Lincoln University

Te Whare Wānaka o Aoraki

AOTEAROA • NEW ZEALAND

Lucerne

30th July 2019

Australian Fodder Industry Annual Conference

29-31 July Crowne Plaza, Hunter Valley NSW

Professor Derrick Moot

New Zealand's specialist land-based university

Photo: S Larsen
Lincoln University

85 post grads + 40 visiting interns/scholars

Introduction

- Background
- Drivers of forage production
- Lucerne growth and development
- Quality cutting and grazing
- Genetics - Fall Dormancy - yield

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.

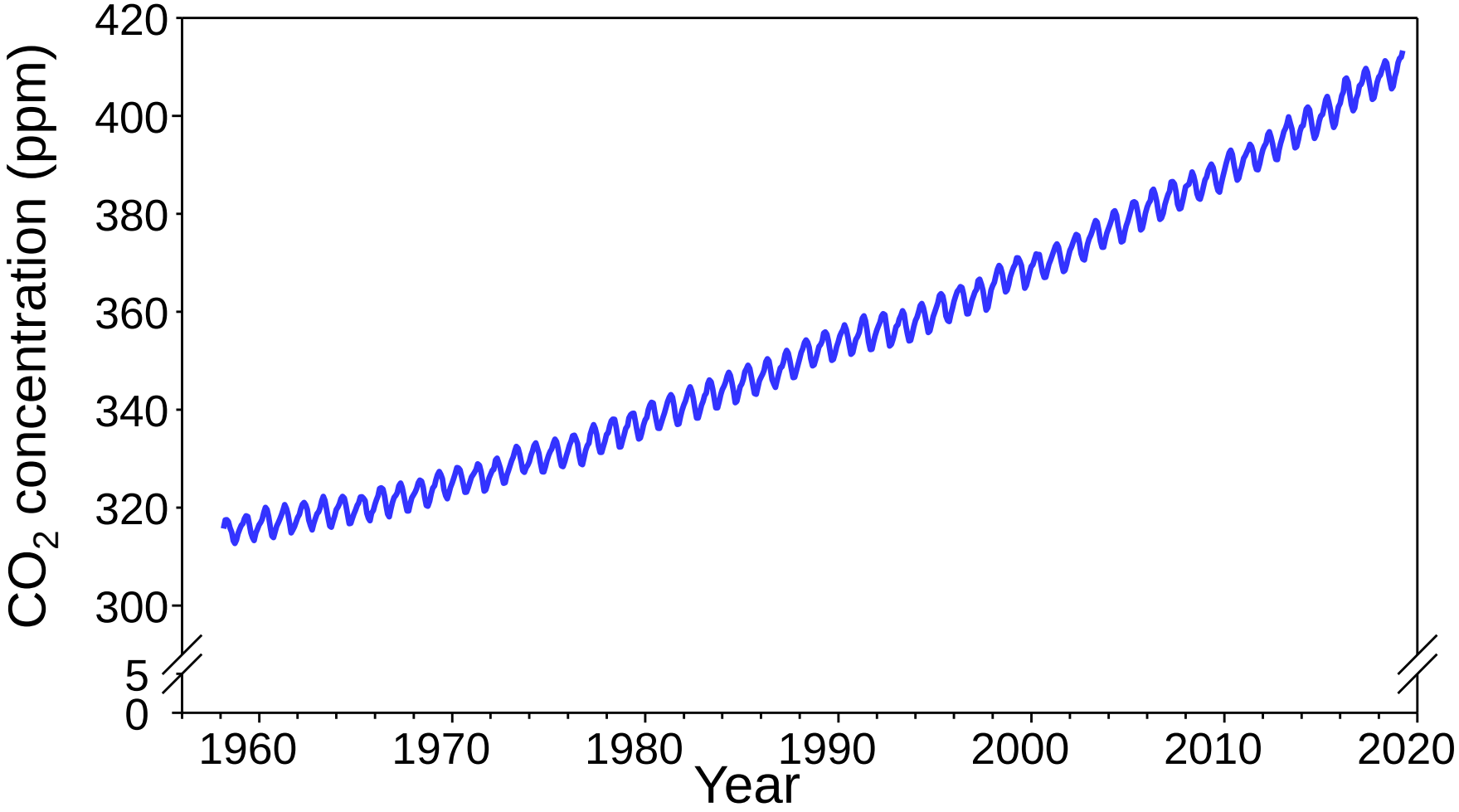
Absent: Helen CAMERON, Ian TATE.

Value of good data

The Village Pub

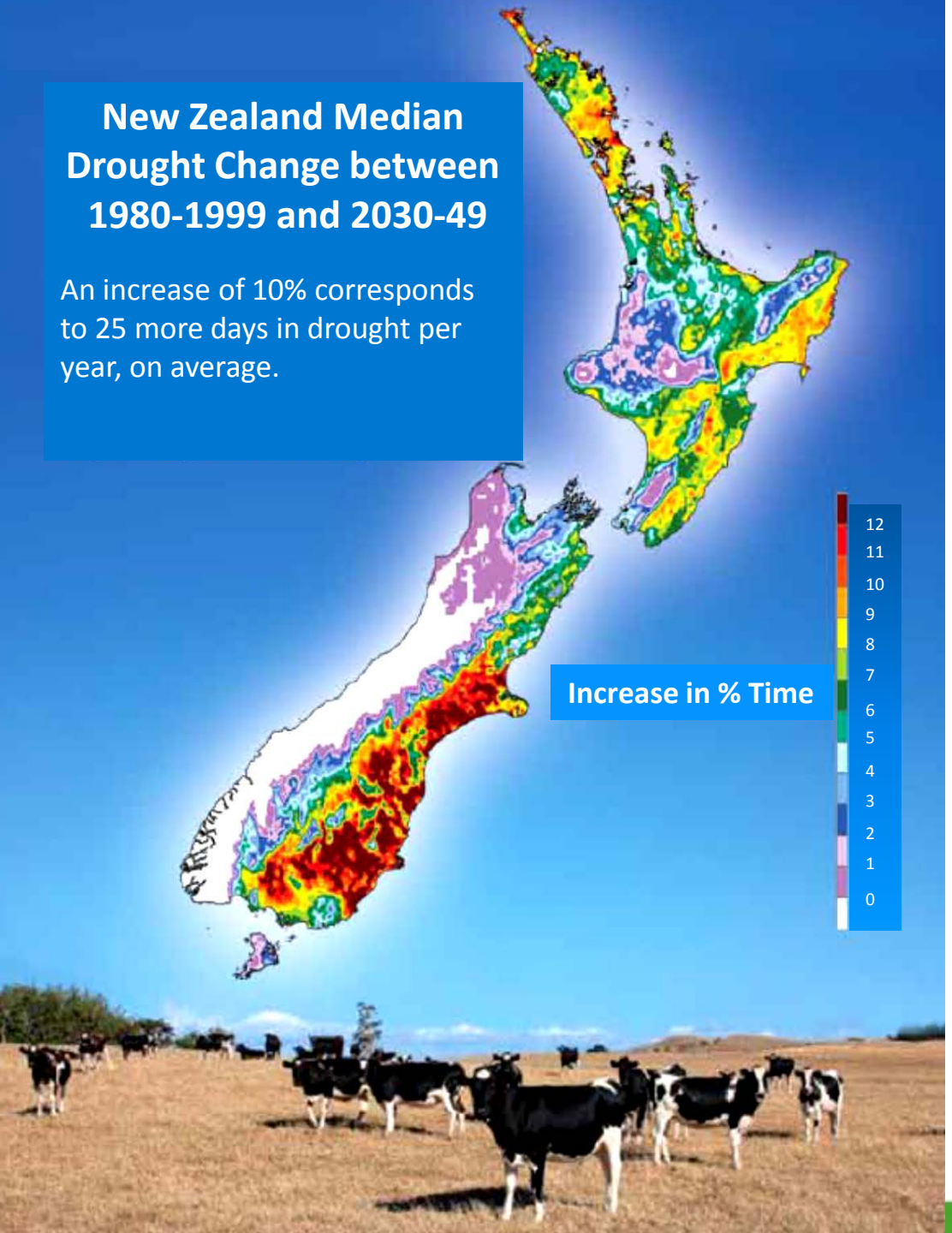
Roger Protz *and* Homer Sykes

CO_2 concentration at Mauna Loa, Hawaii



Data source:

Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends/) and Dr. Ralph Keeling, Scripps Institution of Oceanography (scrippsco2.ucsd.edu/). (28/5/2019)



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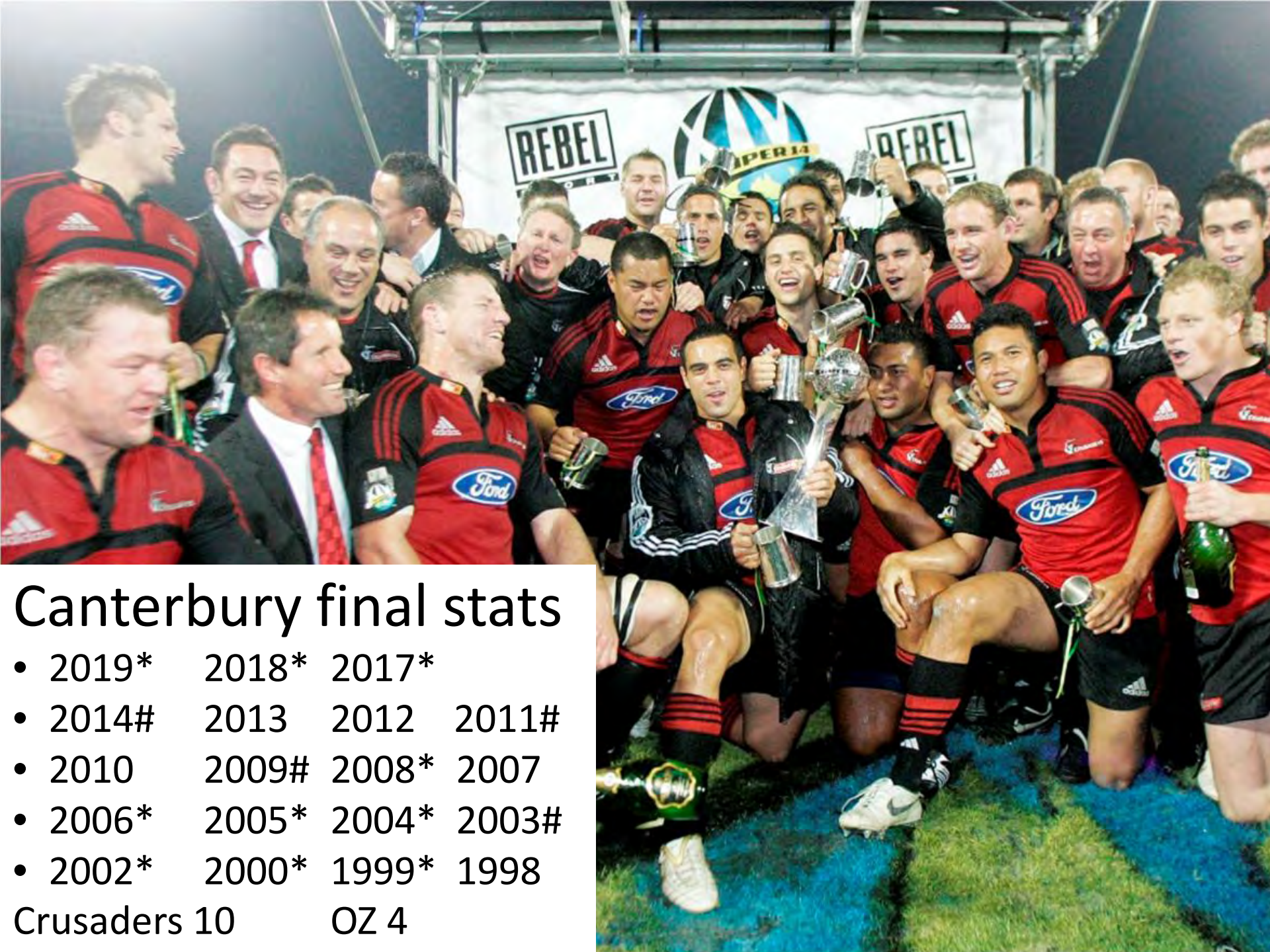
Predicted climate change in New Zealand by 2040

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

Canterbury = largest flat land area – mixed crop/sheep



Canterbury final stats

- 2019* 2018* 2017*
- 2014# 2013 2012 2011#
- 2010 2009# 2008* 2007
- 2006* 2005* 2004* 2003#
- 2002* 2000* 1999* 1998

Crusaders 10 OZ 4

“The Canterbury Plains in the South Island of NZ depend almost entirely on nitrogen fixed by clover and are highly productive”

T. M. Addiscott – 2005 Nitrate agriculture and the environment

By 2030 - Drier:

Drought – increased duration and frequency

Abundant aquifer water = 500,000 ha irrigated dairy

Photo: Dr WR Scott
Lincoln University

Dairying in Canterbury

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

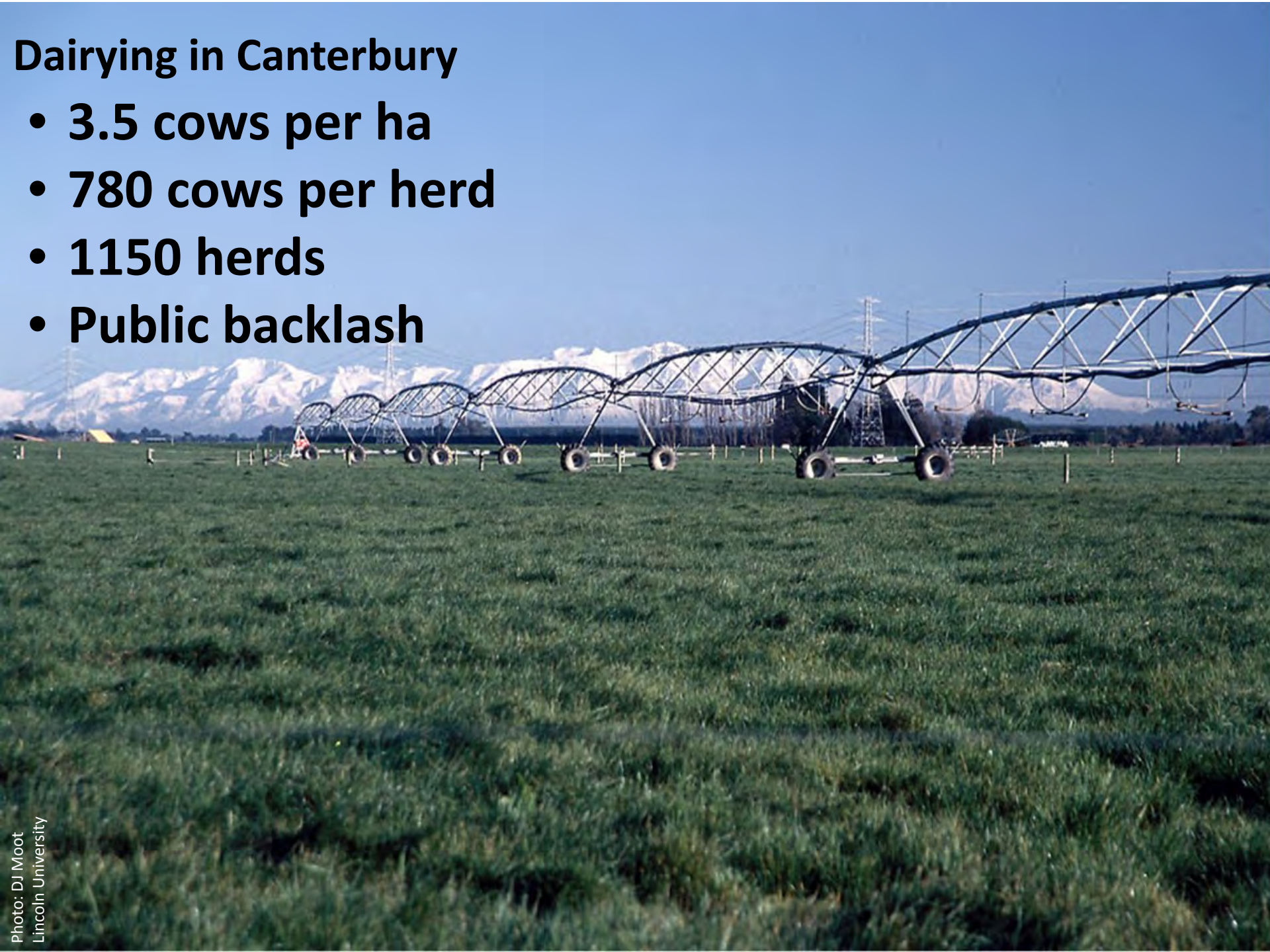


Photo: DJ Moot
Lincoln University

Experiment site

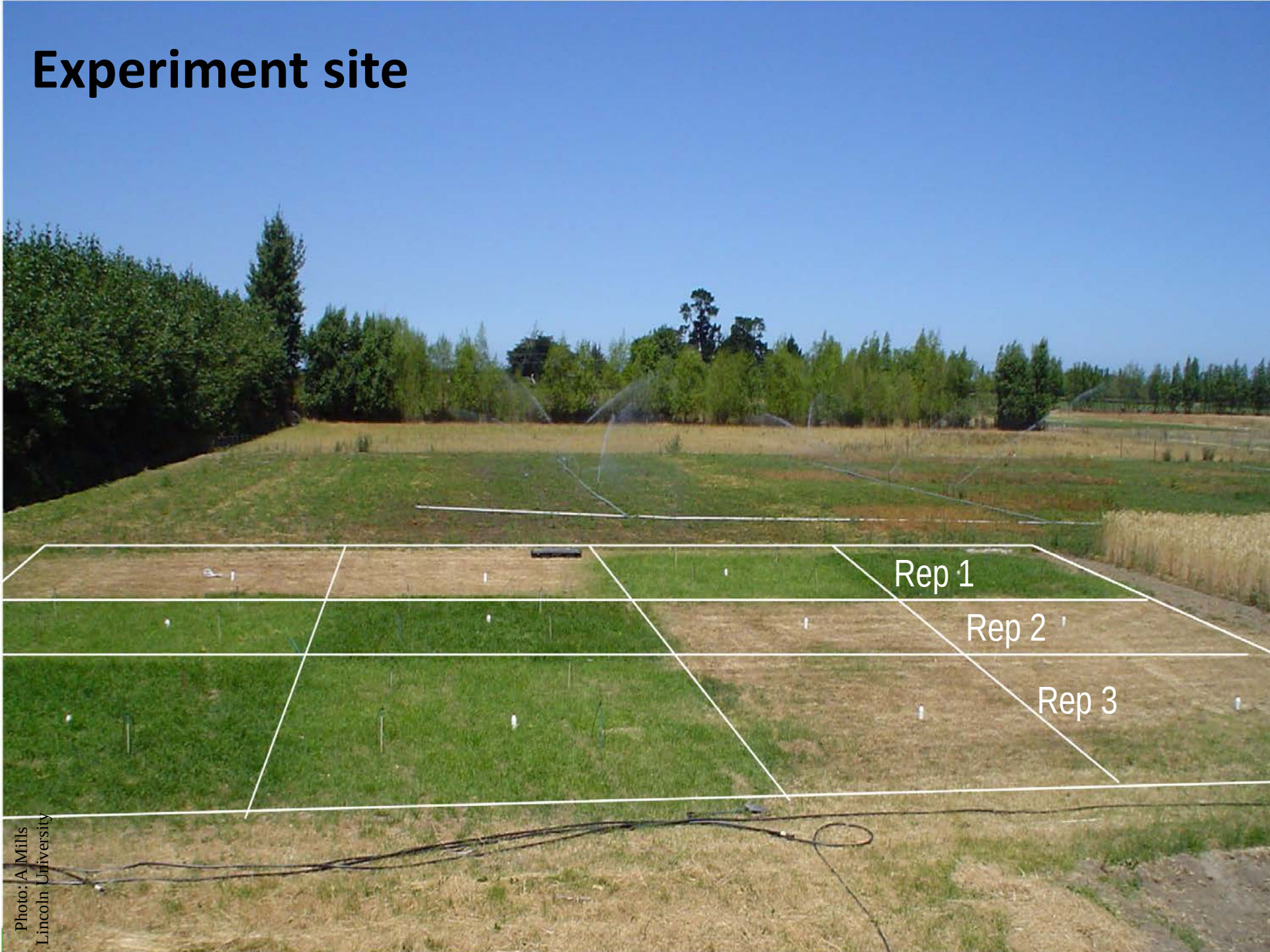
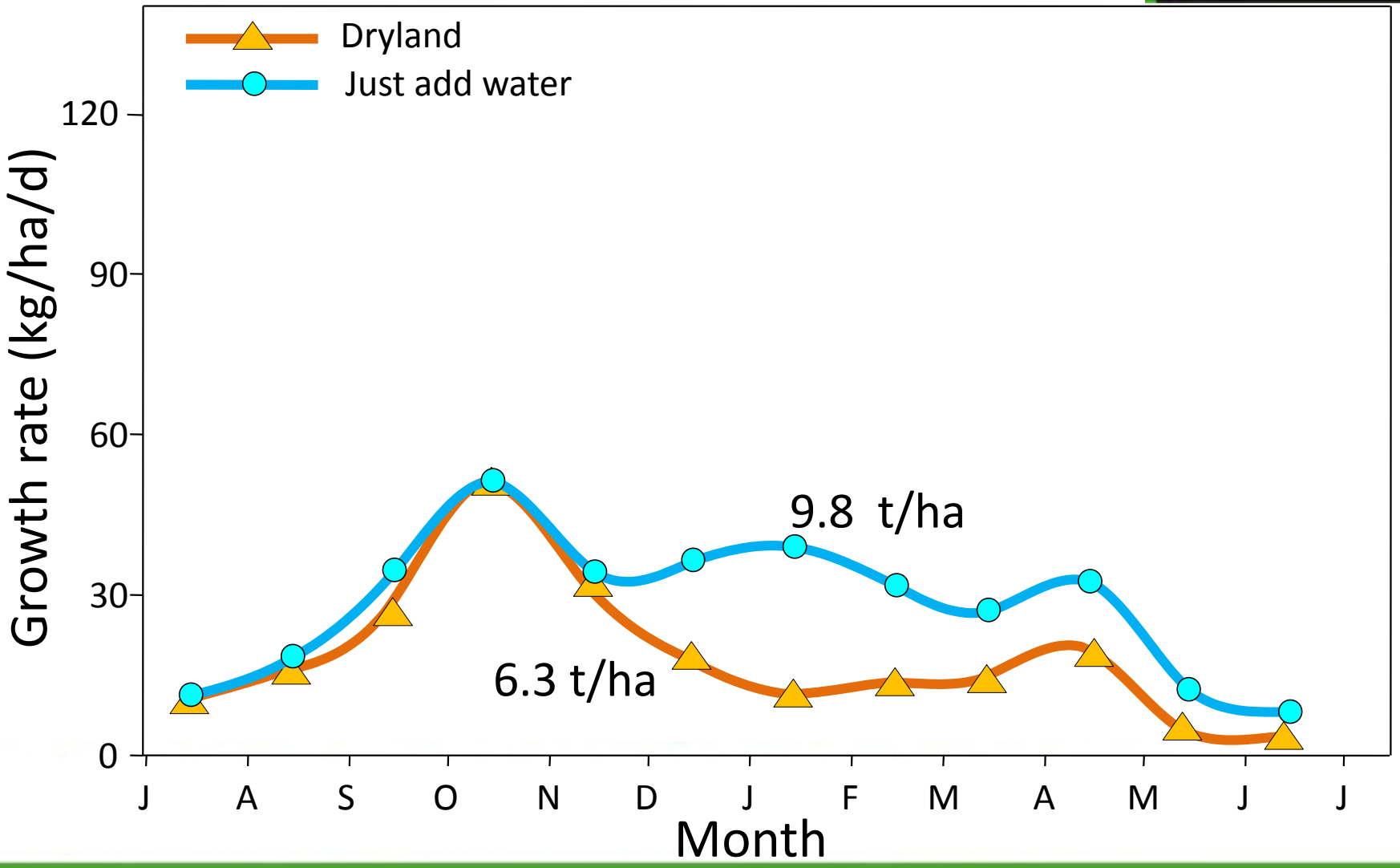


