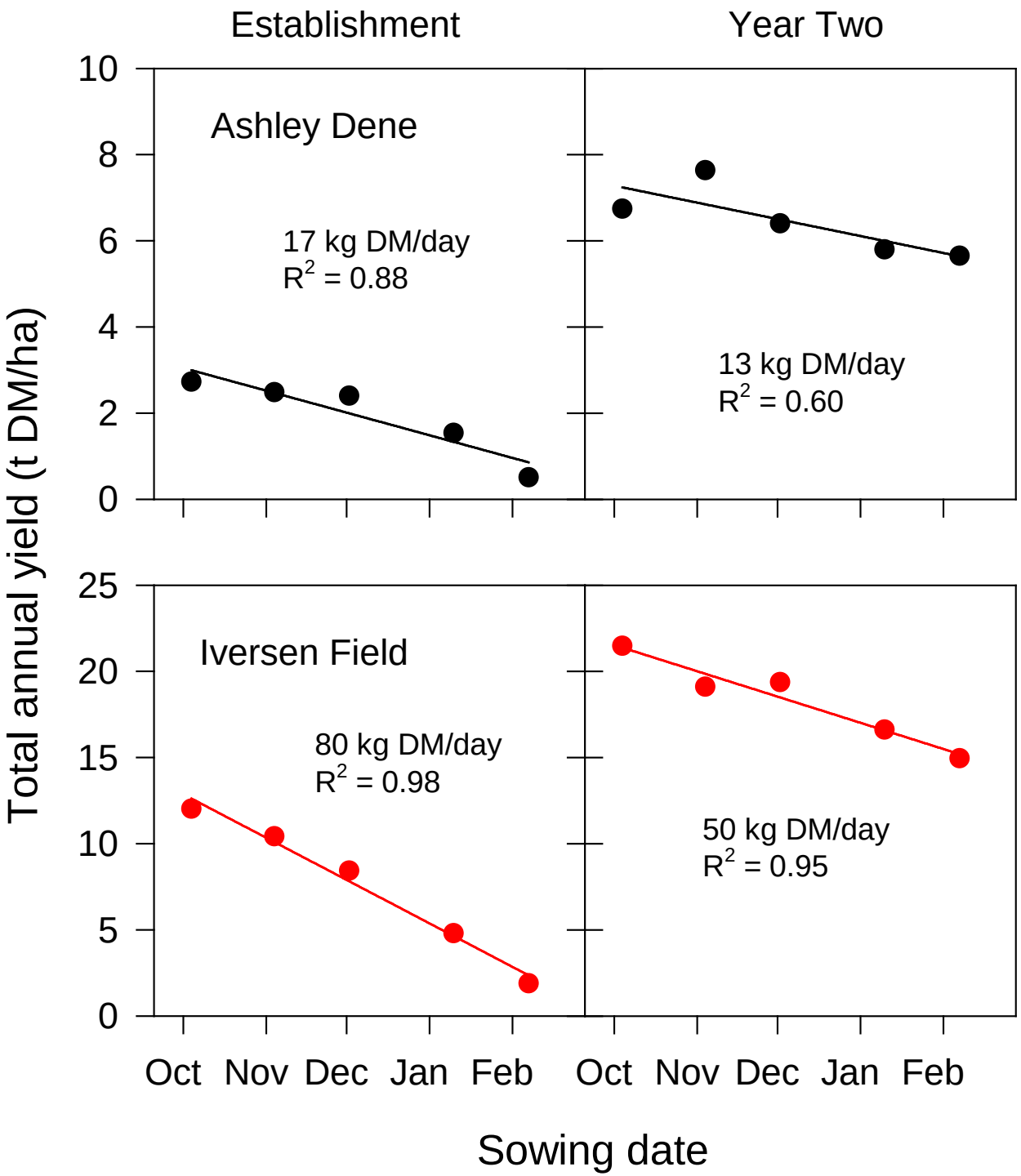

1) Lismore stony silt loam


Volumetric water content (mm3/mm3)
0.0
0.1
0.2
0.3
0.0
0.5
1.0
1.5
2.0
Depth (m)
~115 mm
Drained upper limit
Lower limit


2) Wakanui silt loam


Volumetric water content (mm3/mm3)
0.0
0.1
0.2
0.3
0.4
0.0
0.5
1.0
1.5
2.0
Depth (m)
~325 mm
DUL
LL; lucerne


Seedling
Regrowth (year 2)
Iversen 12, January 2012



Delayed sowing cost yield

Sown: February ~ October

Sampled: June

Taproot mass

Taproot mass – Iversen 12

	Root mass (t DM/ha)		
Sowing date	Establishment	Year Two	Shoot+root (Year 2)
October	5.3 $_{b}$	6.7 $_{a}$	21.9
November	5.7 $_{a}$	6.6 $_{a}$	20.0
December	4.9 $_{ab}$	6.6 $_{a}$	21.2
January	3.2 $_{c}$	6.9 $_{a}$	20.3
February	1.1 $_{d}$	5.7 $_{b}$	19.5
P	<0.001	<0.05	
SEM	0.30	0.23	

