Lincoln University
Te Whare Wānaka o Aoraki
AOTEAROA • NEW ZEALAND

Legumes for vineyards? – Renwick

Professor Derrick Moot

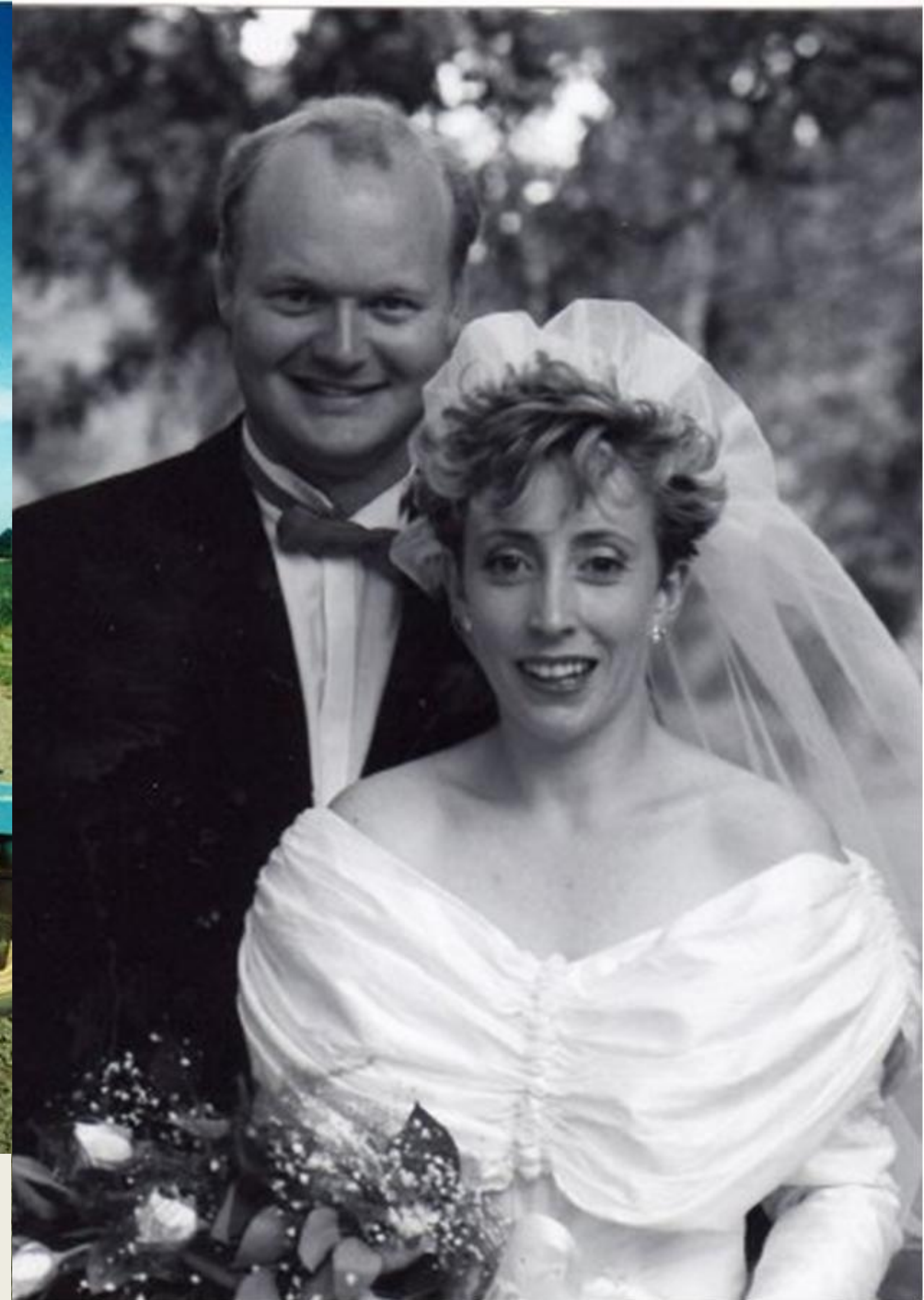


PLSC 401 AGRONOMY 1986

Back Row: Graeme BASSETT, Justin de la ROCHE, Peter MOYNIHAN, Ivan LINES, George STEVEN, Kathy NICHOLSON, Nigel UDY, Gaya PRASAD.

Front Row: Derrick MOOT, Roger BANFIELD, Malcolm MURRAY, John McCOY, Ann BOWEN, Andrew McKAY, Bruce McKAY.

Absent: Helen CAMERON, Ian TATE.

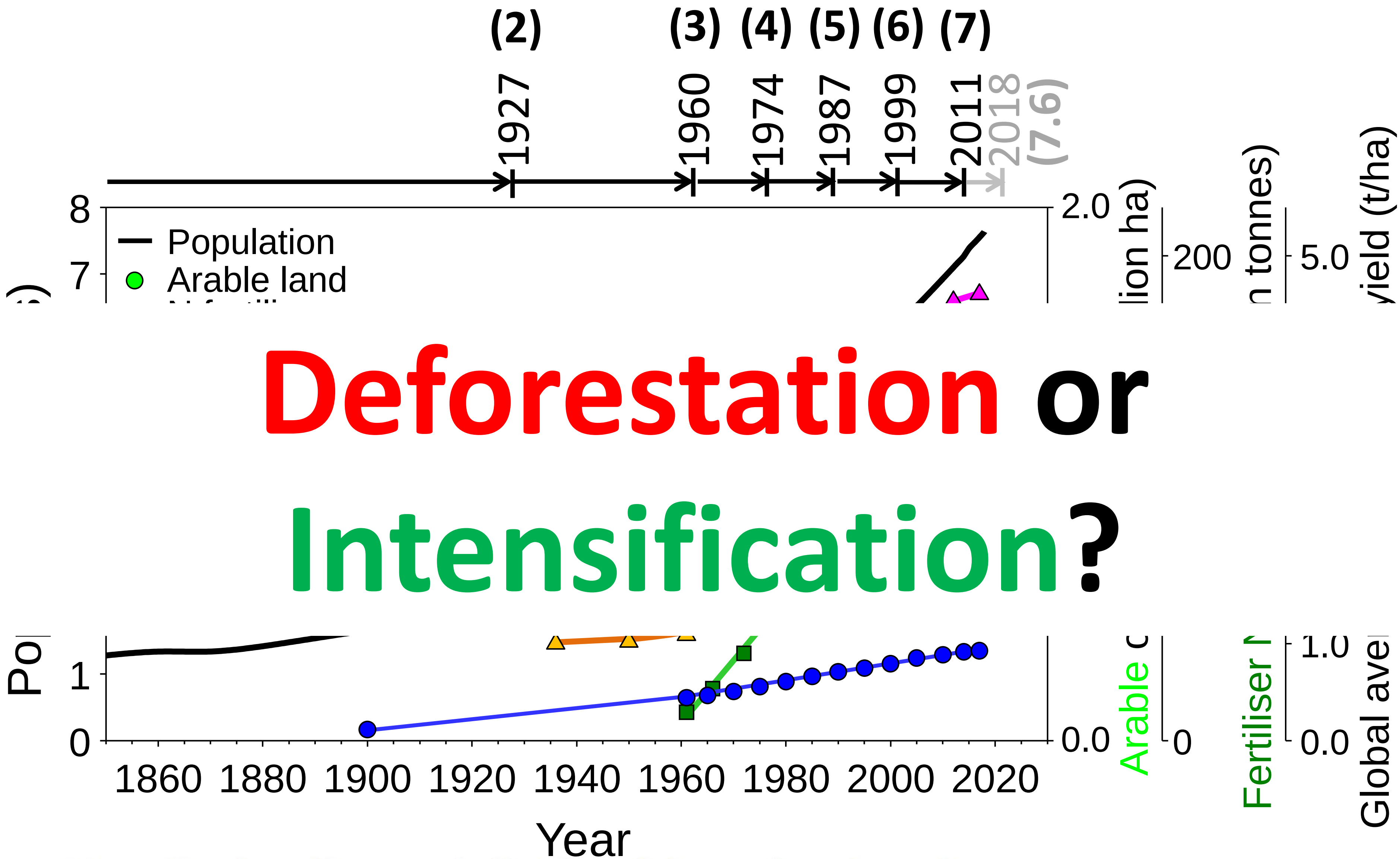


Value of support

The Village Pub

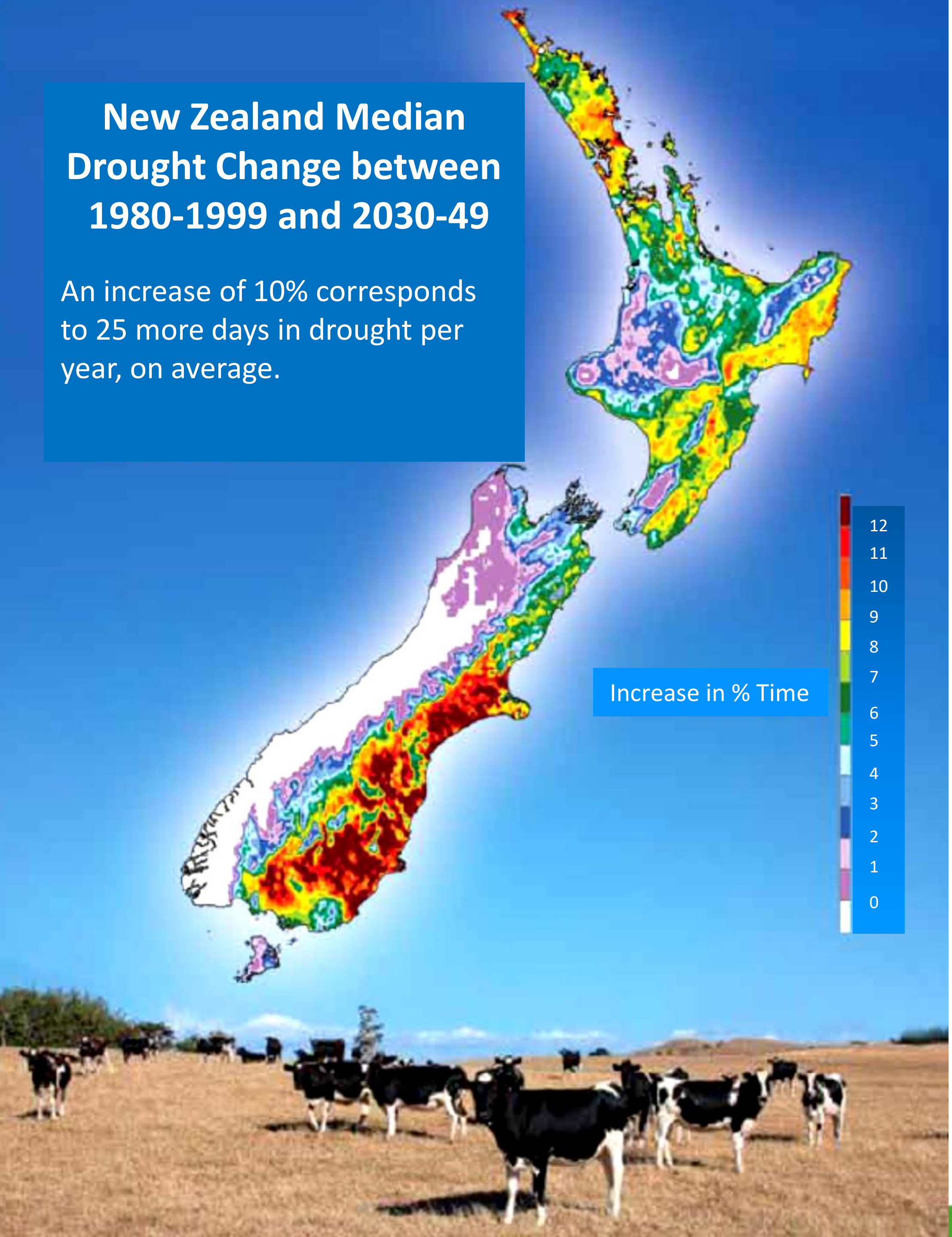
Roger Protz *and* Homer Sykes

Cabbage = 49 pesticides



Deforestation or Intensification?