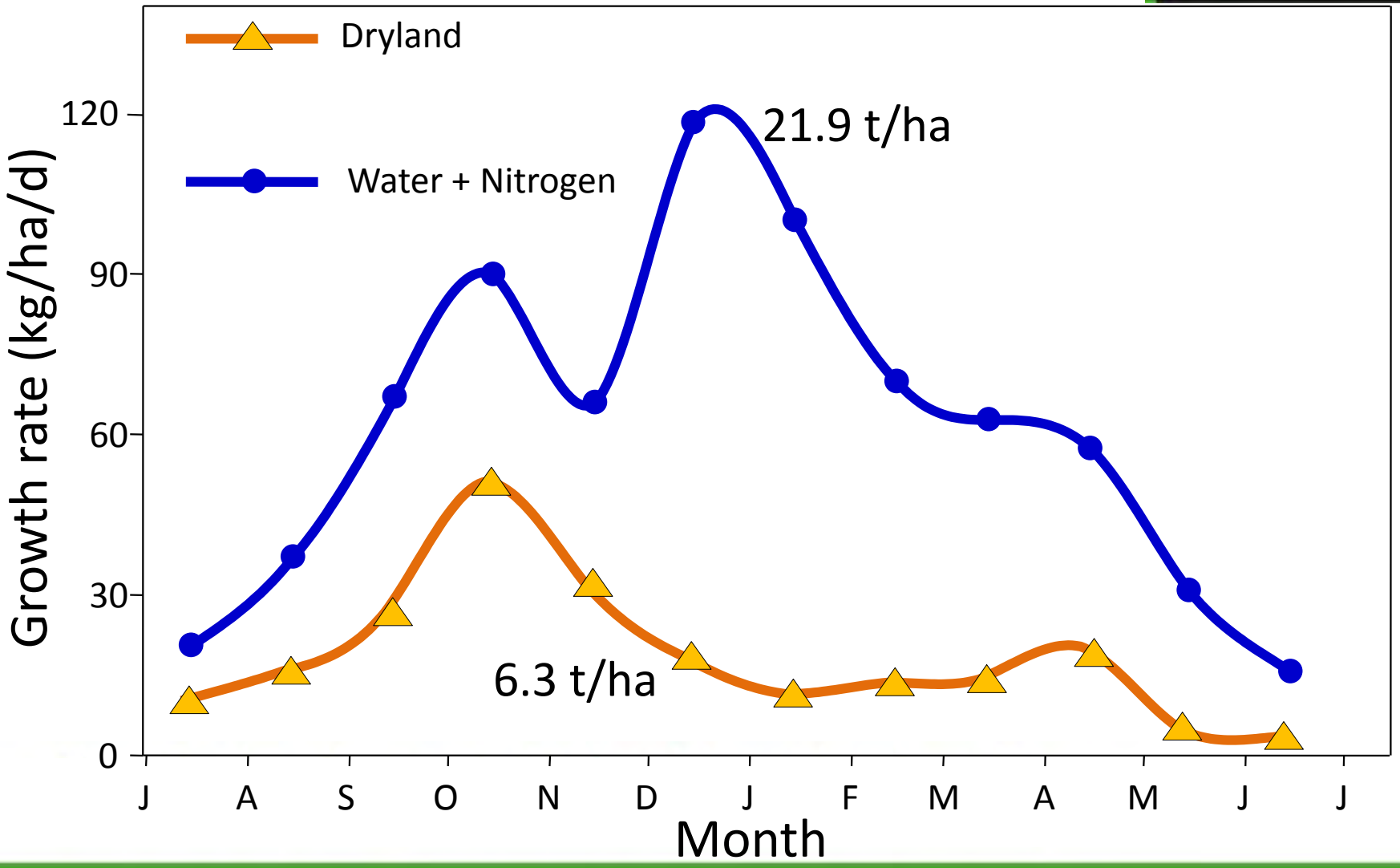
Photo: A Mills
Lincoln University

Growth rates (2 year means)



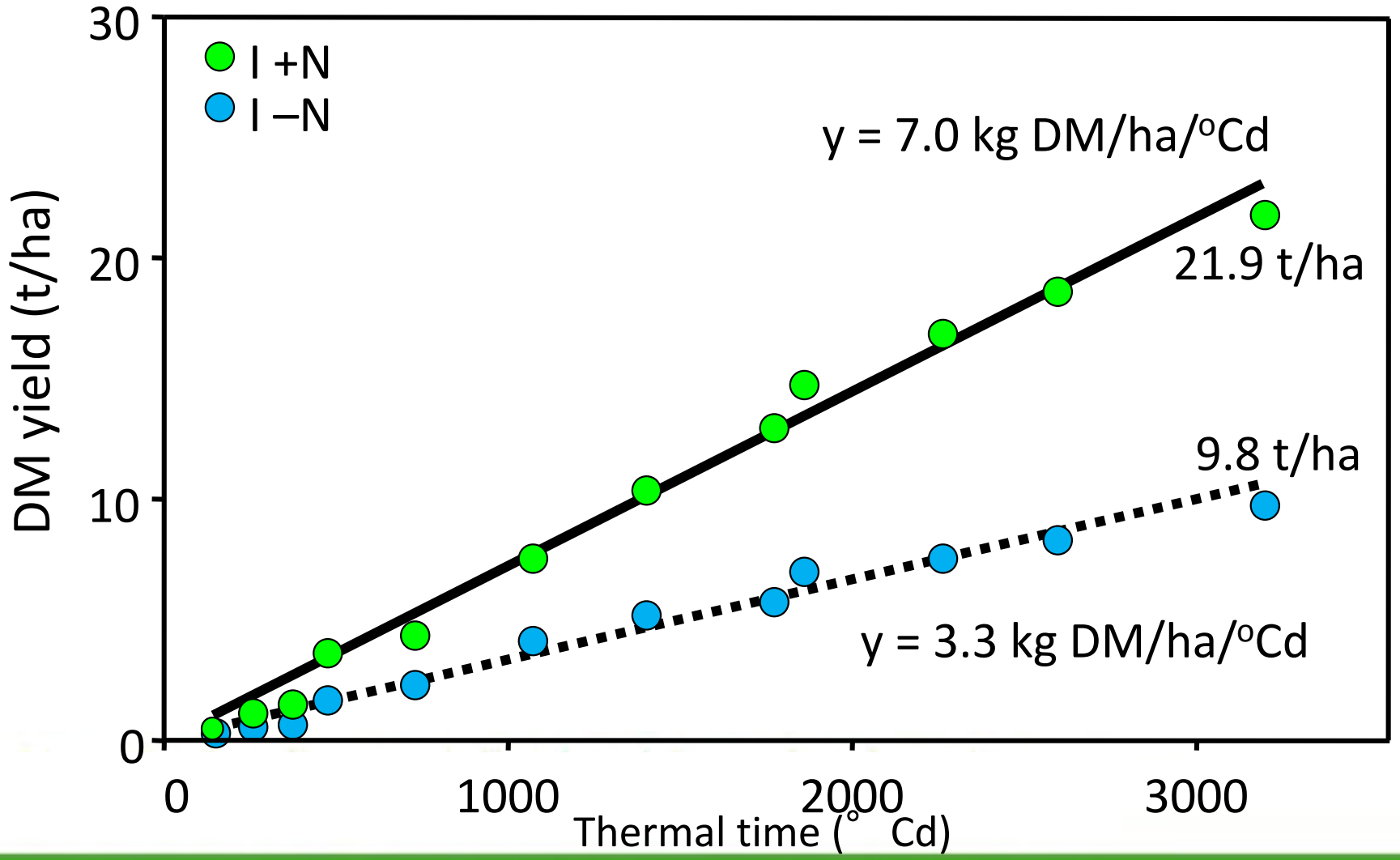
Mills *et al*. 2006, 2009

Growth rates (2 year means)