Establishment – sowing to June 2011
Year Two – June 2011 to July 2012

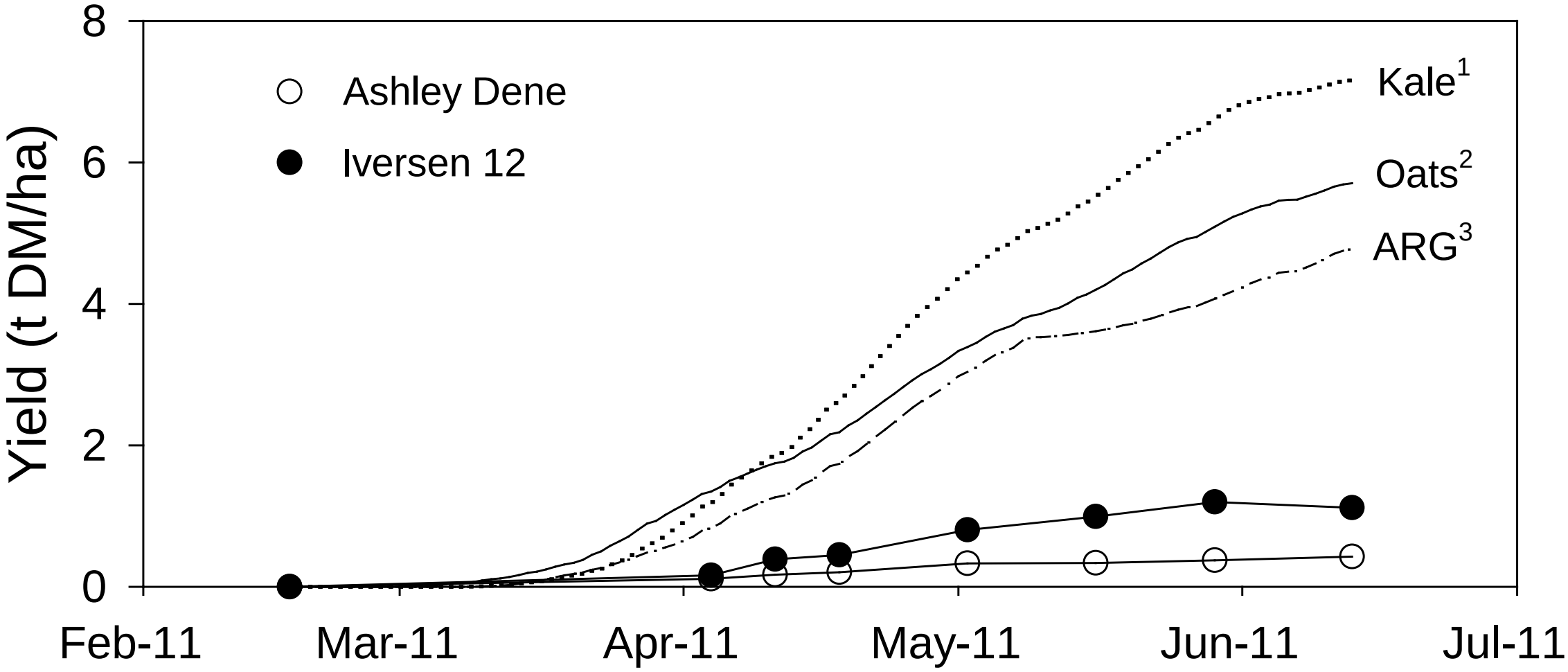
Taproot mass – Ashley Dene

	Root mass (t DM/ha)		
Sowing date	Establishment	Year Two	Shoot+root (Year 2)
October	2.2 $_{a}$	4.8 $_{a}$	9.3
November	2.0 $_{a}$	4.6 $_{ab}$	9.2
December	1.6 $_{ab}$	4.0 $_{b}$	8.2
January	1.2 $_{b}$	3.5 $_{b}$	8.1
February	0.6 $_{c}$	3.4 $_{b}$	8.5
P	<0.001	<0.05	
SEM	0.19	0.24	

Establishment – sowing to June 2011

Year Two – June 2011 to July 2012

Potential yield of alternative crops



[1] Chakwizira (2008), Chakwizira *et al*., (2011); [2] Martini et al., (2009); [3] Martini, (2012)

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Water extraction – understanding yield

- **Neutron probe (2.3 m)**
- **Seedling vs. regrowth lucerne**
- **The influence of soil type**