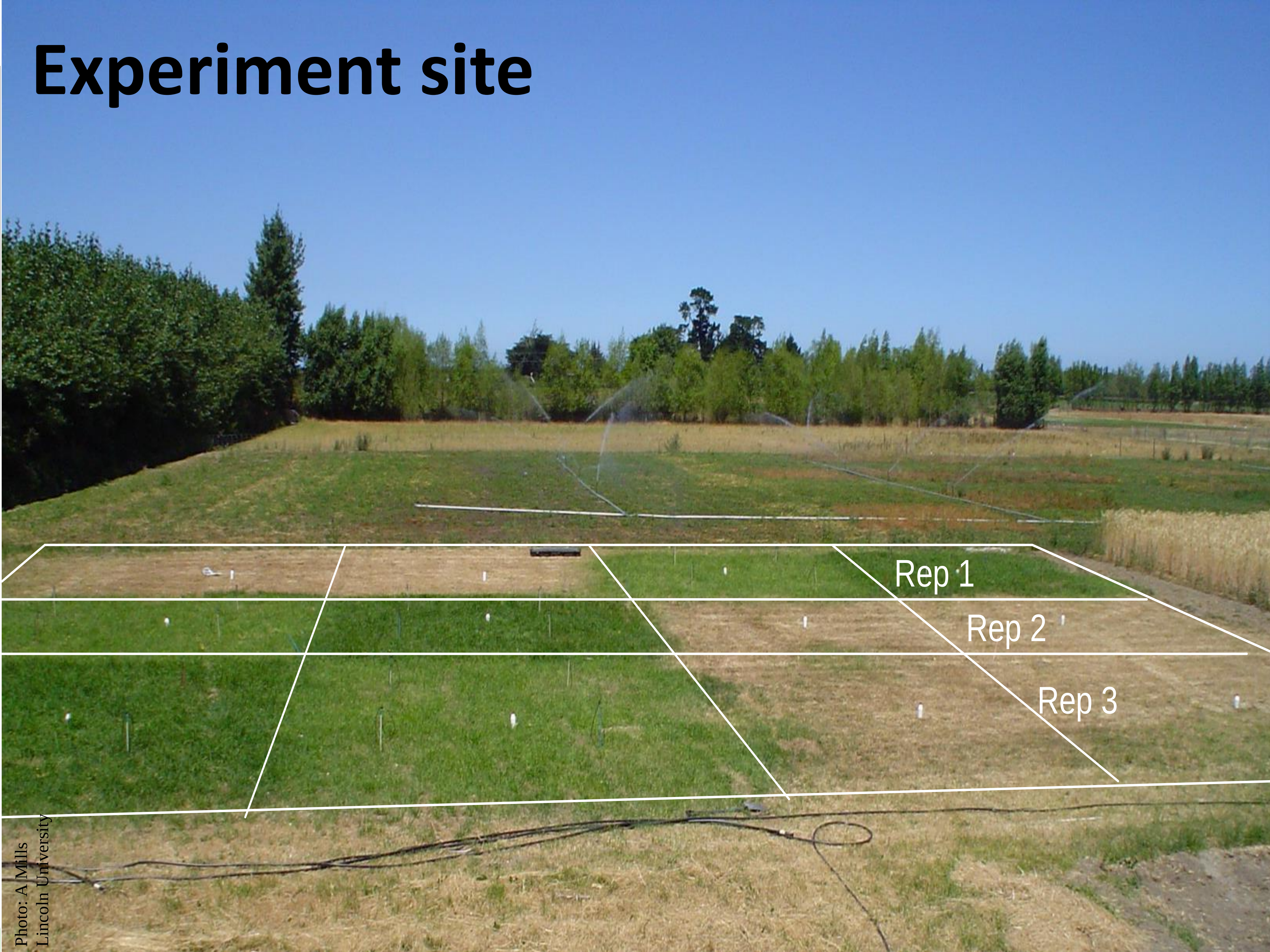
Recreated from Evans 1998, M.K. van Ittersum & FAOSTAT (2019)



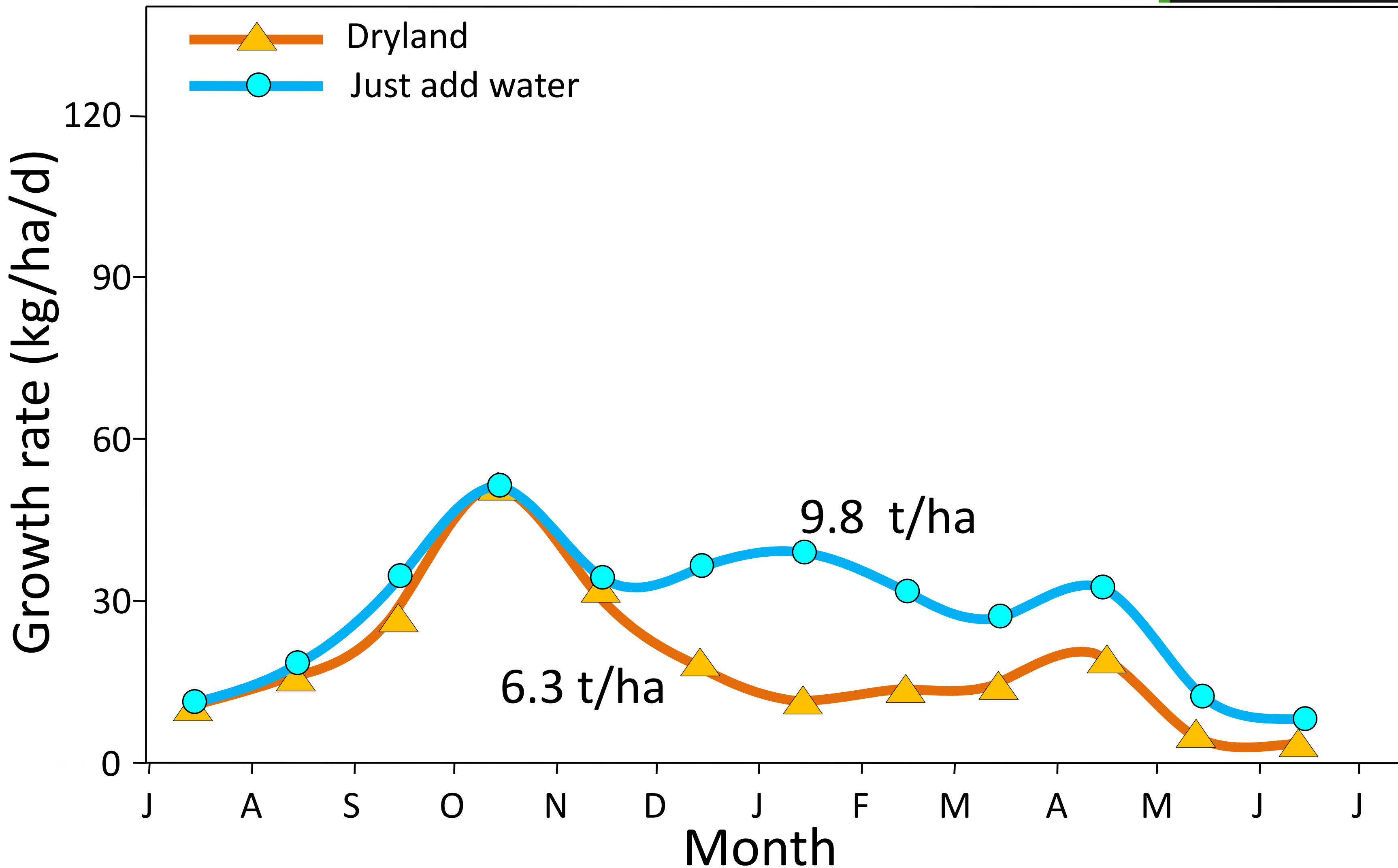
Predicted climate change in New Zealand by 2040

MPI-NIWA-Drought-in-a-Changing-Climate%20.pdf
http://www.mpi.govt.nz/document-vault/133

Experiment site



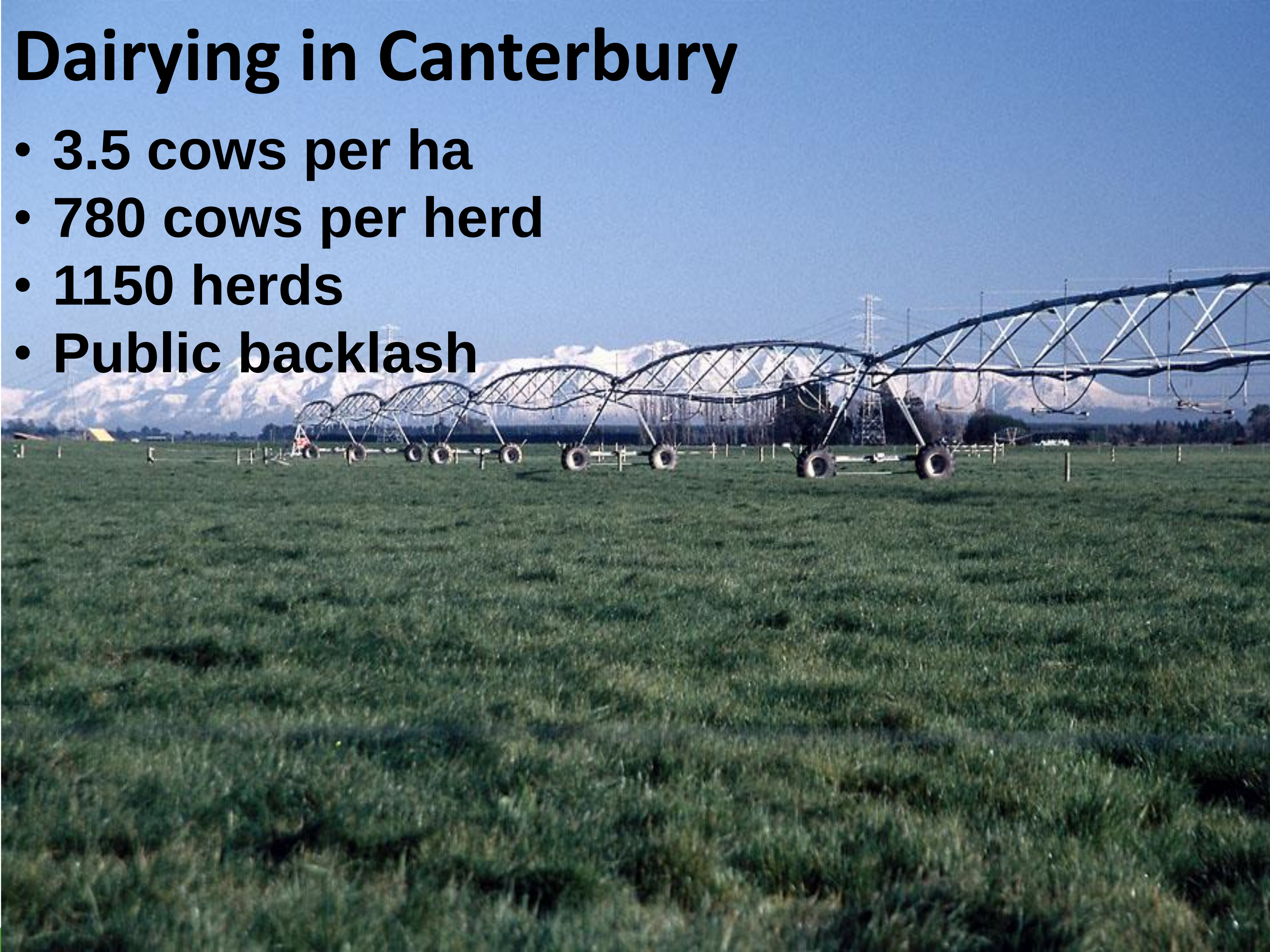
Growth rates (2 year mean)