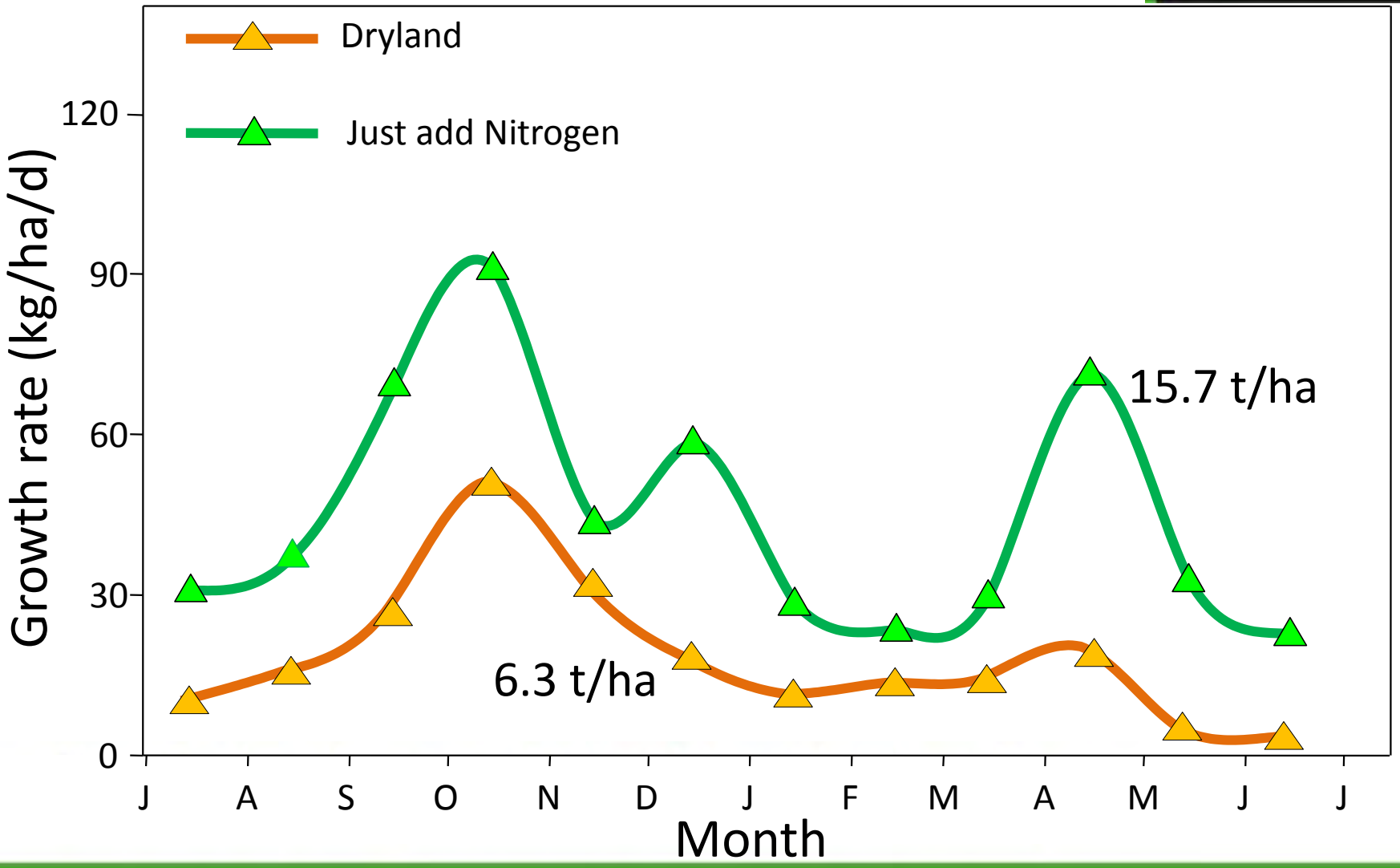
Mills *et al*. 2006, 2009

The Nitrogen gap



Mills *et al*. 2006; 2009

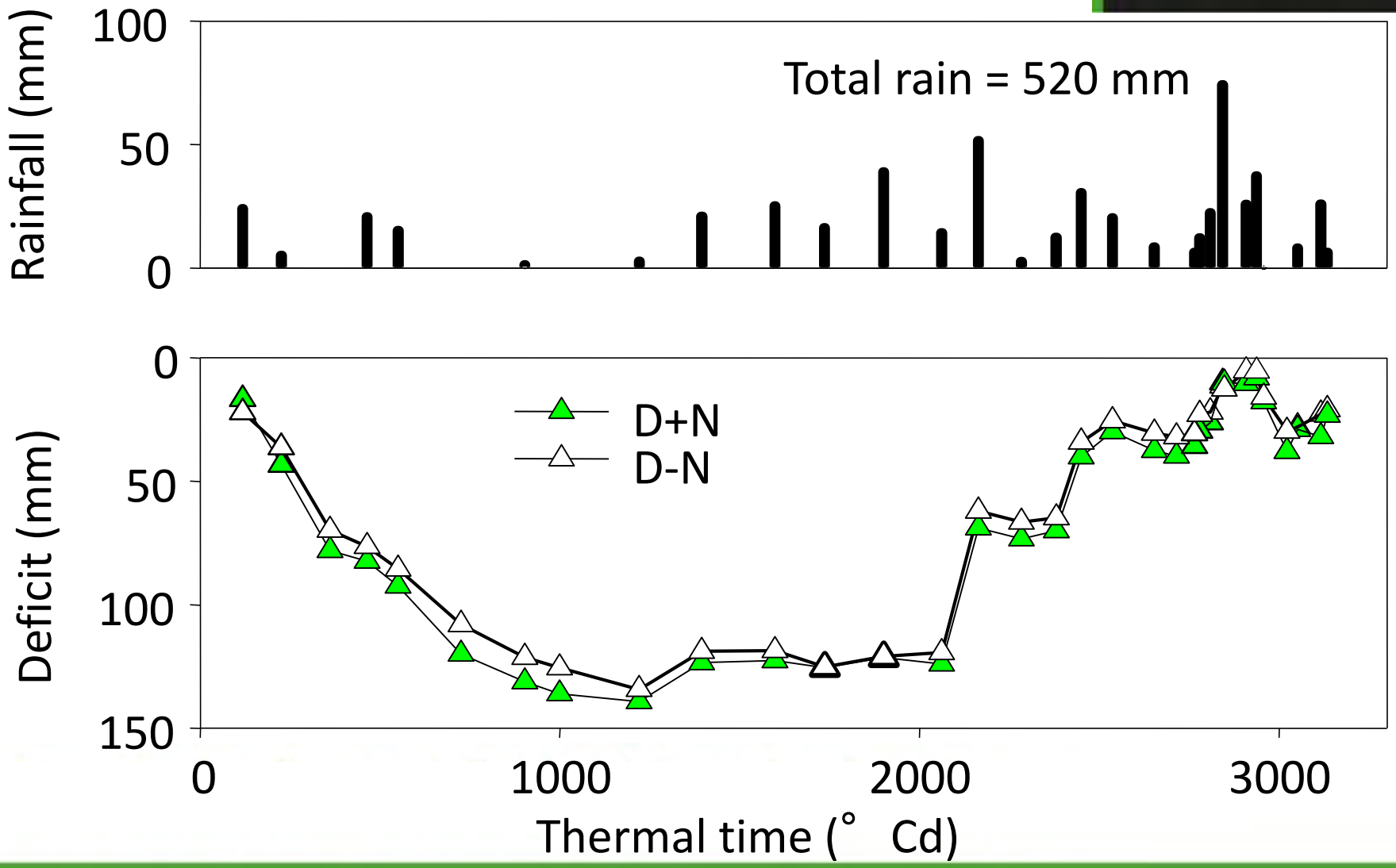
Growth rates (2 year means)