beef+lamb new zealand

Water extraction

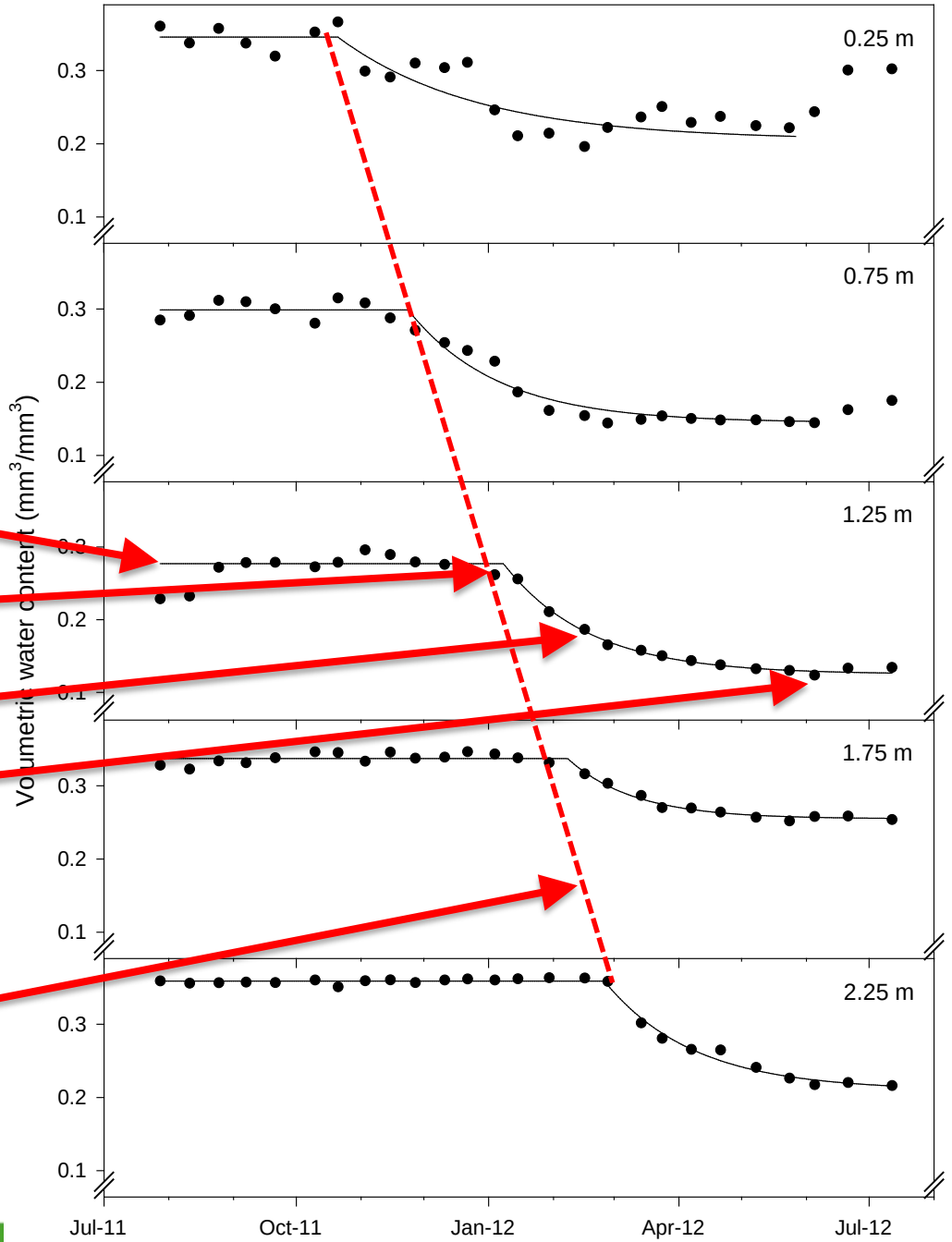
Field capacity

Start of extraction

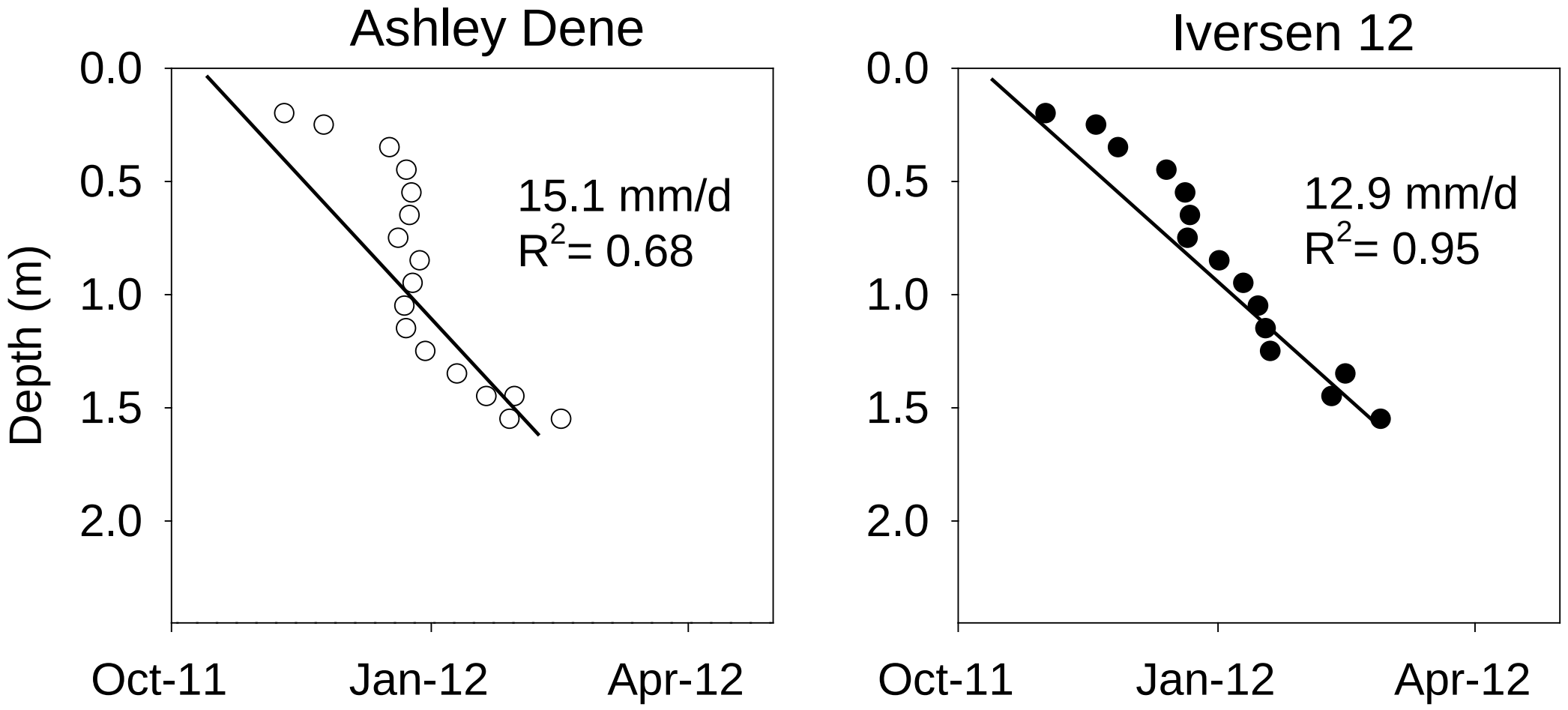
Rate of extraction

Lower limit

Extraction front velocity



Extraction front velocity - establishment

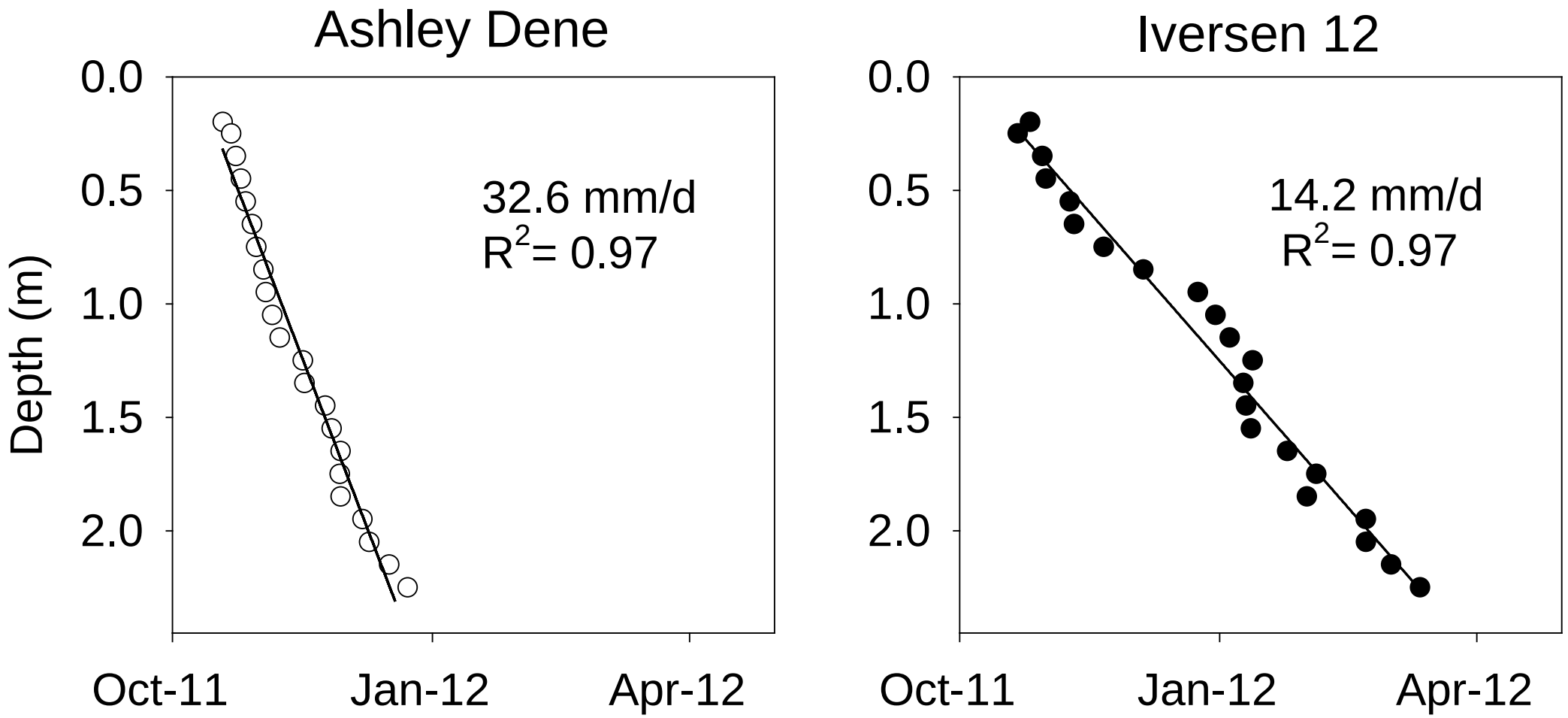


Ashley Dene

- Sown 10 October
- Emerged 18 October
- 200 plants/m^2

Iversen 12

Extraction front velocity – Year 2



Conclusions from establishment

- Spring sow or grow a forage crop