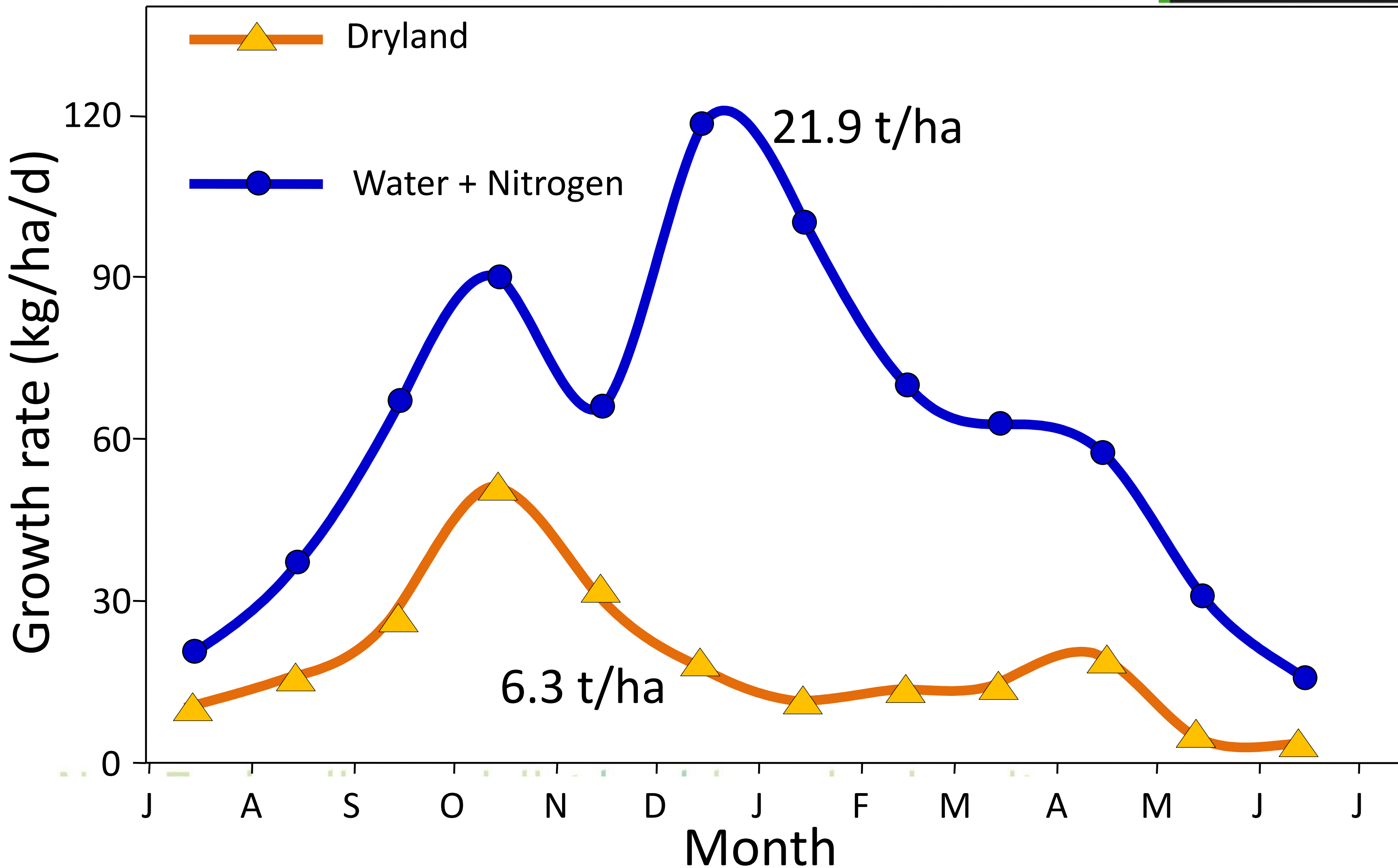
Mills *et al*. 2006, 2009

Dairying in Canterbury

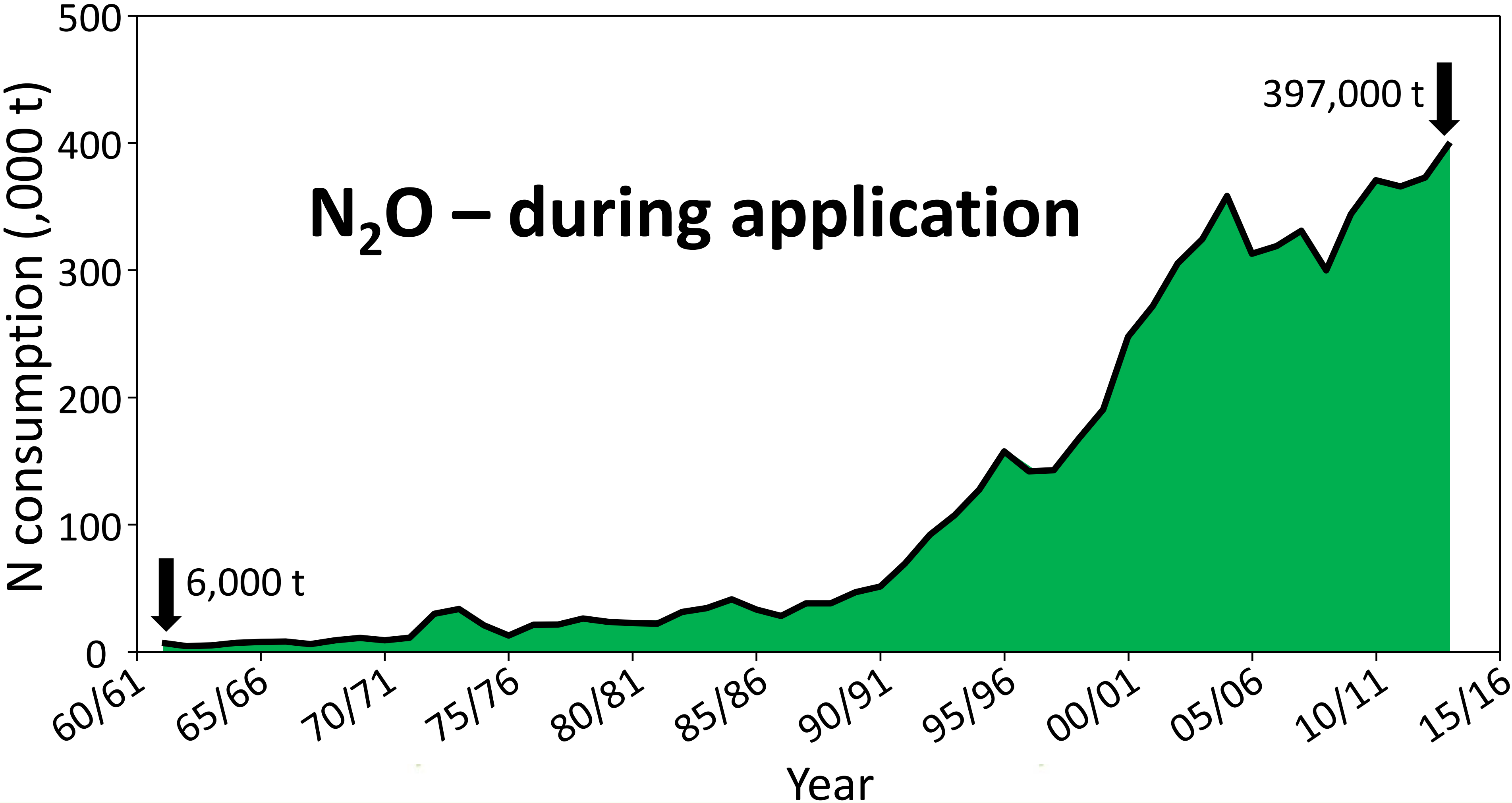
- 3.5 cows per ha
- 780 cows per herd
- 1150 herds
- Public backlash



Growth rates (2 year means)

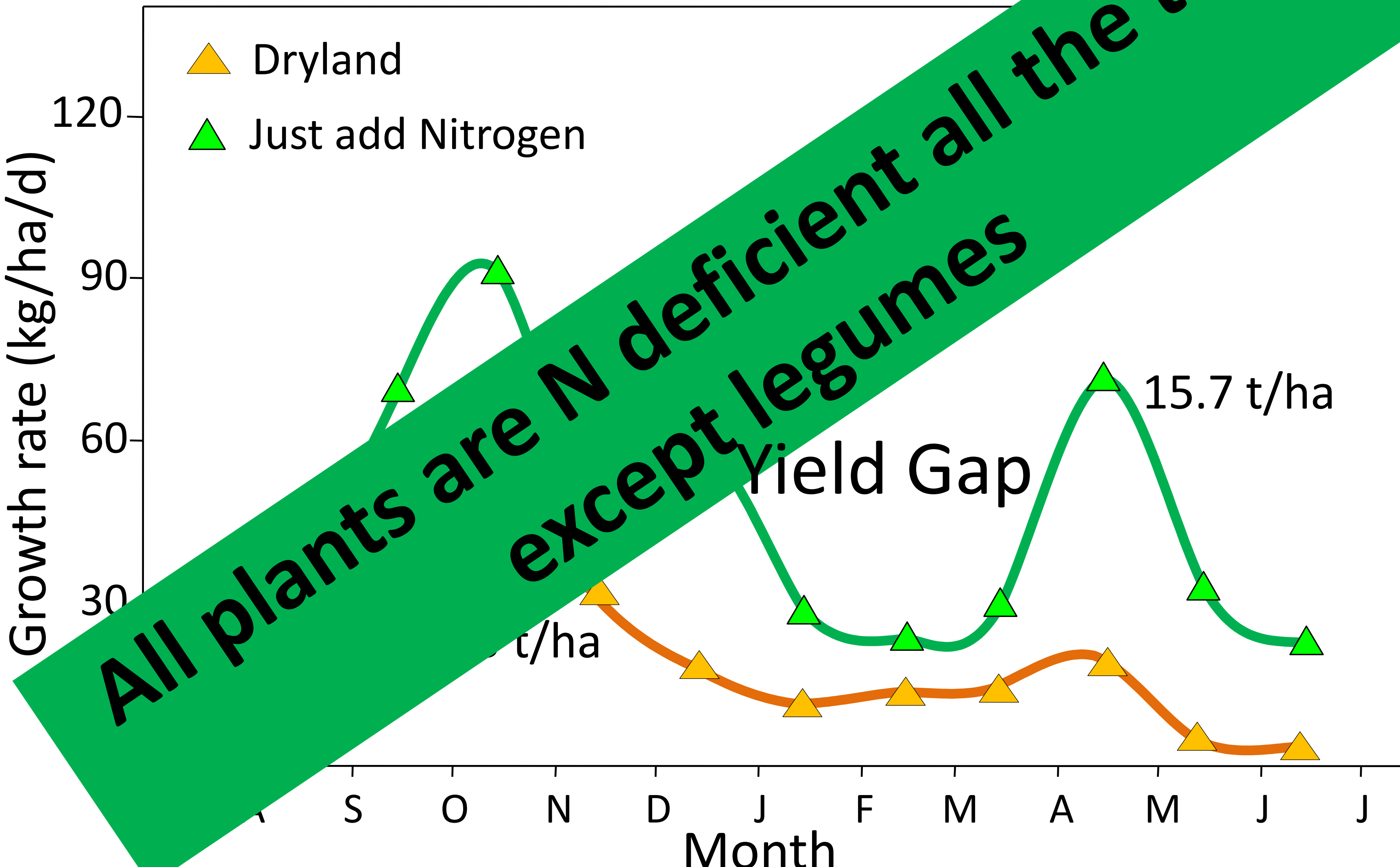


Nitrogen applied in NZ



NZ Fertiliser Association, 2015

Growth rates (2 year means)



All plants are N deficient all the time except legumes

Mills *et al*. 2006, 2009


Landscape farming


200-300 t OM/ha in NZ pastures

Hill country futures – Mid Cant.

- Aerial No til = Low carbon footprint
- N to break down thatch (40:1 C:N ratio)
- Minimal Risk of N leaching from hills
- Legumes to provide the N base

Photo: D J Moot
Lincoln University

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Phacelia (Purple tansy) between vines in NZ

Carbon dominant

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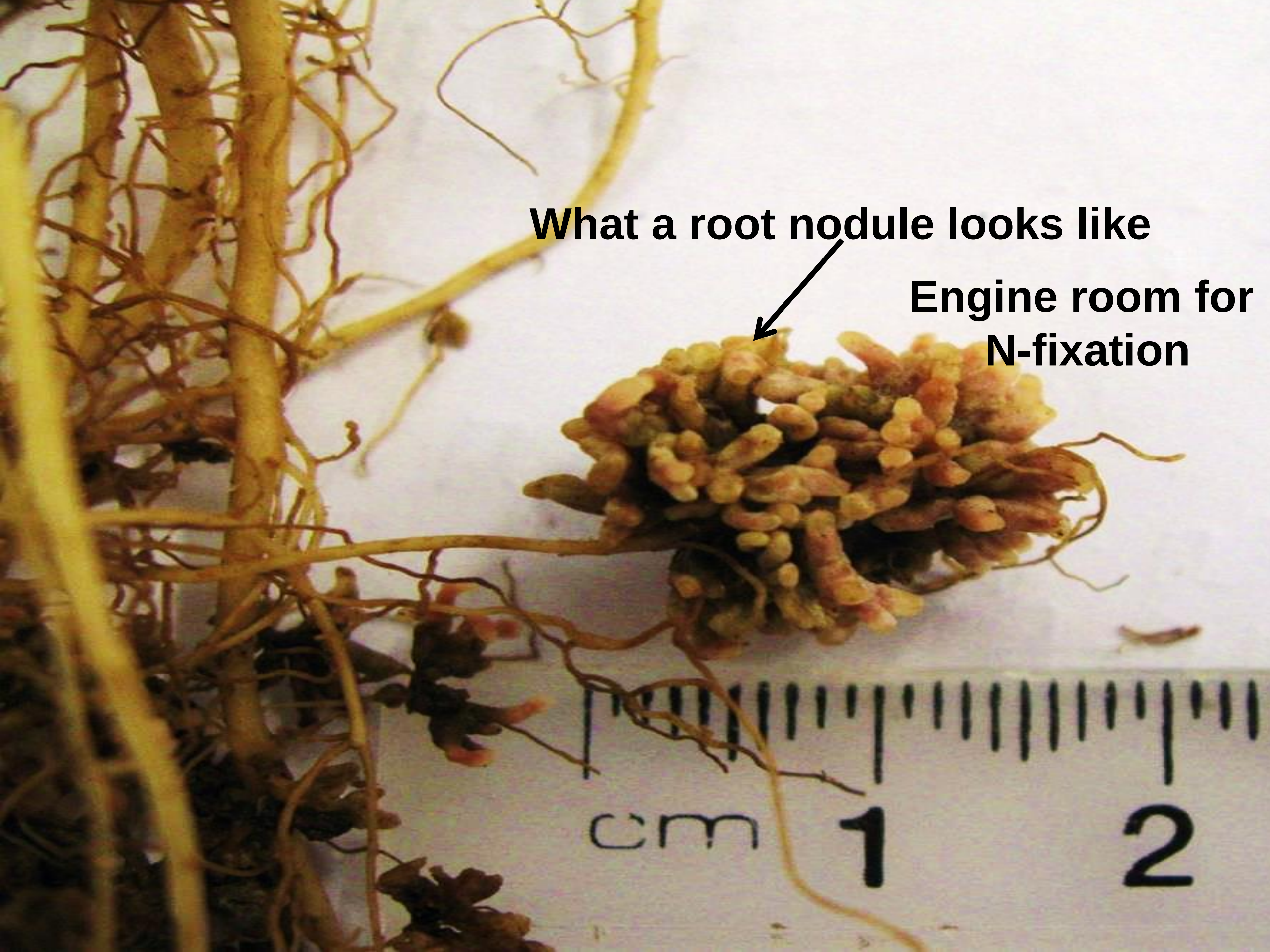
Buckwheat between vines in NZ
-Biological control