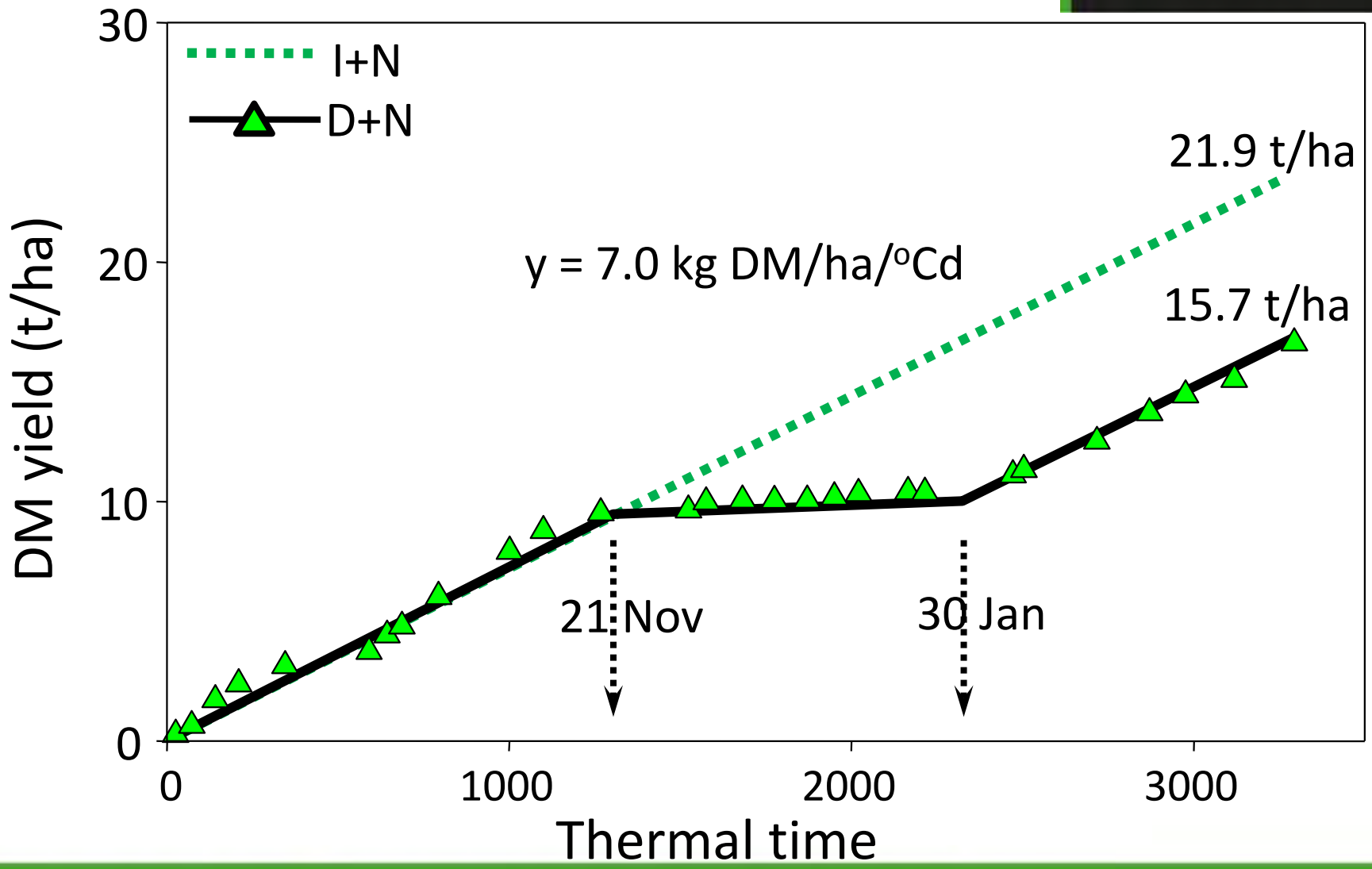
Mills *et al*. 2006, 2009

Summer ⇒ moisture response

Soil moisture deficit 2003/04



Water stress effect on yield



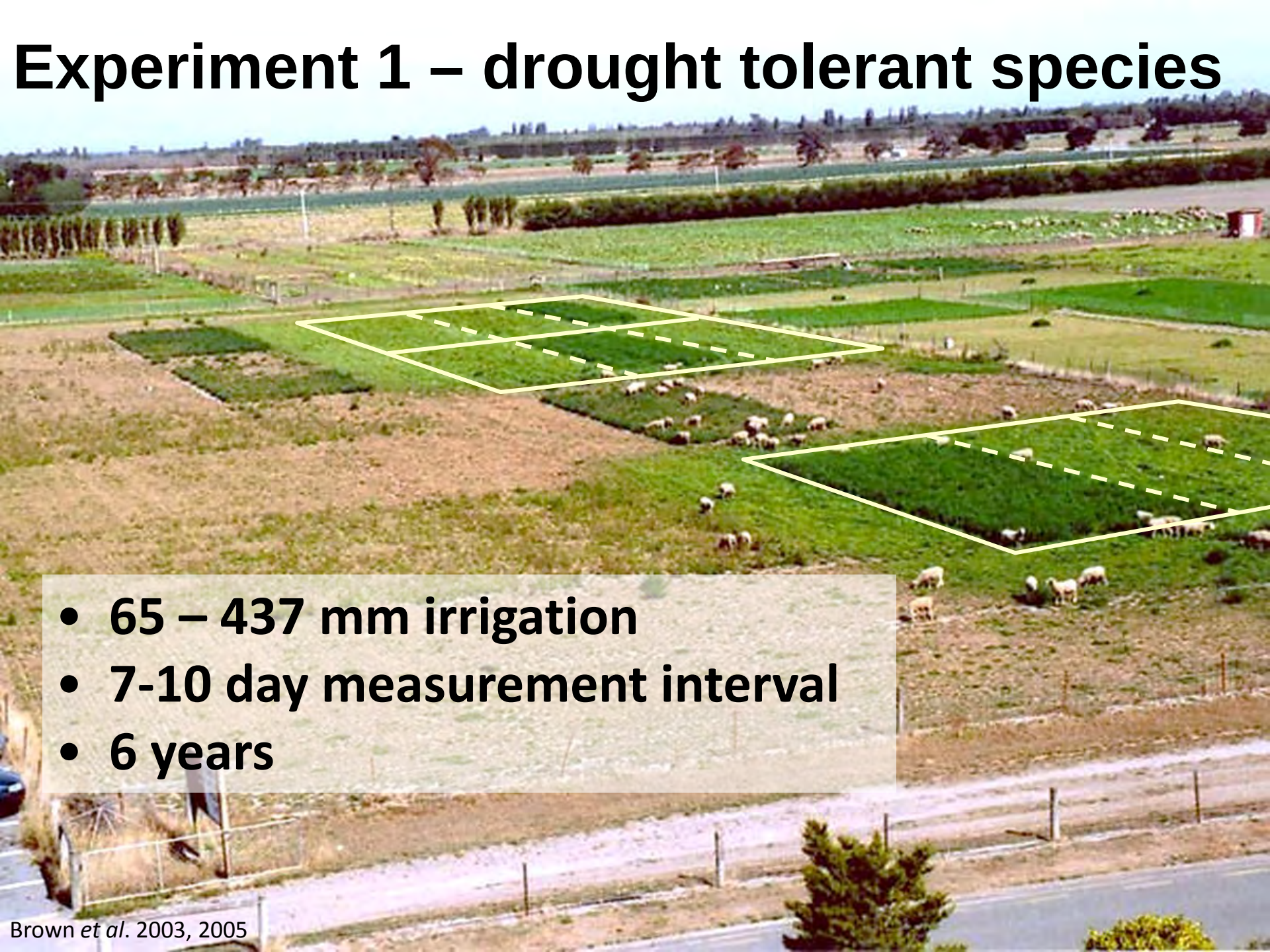
Mills *et al*. 2006

Nitrogen fixation
25-30 kg N/t DM

Photo: DP Monks
Lincoln University

Lucas *et al*. 2010

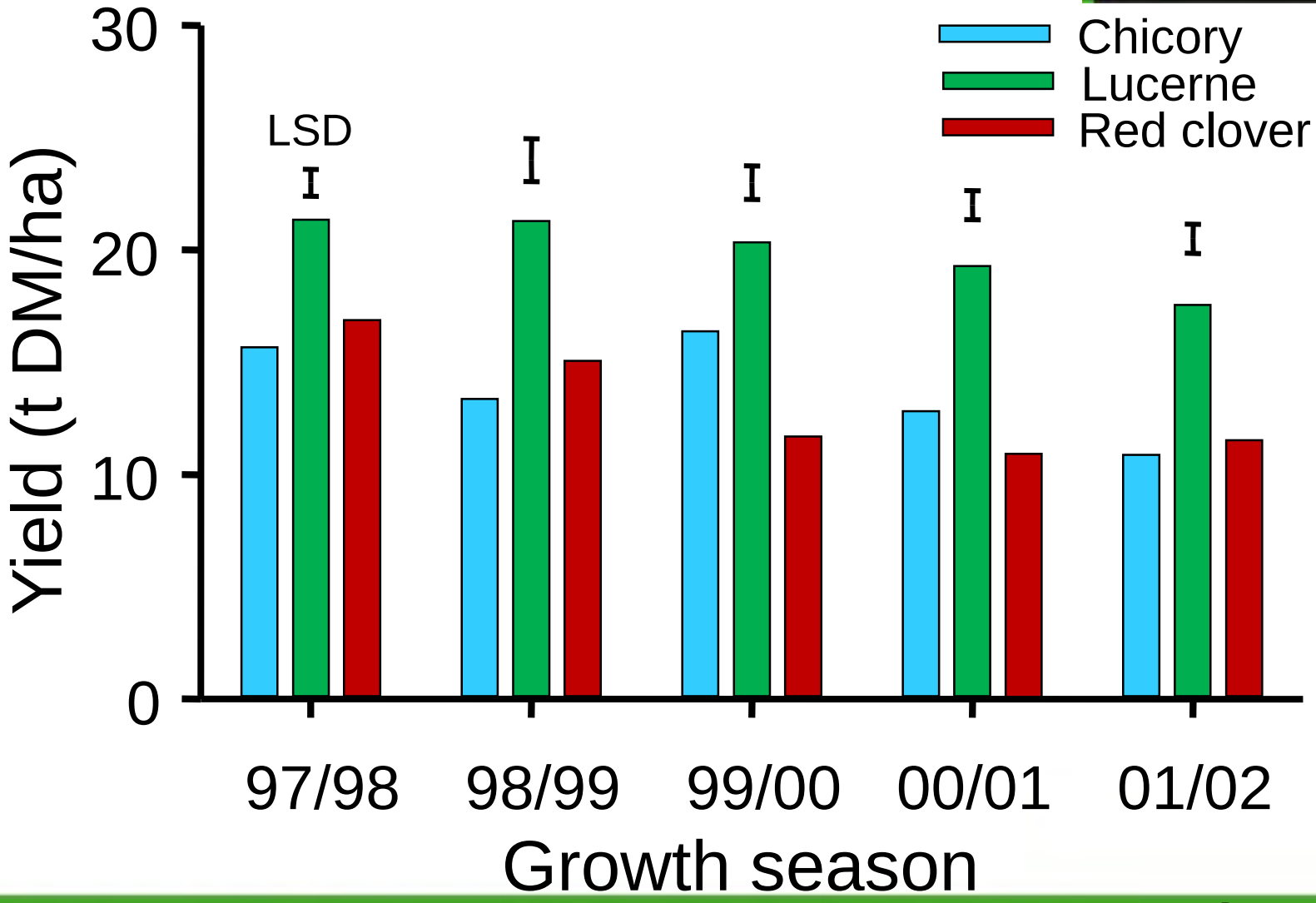
Experiment 1 – drought tolerant species



- 65 – 437 mm irrigation
- 7-10 day measurement interval