- Yield in year one is lower due to partitioning
- Plant population self thins over time
- Inoculation is important in new sites
- Sow on deep soils
- Regrowth crops on shallow soils use soil water quickly
- Spread feed supply by new sowings each year

Lucerne grazing options

- **Rotational grazing**
- **Set stocking**
- **Grass mixes**

Pastoral 21 BLNZ funded programme

Growth:

is dry matter accumulation as a result of light interception and photosynthesis

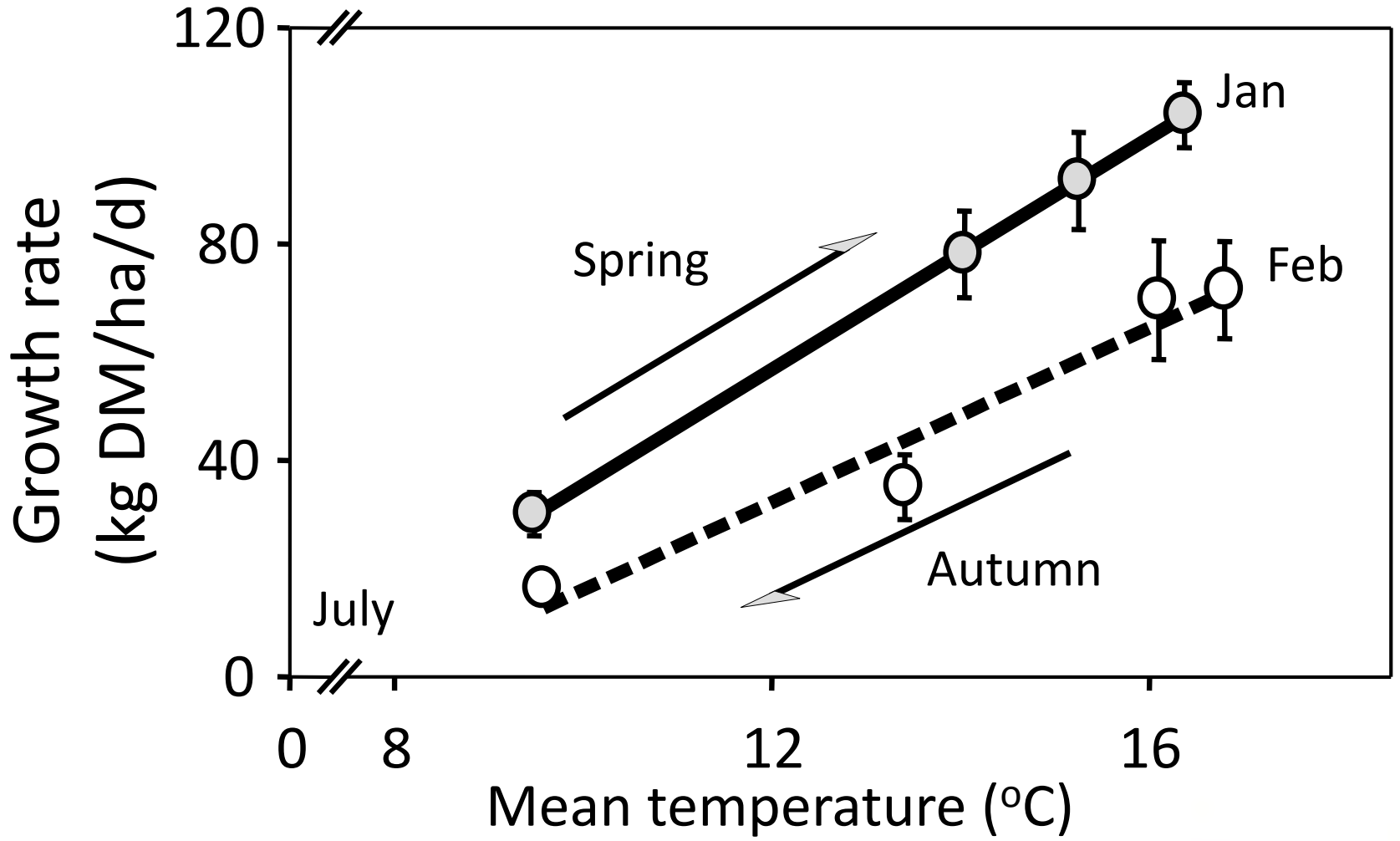
Development:

is the ‘age’ or maturity of the regrowth crop e.g. leaf appearance, flowering

Growth and development are both influenced by environmental signals

The canopy: the energy capture device

Vegetative growth



Source: Moot *et al*. 2003

Experiment 2 flexible grazing

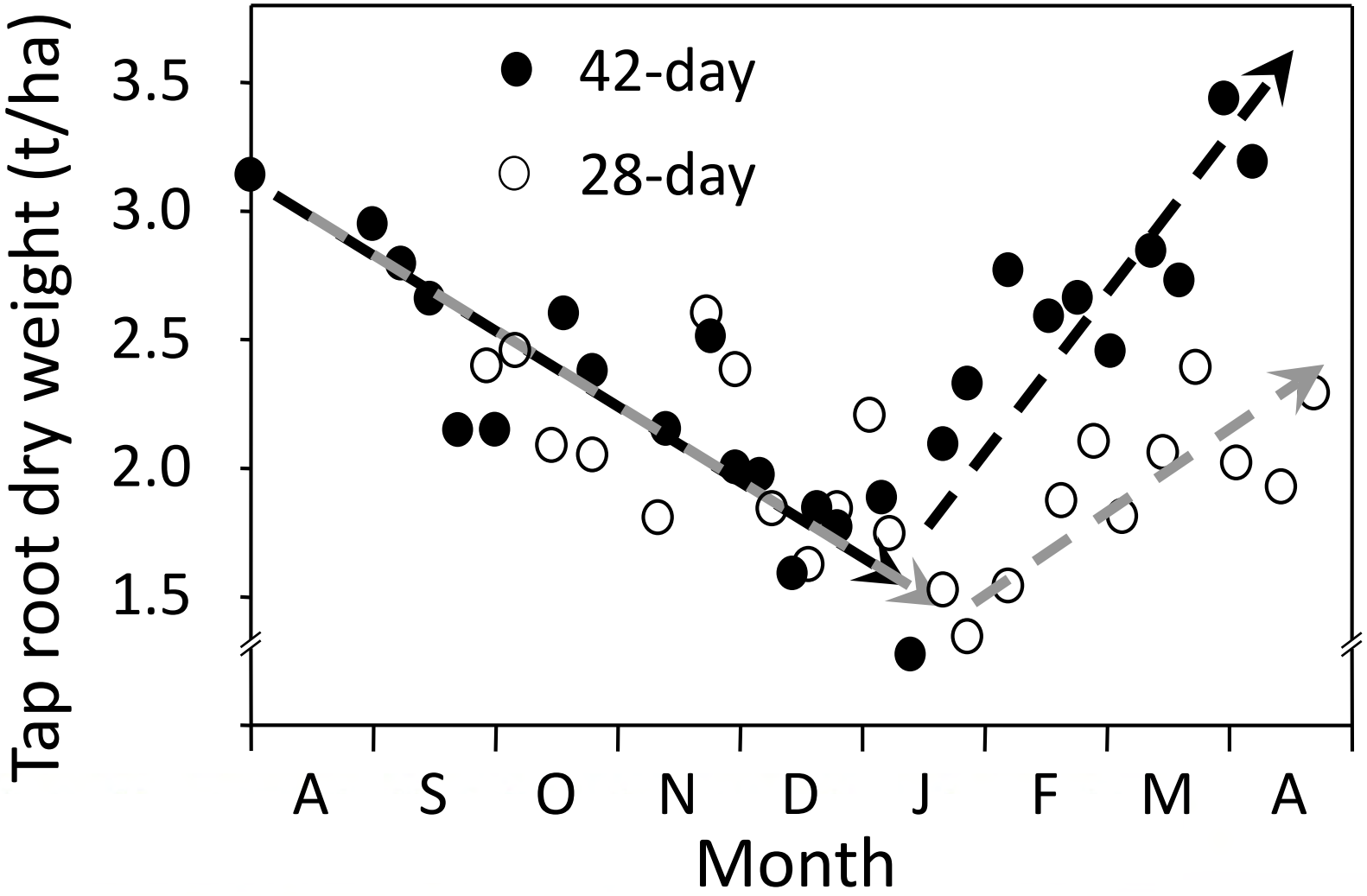
38 days resting

4 days grazing

25 days resting

3 days grazing

Partitioning to roots



Source: Moot *et al*. 2003

Seasonal grazing management

Spring

- 1st rotation aided by root reserves to produce high quality vegetative forage.