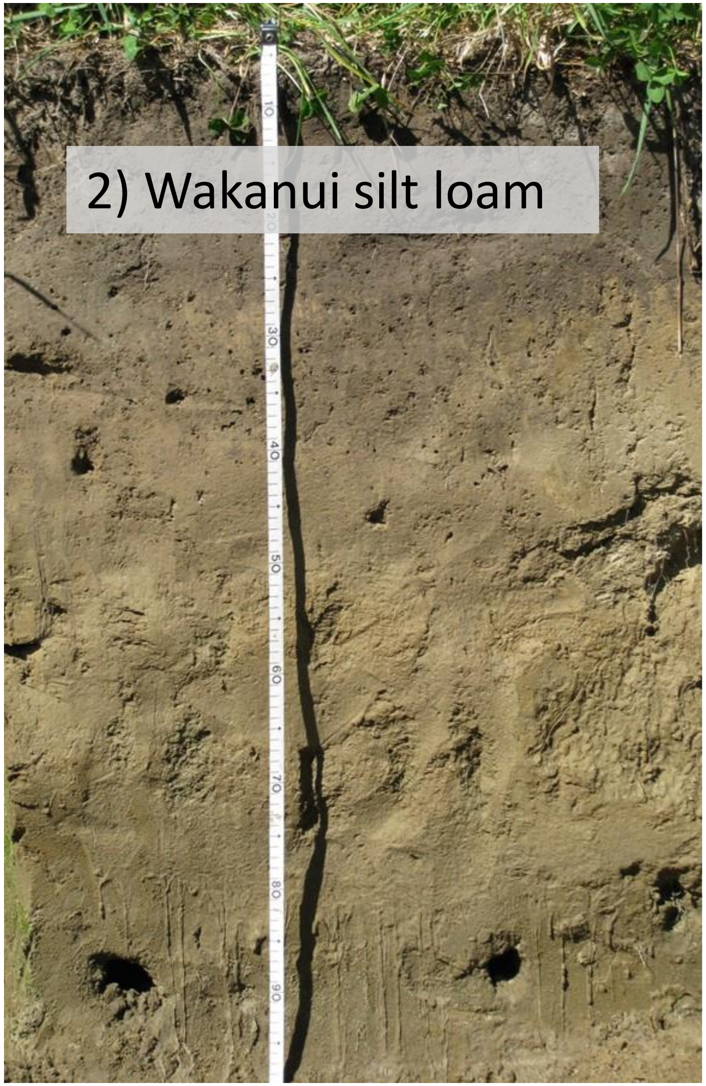
Lucerne between Shiraz vines in Australia

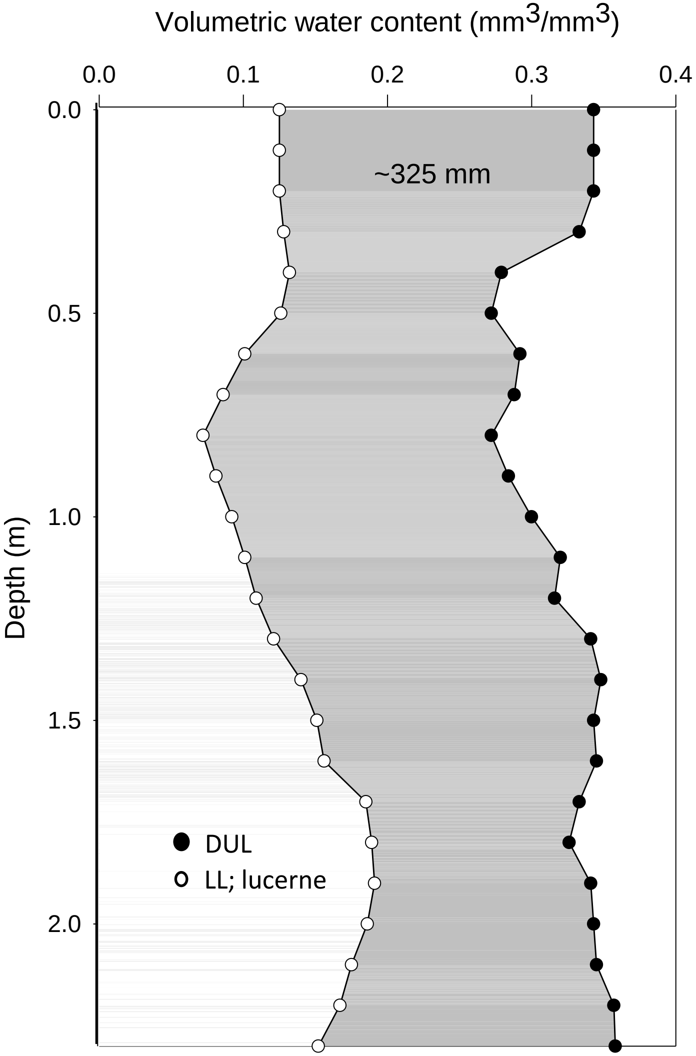

What a root nodule looks like
Engine room for N-fixation
cm
1
2

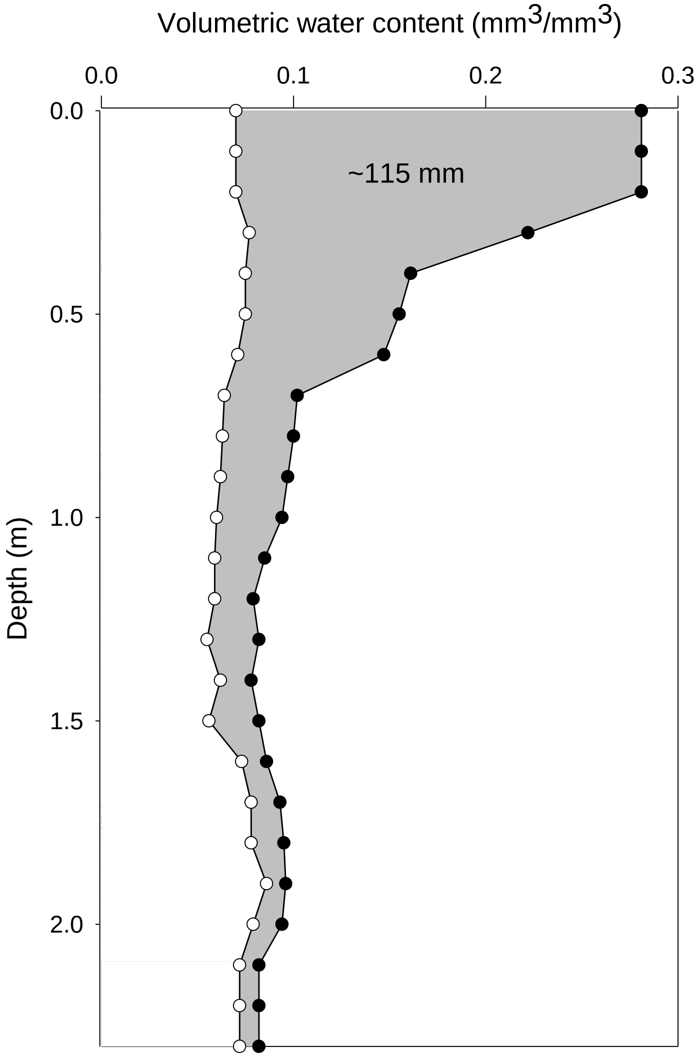
Red clover root nodules

Lucerne root

~8 months after sowing
> 1.5 m length


2) Wakanui silt loam

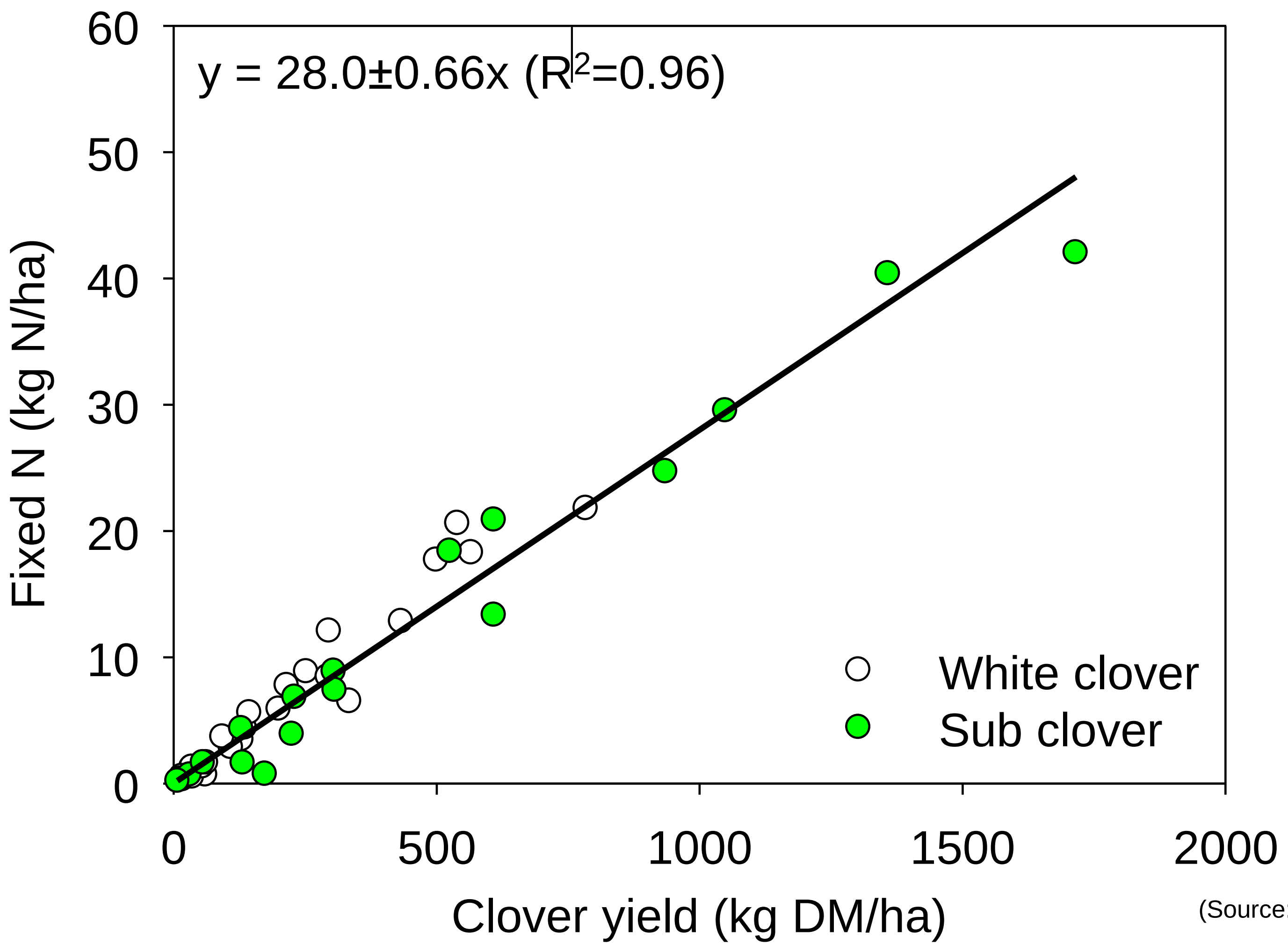

Volumetric water content (mm3/mm3)
0.0
0.1
0.2
0.3
0.4
Depth (m)
0.0
0.5
1.0
1.5
2.0
~325 mm
DUL
LL; lucerne