- can graze before flowers appear (~1500 kg DM/ha) ideally ewes and lambs but

<u>Growing point at the top of the plant</u>

5th September 2011 – Cave Sth Canterbury

Stocking rates in New Zealand

- Spring 14 ewes plus twins/ha
- Summer 70 lambs/ha
- Ideally 7-14 days maximum on any one paddock
- Less intensive systems – don’t open the canopy

Spring grazing

Seasonal grazing management

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Spring/summer (Nov-Jan)

- Priority is stock production (lamb/beef/deer)
- graze 6-8 weeks solely on lucerne
- 5-6 paddock rotation stocked with one class of stock (**7-10 days on**)
- allowance 2.5-4 kg DM/hd/d – increase later in season


14 ewes + twins/ha

High numbers for 7-10 days


Fibre and salt

Maximize reliable spring growth – high priority stock

Seasonal grazing management

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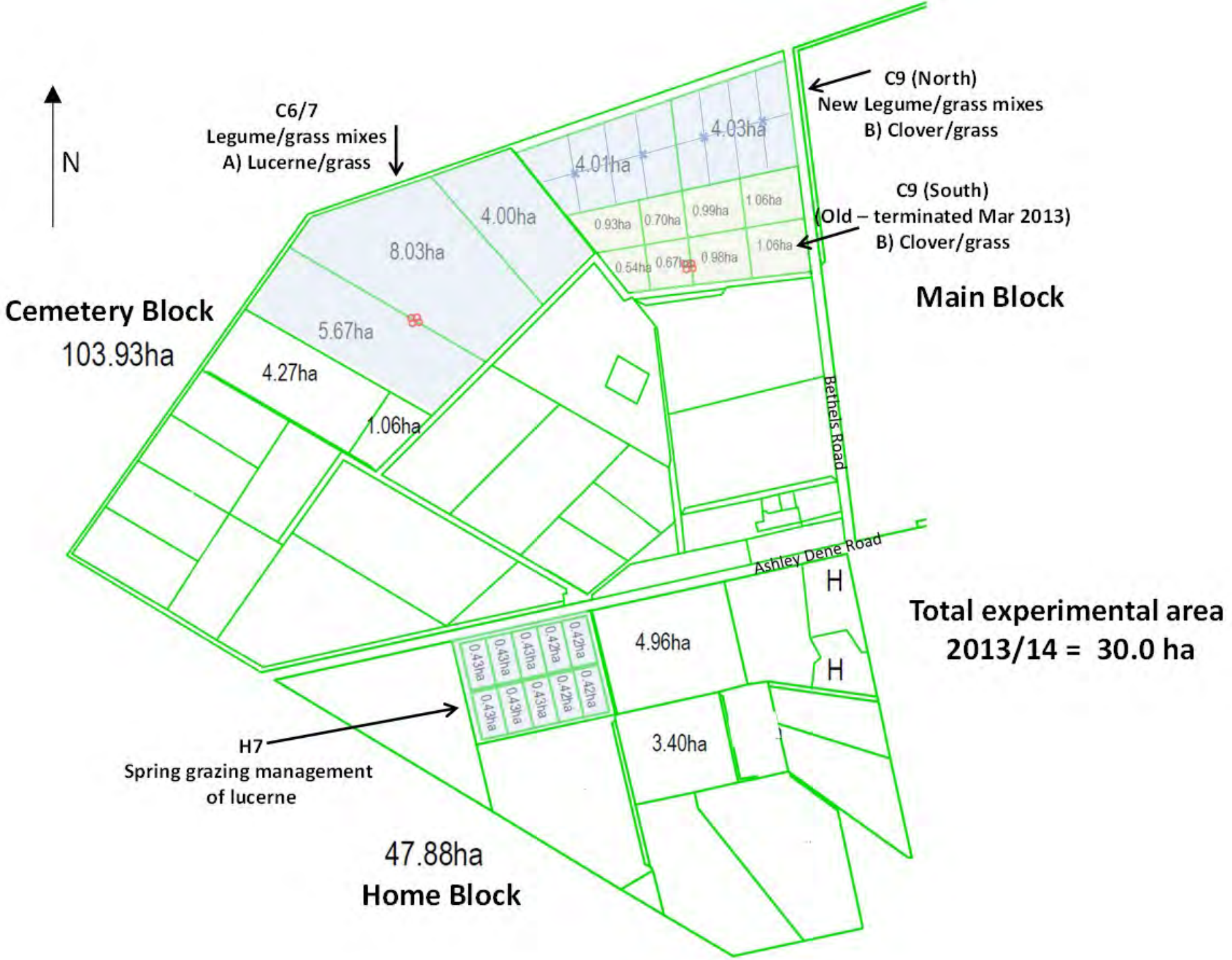
Early autumn (Feb-April)

- terminal drought ⇒ graze standing herbage
- allow 50% flowering
- long rotation (42 days) somewhere between Jan and end of May

⇒ **build-up root reserves for spring growth and increase stand persistence**

Autumn = flowering plants
But don't flush on this!

Rotation 4 Pre-graze
Plot 6 (28/2/08)
2.0 t DM/ha produced in 51 d



Total experimental area
2013/14 = 30.0 ha

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beef+lamb new zealand

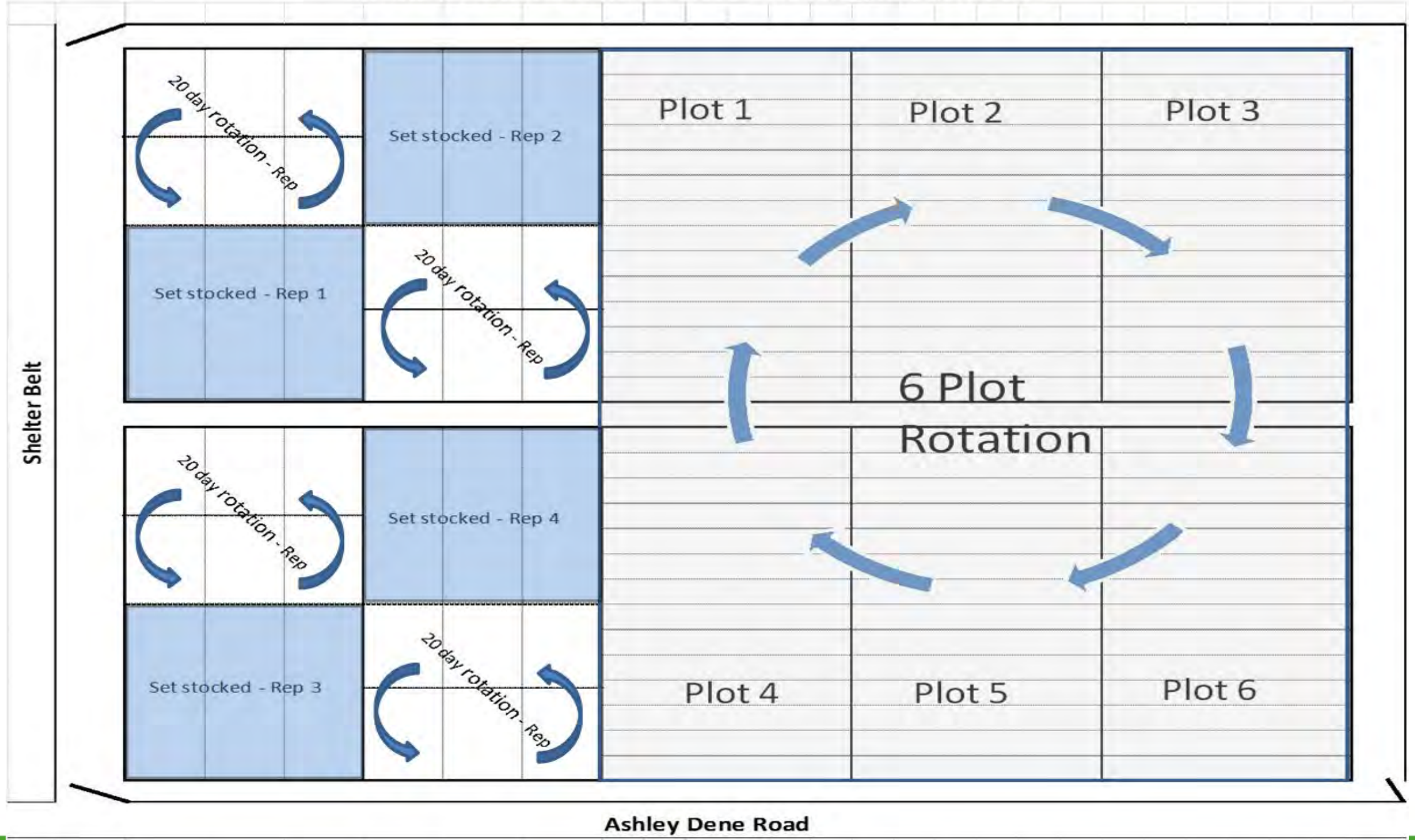
Objective

- Evaluate three spring grazing management strategies for lucerne monocultures
  - Rotational grazing (6 paddock system)
  - Set stocked (SS) until weaning
  - Semi set stocked (SSS) until weaning (10 day shifts)

- After weaning SS and SSS lambs mobbed up and moved to an 8 paddock rotational grazing system (RECOVERY PHASE)