New Zealand's specialist land-based university

Biological N fixation

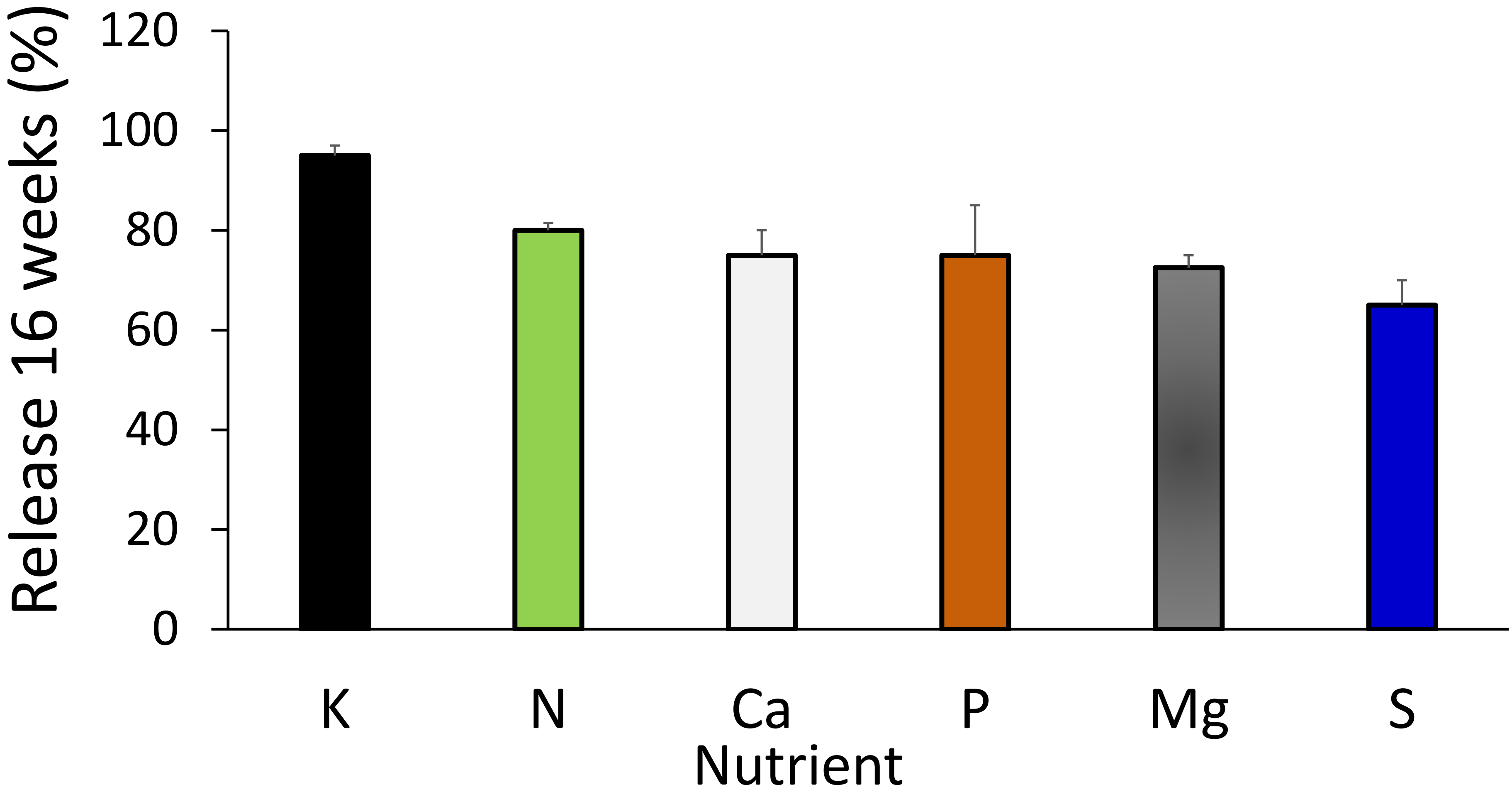
N_2 – NH_4 – amino acids



(Source: Lucas et al. 2010)

White clover in irrigated pasture - perennial

Release of nutrients from decomposing **ryegrass + white clover - Italy**



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(Source: Brunetto et al. 2011)

20%

Average N available from cover crops in the first year

80%

Estimated unavailable N: lost as volatile ammonia or tied up in the soil organic matter (available slowly over following years as mineralised by the soil microbes)

(Source: Brunetto et al. 2011)

Average N uptake by grapevines from the initial amount of N present in the litter of **ryegrass** and **clover - Aus**

(Source: Penfold and Collins 2012)

Growth in the field 20 month old plants – grazed by sheep

Widdup, 2003

Legume establishment

Target: clover

Soil fertility

Soil test >8 months before sowing:

- assist legume est.

N = no (direct drilling?)

P = yes (25-35 kg P/ha)

K = maybe (volcanic soils)

S = yes (11% in super)

Mo : trace – e.g. 140 g/ha – sodium molybdate


Olsen P>20


Olsen P<6

Wairarapa – P, K, Mo

(26/10/2017; Plot 25)

Fertility management

Sub clover - introduction

- Botanical name: *Trifolium subterraneum*
- Three subspecies: *subterraneum*

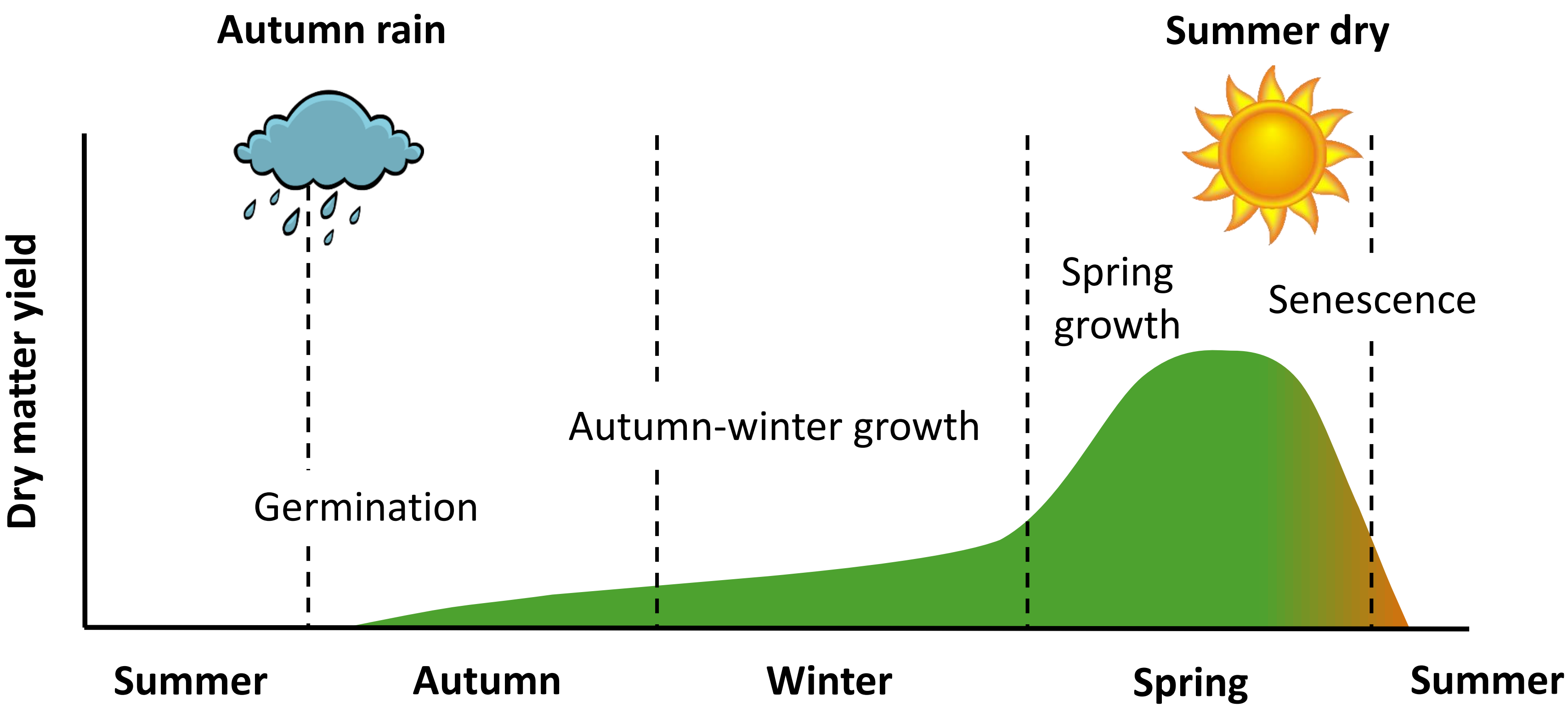
  brachycalycinum

  yanninicum
- Native in Western Europe – Mediterranean basin – West Asia
- Grown widely in Australia
- Seed imported from Australia

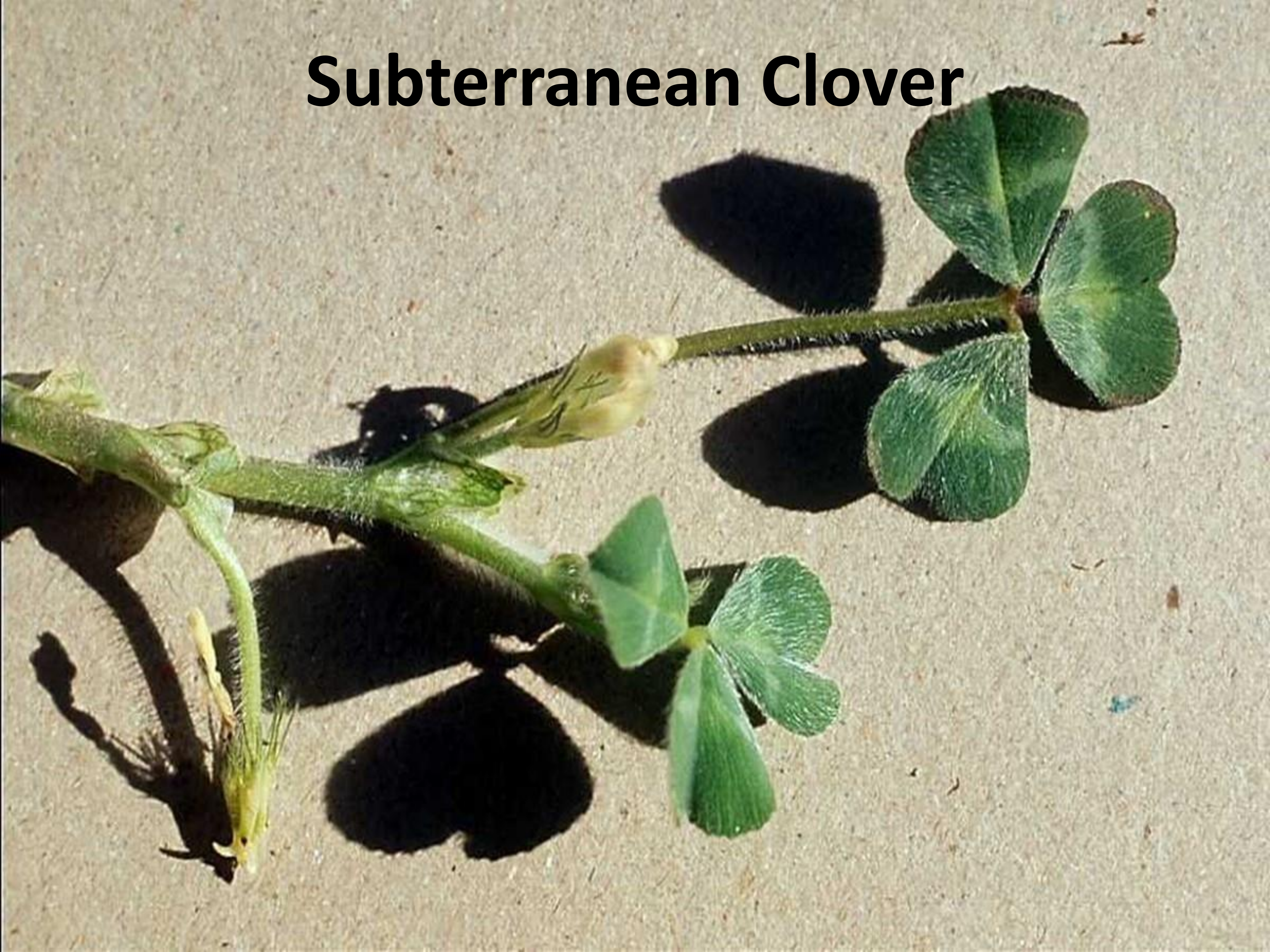
Sub clover – lifecycle

- winter annual species
- establishes in bare ground in autumn
- 90% of DM produced in spring
- buries seed late spring/early summer and dies
- N released to companion plants

Sub clover – life cycle



Subterranean Clover

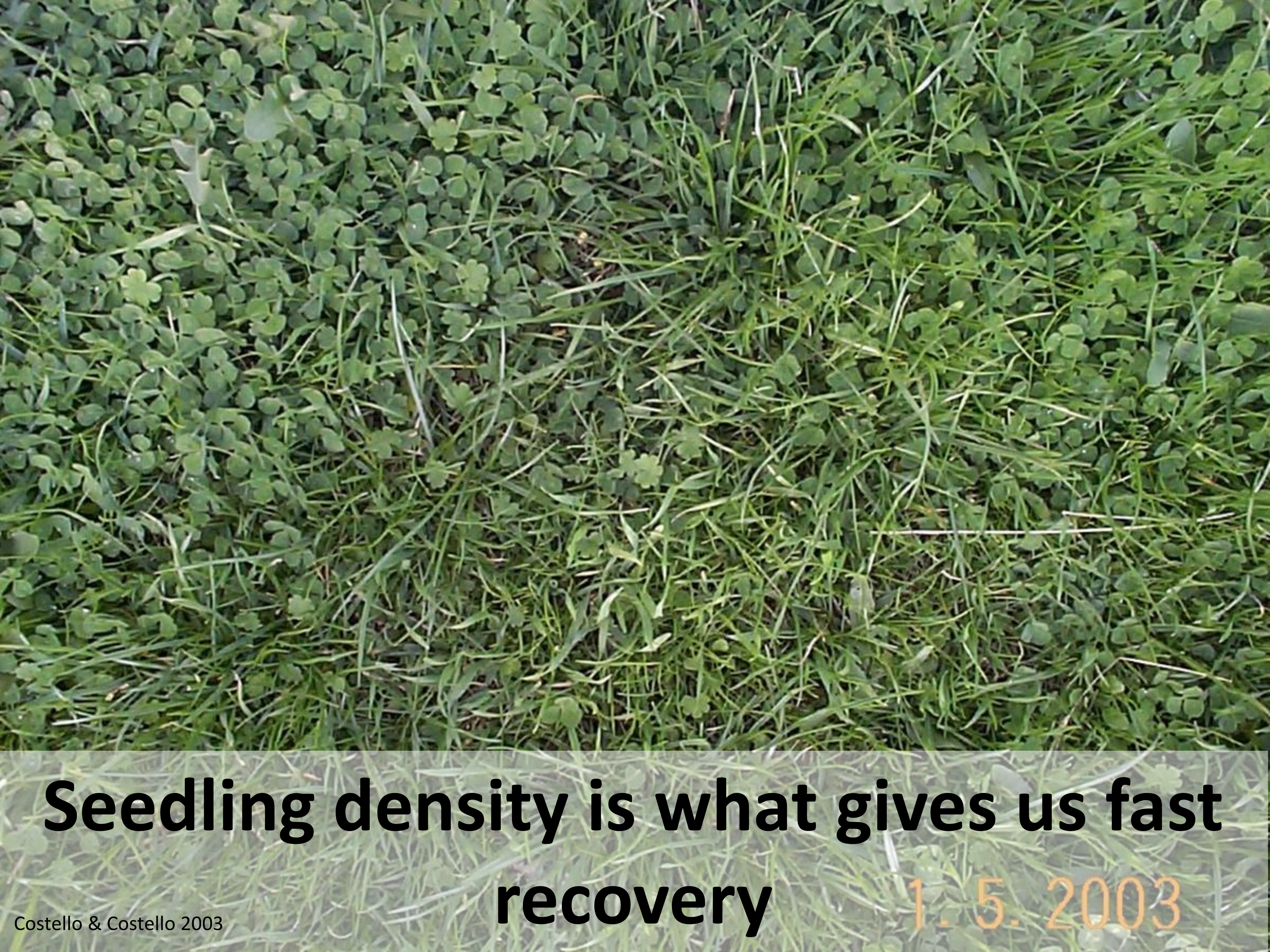


Direct drill before rain

Initial population for seed build up


5. 4. 2003


12. 4. 2003



Seedling density is what gives us fast recovery

Costello & Costello 2003

Sub clover ‘Antas’ drilled into pasture

Cover crops in grapevines - Chile

90% of N

Contained in **sub clover** and **burr medic** is derived from natural N_2 fixation

SPRING

Period of rapid N mineralization in soil organic matter coincides with peak N demand by the vines (bloom/fruit set)

(Source: Ovalle et al. 2006, 2010)

Cover crops in grapevines

136 kg N/ha

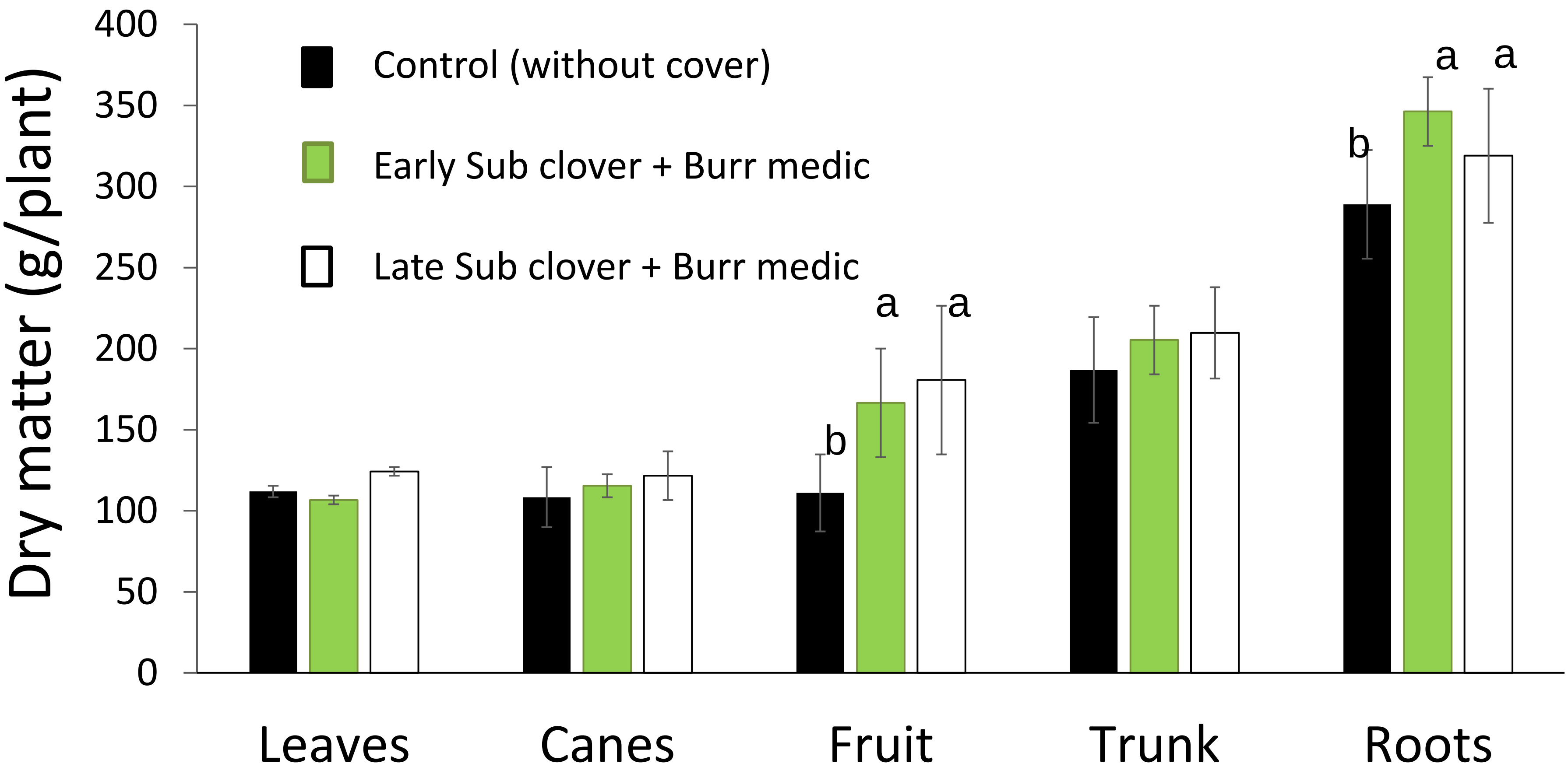
Average N supply of cover crop legumes per year

12-15 kg N/ha

N estimated to be recovered by vine plants from cover crop legume supply

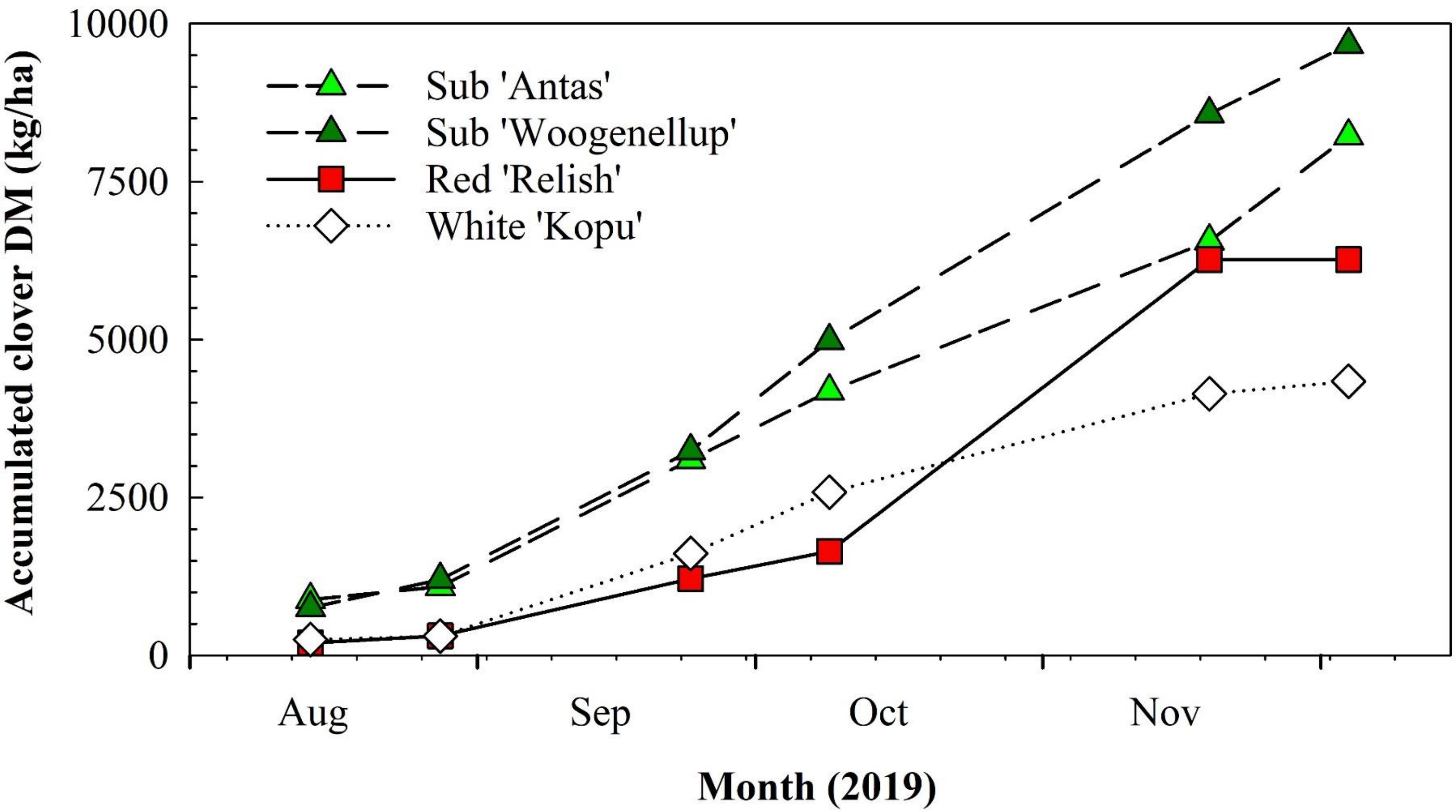
(Source: Ovalle et al. 2010)