Contributes to: Critical measures A & B

Ashley Dene Lucerne - H7 – Grazing Treatments



Project 3 –
Spring grazing management of lucerne

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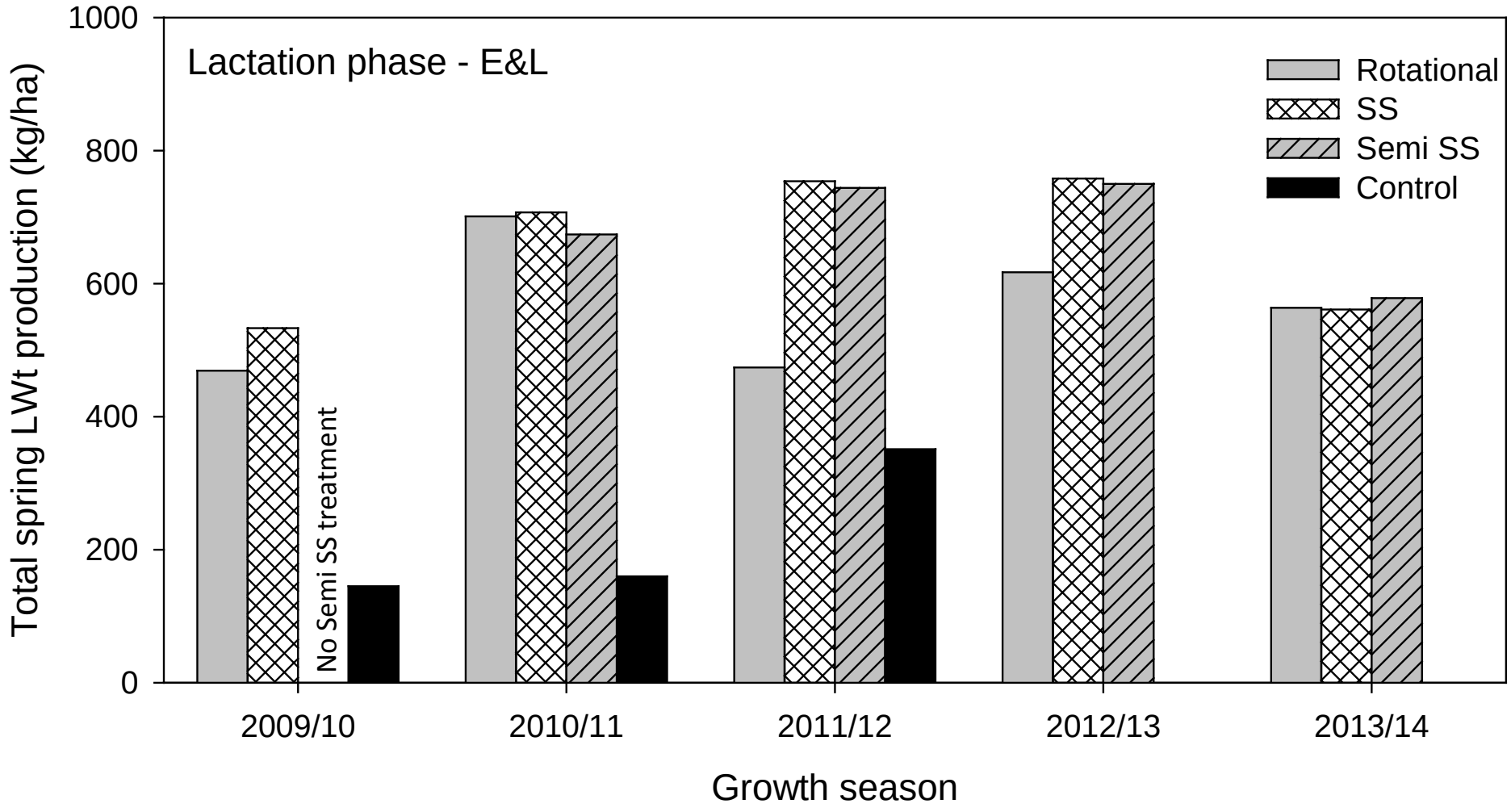
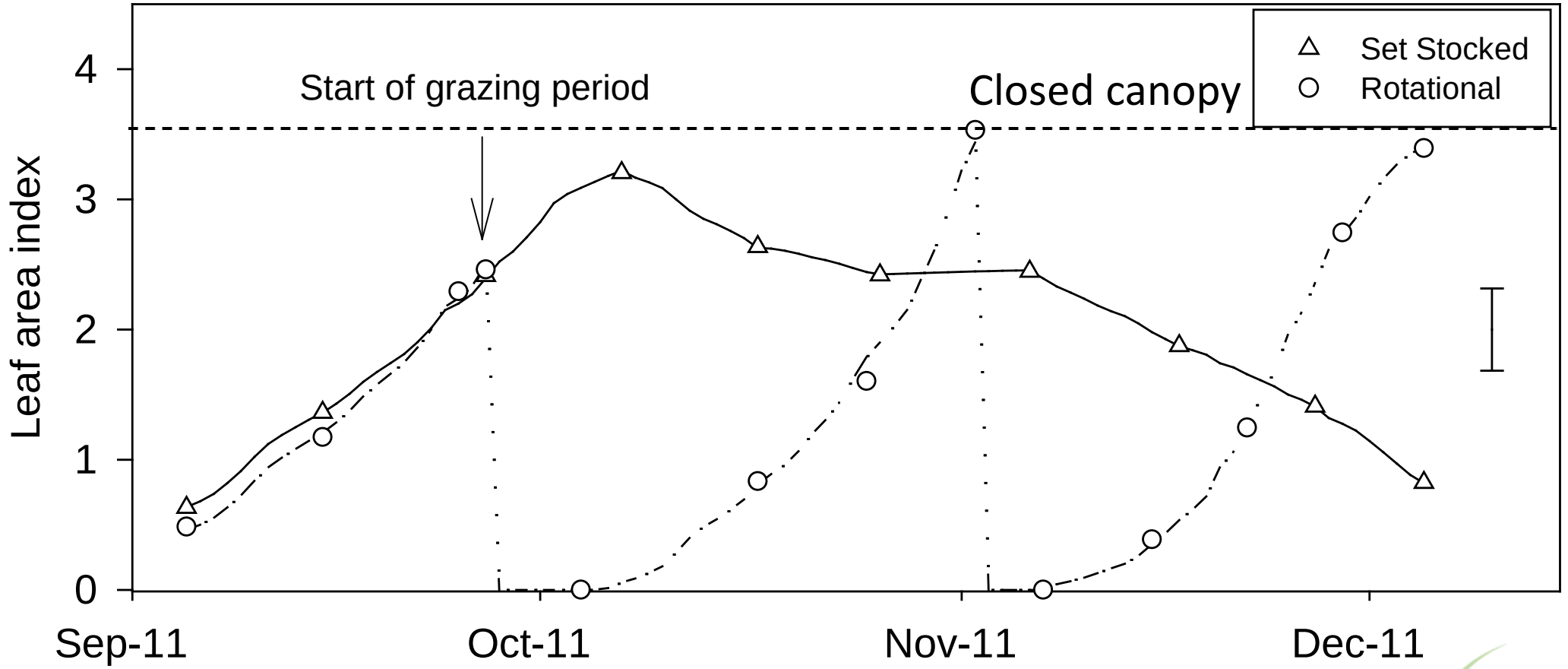
beef+lamb new zealand

Total LWt produced



Crop canopy



RULES FOR SET STOCKING LUCERNE

1. Manage lucerne pure swards first.
2. Choose paddocks to lamb on early in autumn – shelter, older, early clean-up graze and winter herbicide application.
3. Lucerne grass mixes – grass transition.
4. Early and late for condensed lambing (1 cycle).
5. Drift onto lucerne ~14 d prior to lambing
6. Lucerne ~20 cm tall and keep it there.

RULES FOR SET STOCKING cont'd.

7. Stock at about half the rotational grazing rate
8. SS for 4-5 weeks – then rotate
9. SS lambs use the taller feed as shelter.
10. Stocking rate to keep closed canopy!
11. Canopy gets taller over 4-5 weeks not shorter
12. Once canopy reduces begin rotational grazing
13. Open canopy = twitch, yarrow, dandelions.
14. Paddocks need autumn (6 wks) recharge.

References & Links

Lincoln University Dryland Pastures Website: http://www.Lincoln.ac.nz/dryland

Lincoln University Dryland Pastures Blog: http://www.lincoln.ac.nz/conversation/drylandpastures/

MaxClover Photo Diary (18 MB; PDF File)

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