Dry matter production of the components of vines without or with cover crops

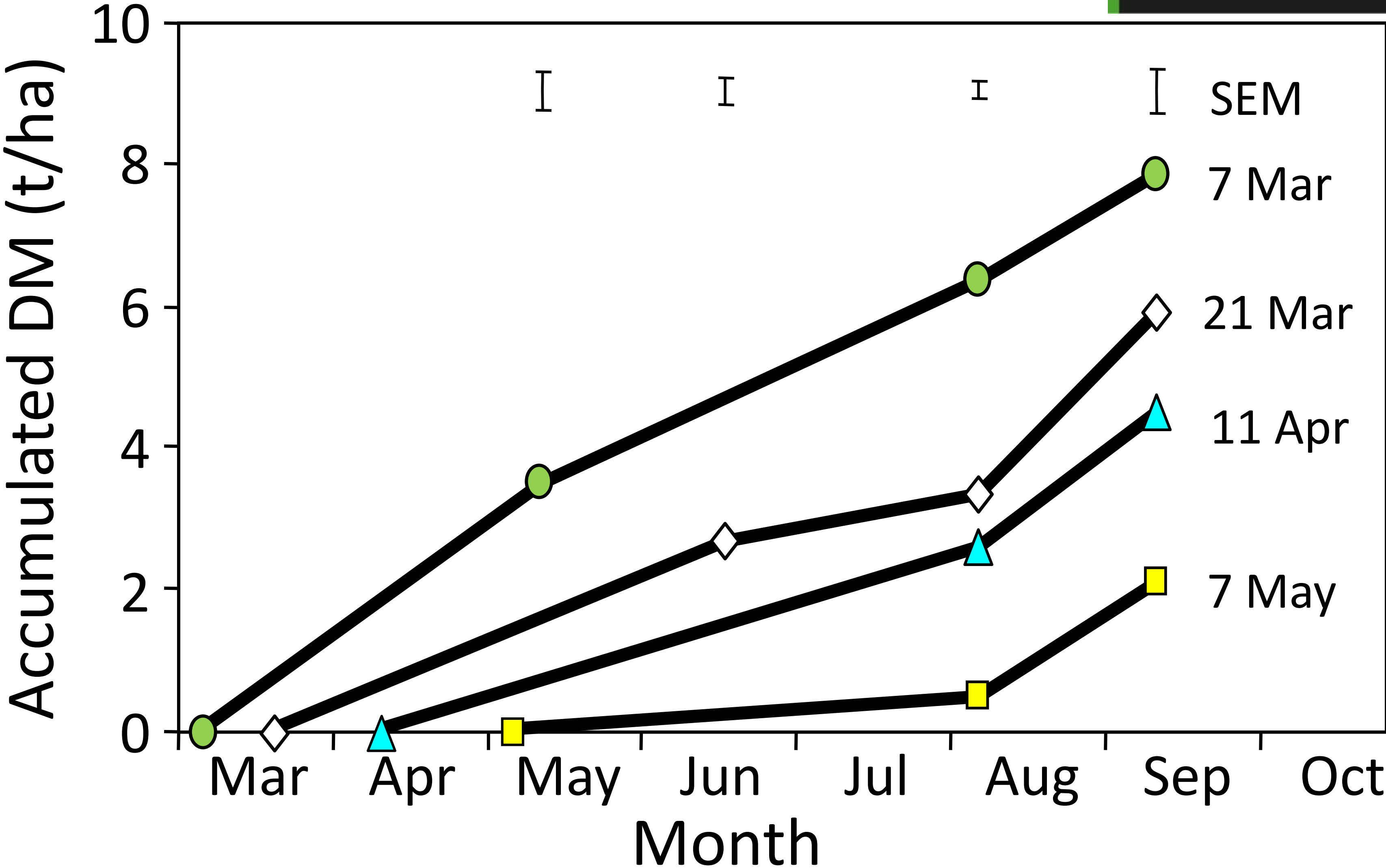


Sub clover is winter active

Accumulated yield of clover monocultures at Lincoln



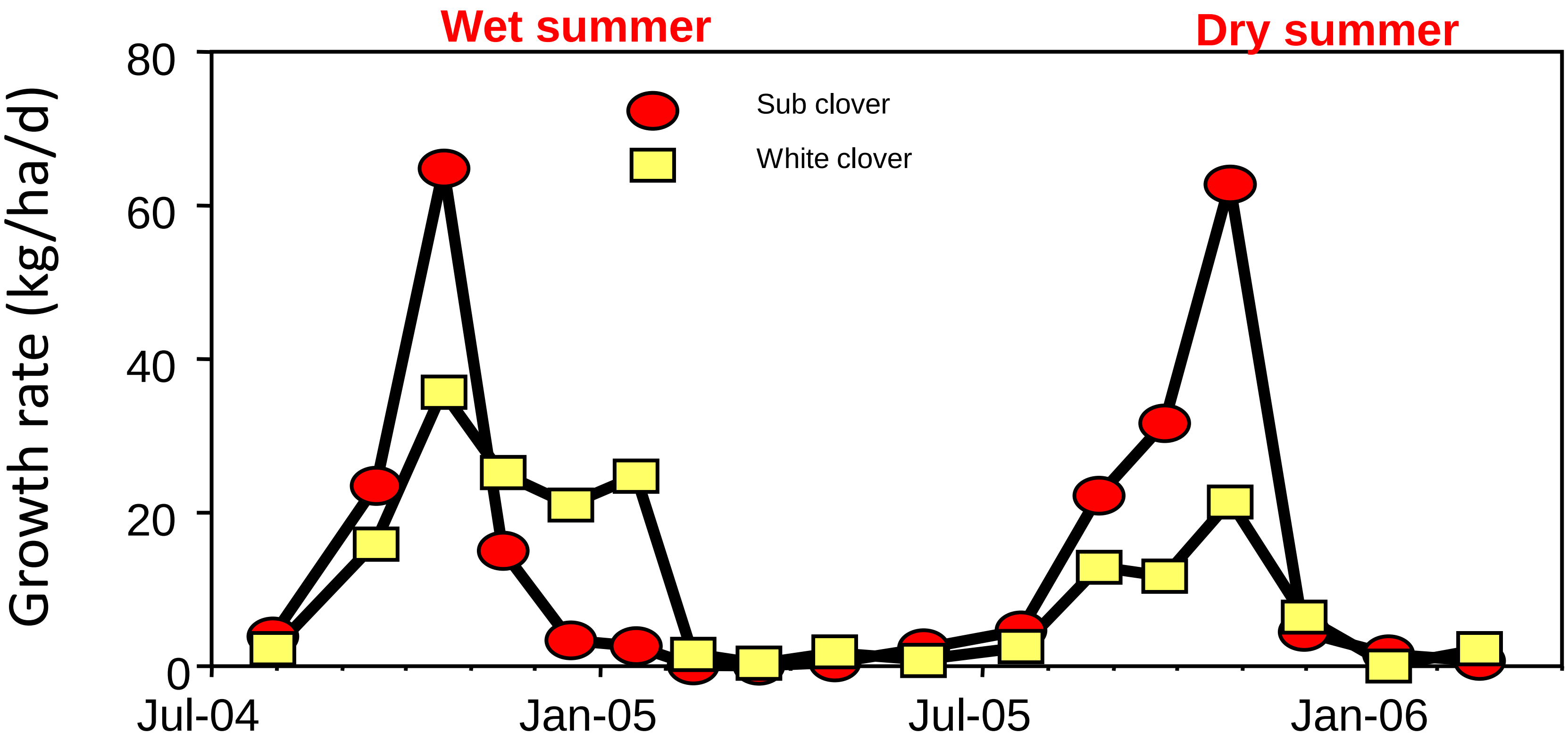
Dry matter yields



21 April 2017


Sub clover dominant pasture 8 Oct 2015

Seasonal clover growth



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Brown *et al*. 2006

Pasture Mix

- 10 kg subterranean clover
  - E.g. Denmark + Woogenellup or Antas
- 1 kg Cocksfoot

- Can be grazed to accelerate release of nitrogen
- N release annually from plant death
- Water breaks down organic material and releases nitrate- which is the preferred form of N uptake

'Cefalu' arrowleaf

'Bolta' balansa

'Prima' gland

'Mihi' Persian

Establishment of annual clover Important to reseed !!

Seed maturity

‘Cefalu’ arrowleaf

‘Bolta’ balansa

‘Prima’ gland

‘Mihi’ Persian

Materials & Methods

Paddock: HRA8, Lincoln University
Soil: Templeton silt loam

Sown: 26/3/2015

Design: RCB Simplex centroid
Species: 'Base' perennial ryegrass
'Tonic' plantain
'Apex' white clover (coated)
'Sensation' red clover

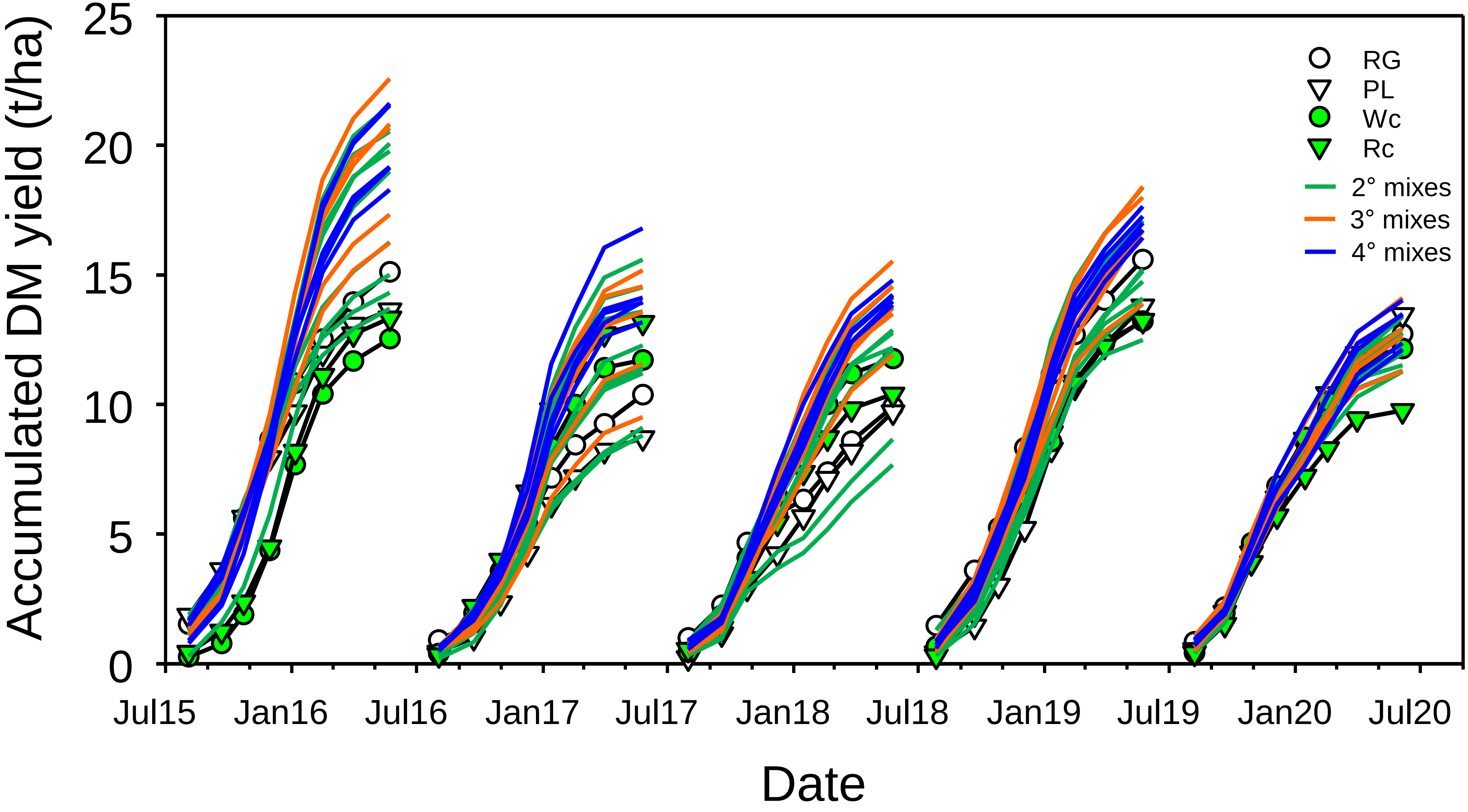
Treatments: 23*
4 x monocultures
9 x binary mixes
5 x tertiary mixes
5 x quaternary mixes
(*inc 4 with component species sown in alternate rows)

Replicates: 4
Total No. plots: 92
Plot size: 2.1 x 6.0 m (12.6 m^2)
Total sowing rate: 833 viable seeds/m^2

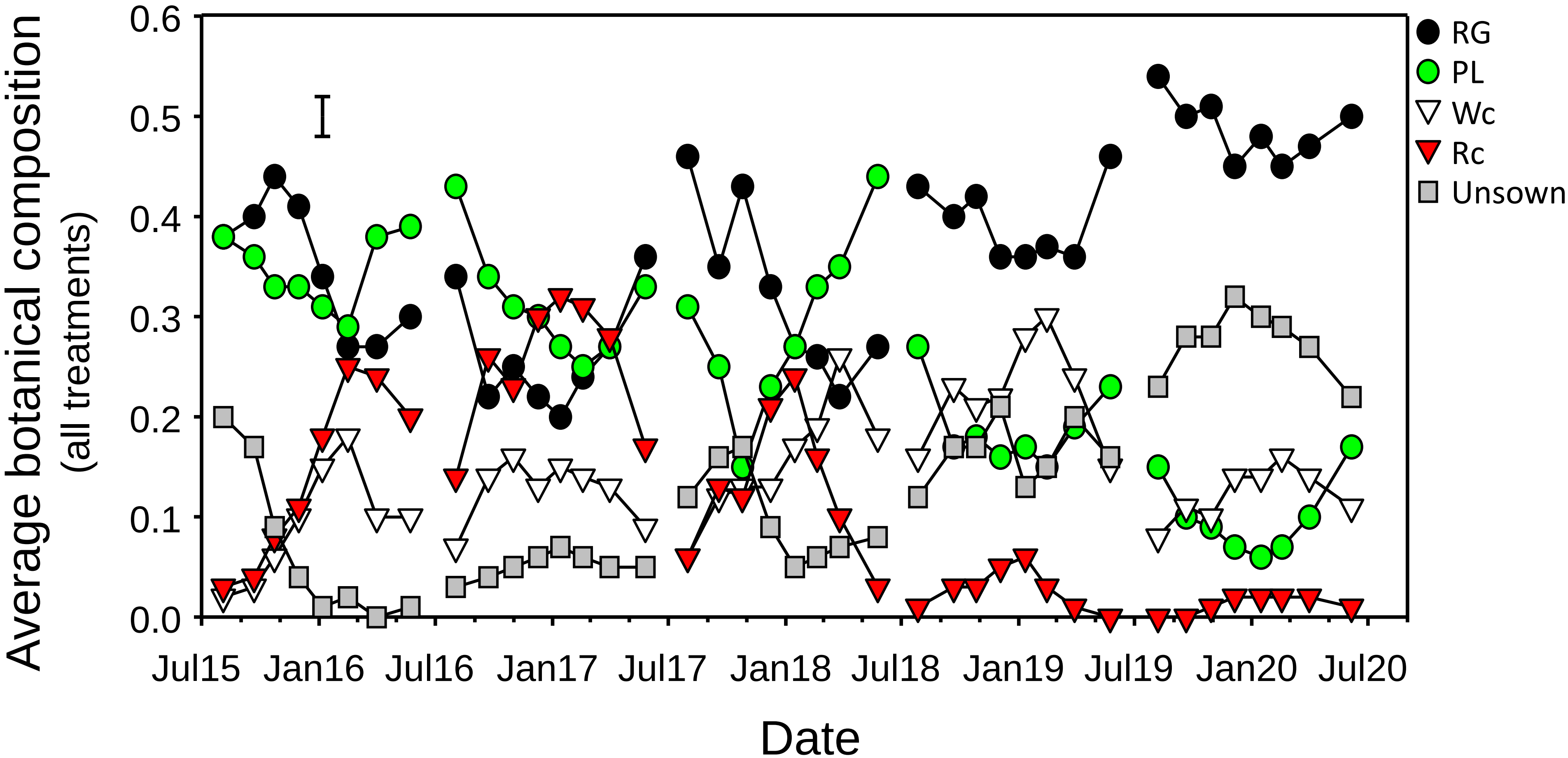
- ✓ Irrigated
- ✓ Grazed post harvest

Summer 2015-2016

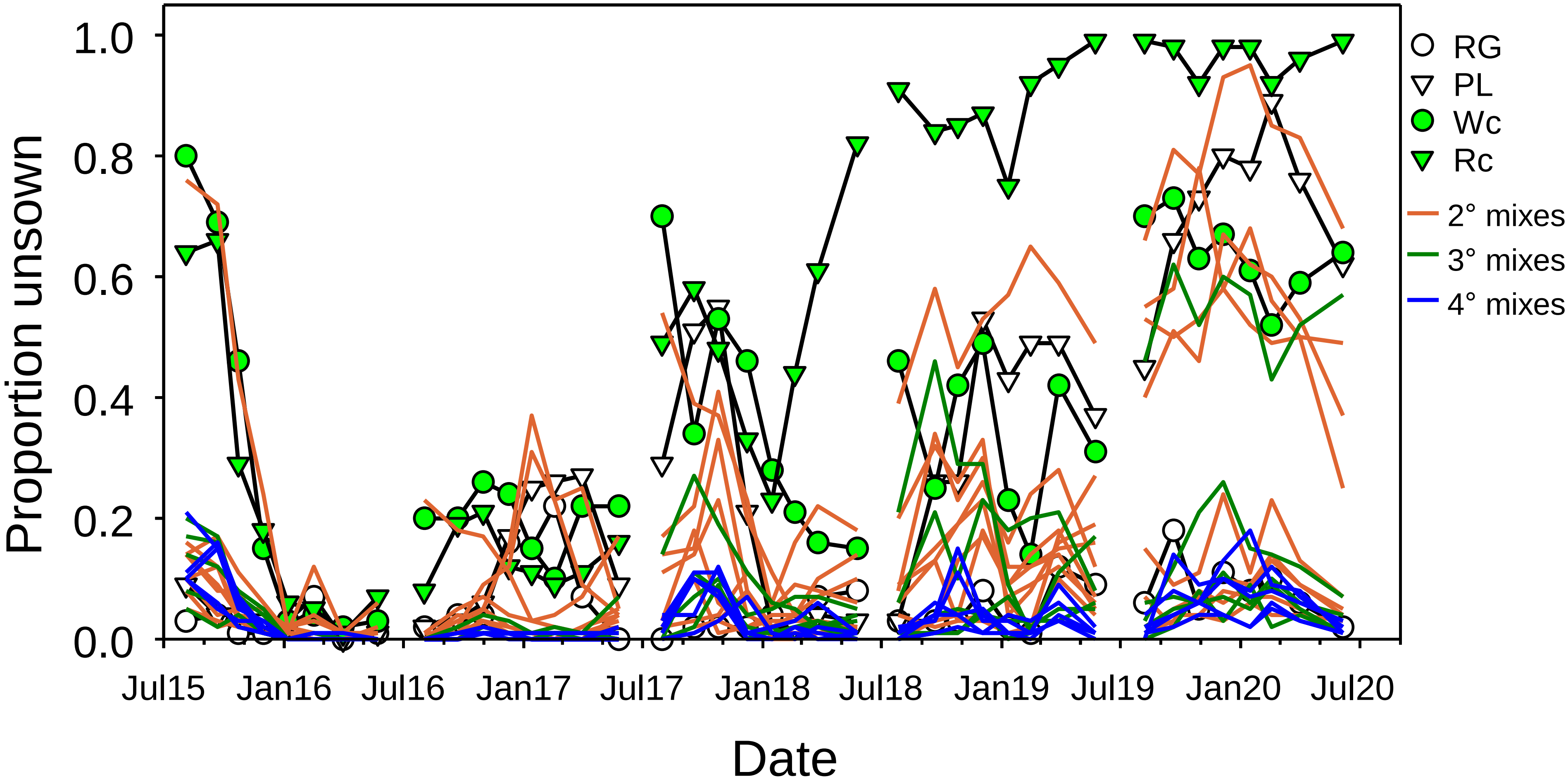
Dry matter production



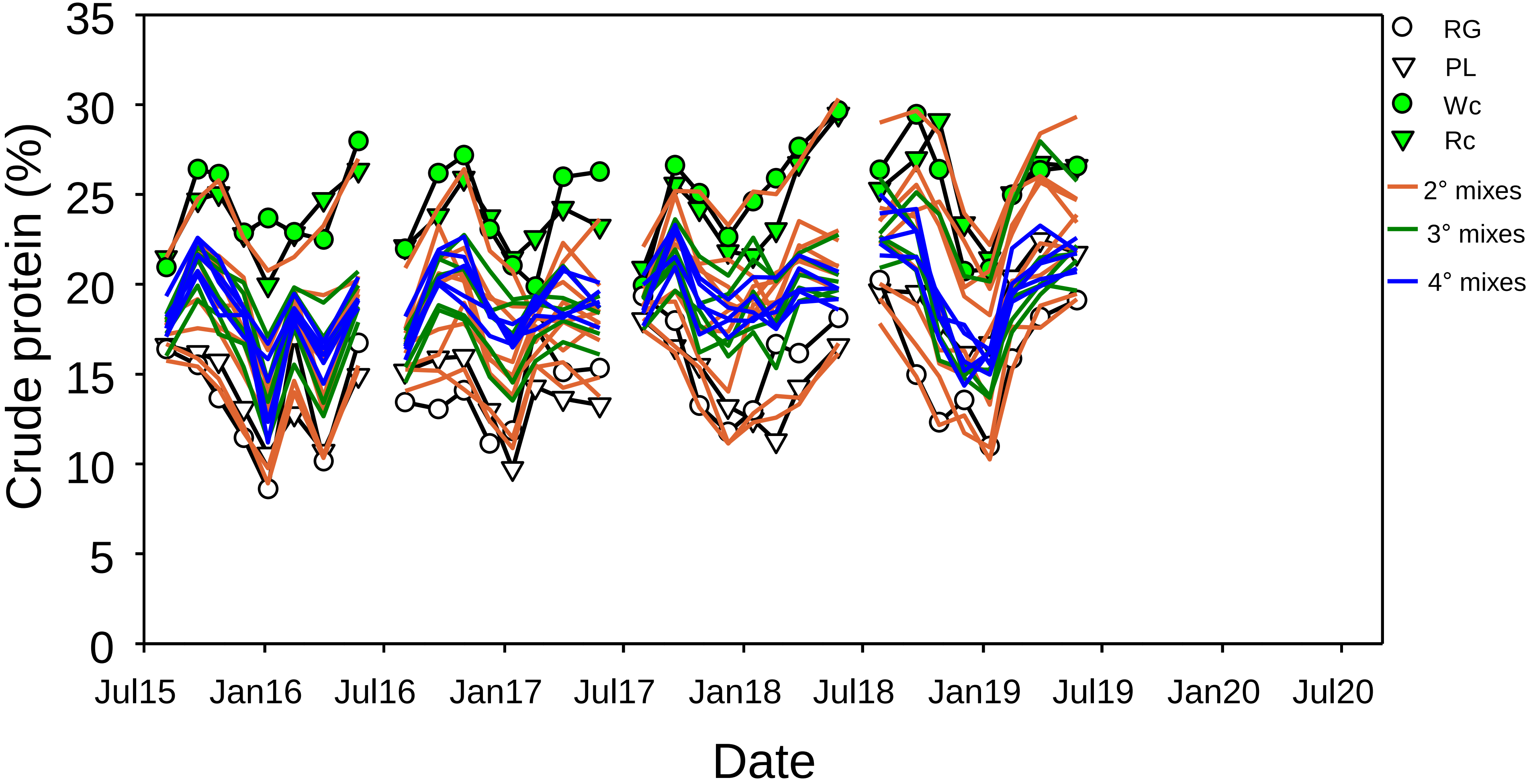
Average botanical composition



Contribution of unsown species



Crude protein (%)



Some key points

- Higher sowing density – early ground cover, suppress weeds but also clover
- Lower sowing density – delayed ground cover (tillering/branching), more clover and weeds
- Conflict – encourage clover versus suppress weeds and early DM production
- Ryegrass dominates but is N deficient!

Conclusions - Legumes

- Fix N from that atmosphere
- Deep tap root that competes for water
- Perennials - CHO and N below ground in autumn – slower N release
- Annuals establish in autumn die in summer
- Beneficial insects from flowering?
- Cut and carry and grazing options

References

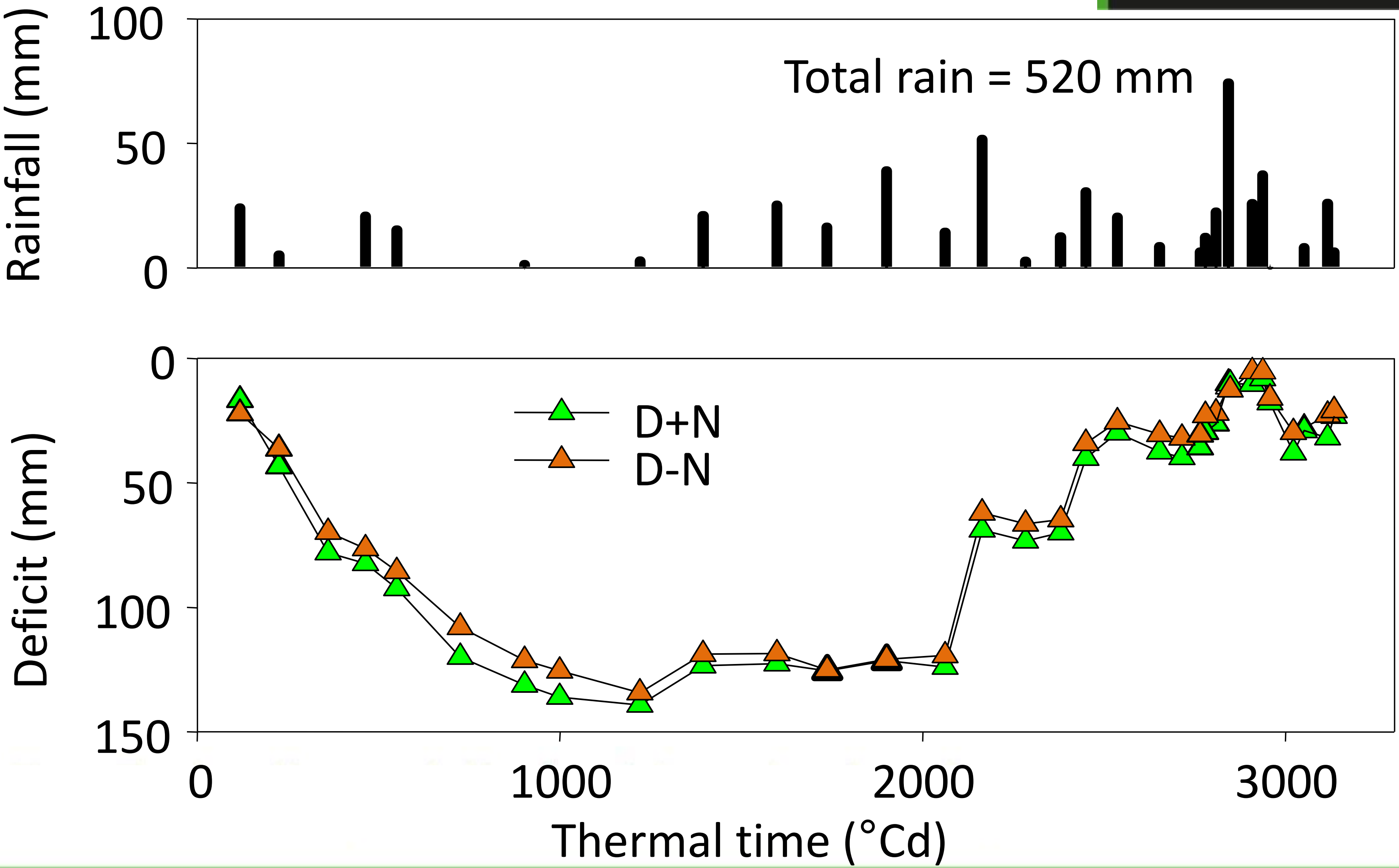
Ovalle, C., Urquiaga, S., Pozo, A.D., Zagal, E. and Arredondo, S., 2006. Nitrogen fixation in six forage legumes in Mediterranean central Chile. Acta Agriculturae Scandinavica Section B-Soil and Plant Science, 56(4), pp.277-283.

Ovalle, C., Del Pozo, A., Peoples, M.B. and Lavín, A., 2010. Estimating the contribution of nitrogen from legume cover crops to the nitrogen nutrition of grapevines using a 15 N dilution technique. Plant and Soil, 334(1-2), pp.247-259.

Brunetto, G., Ventura, M., Scandellari, F., Ceretta, C.A., Kaminski, J., de Melo, G.W. and Tagliavini, M., 2011. Nutrient release during the decomposition of mowed perennial ryegrass and white clover and its contribution to nitrogen nutrition of grapevine. Nutrient Cycling in Agroecosystems, 90(3), p.299.

Penfold, C. and Collins C. 2012. Cover crops and vine nutrition. Wine Australia for Australian Wine, March 2012, 3p.

Soil moisture deficit 2003/04



Mills 2007