- 6 years

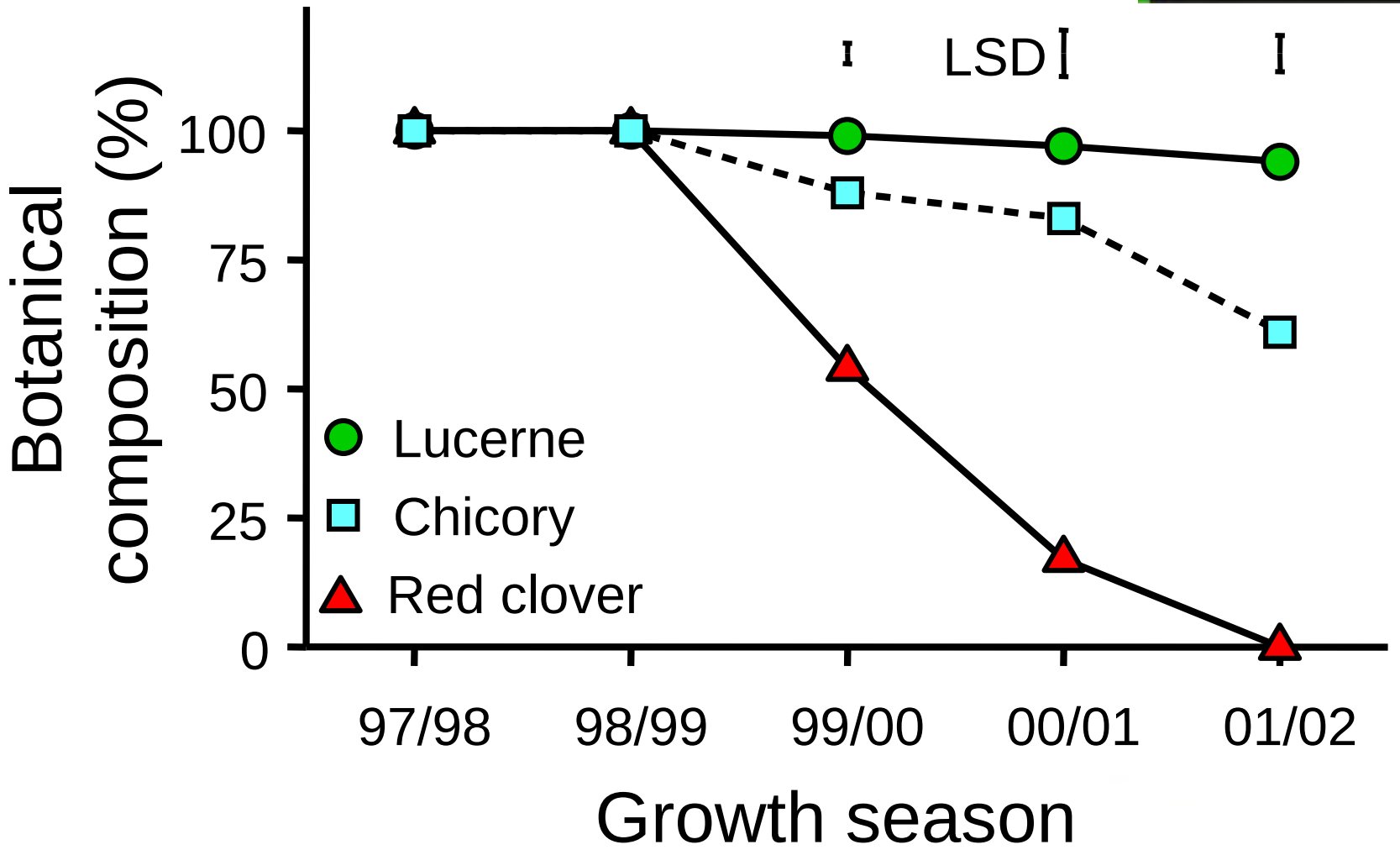
Brown *et al*. 2003, 2005

Annual dry matter yields



Brown *et al*. 2005

Persistence



Brown 2004

Lucerne Objectives

- Understand plant responses to the environment
- Use that information to design management practices
- Determine the influence of genotype
- Understand impacts on yield and quality

Growth:

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

Development:

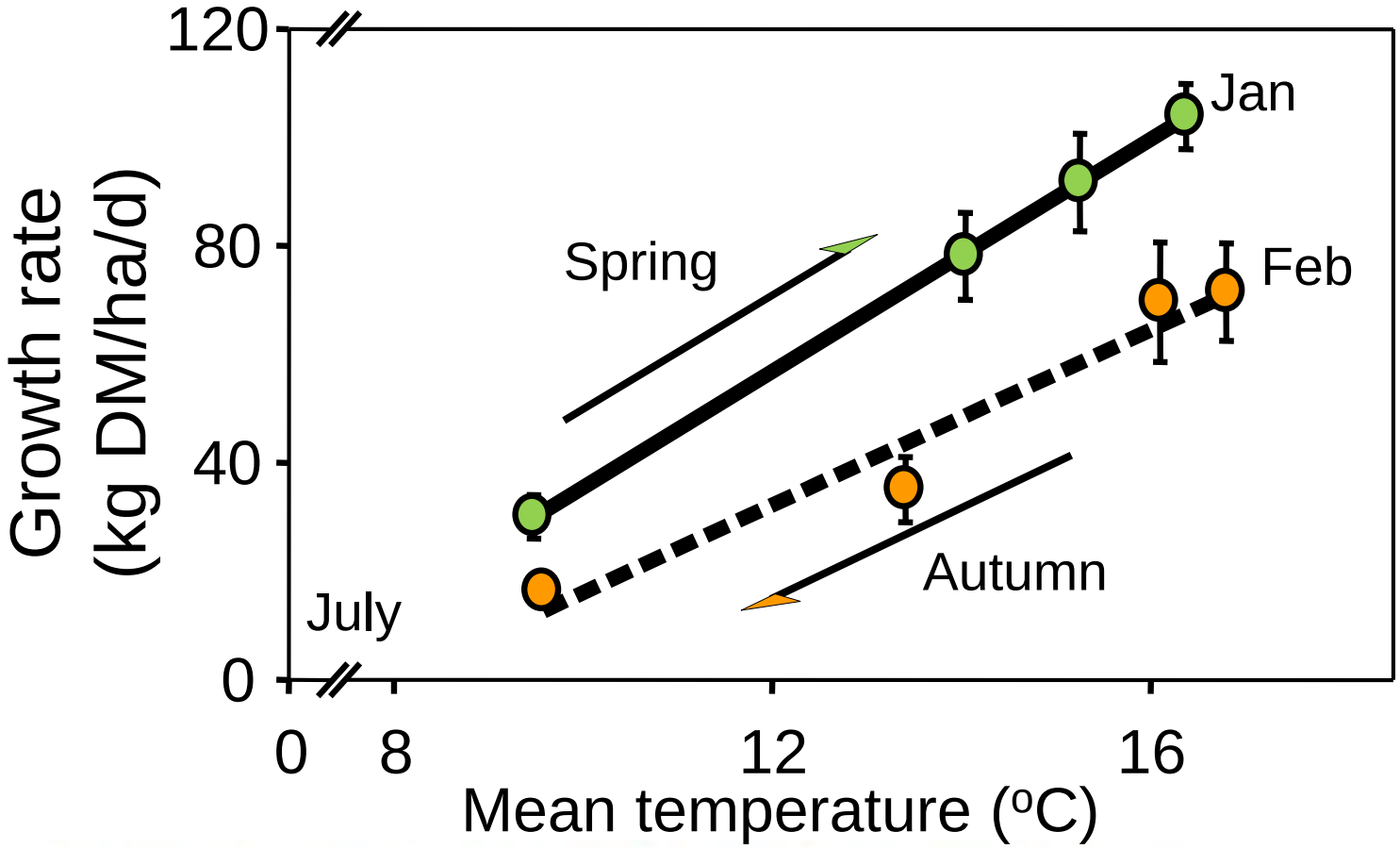
is the ‘age’ or maturity of the regrowth crop e.g. leaf appearance, flowering

Growth and development are both influenced by environmental signals

The canopy:
the energy capture device

Photo: DJ Moot
Lincoln University

Vegetative growth



Moot *et al*. 2003

Experiment 2 flexible grazing

38 days resting

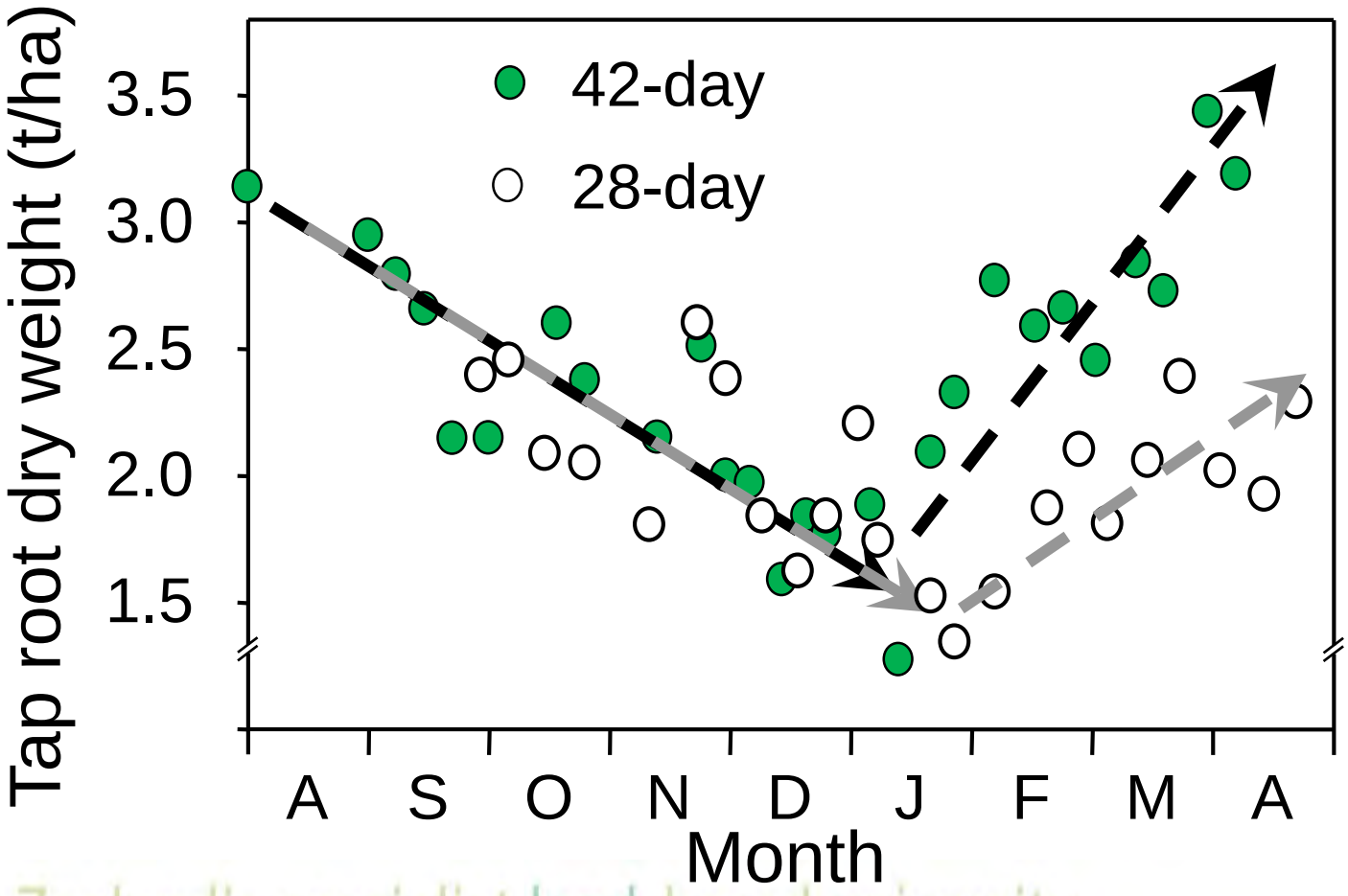
4 days grazing

25 days resting

3 days grazing

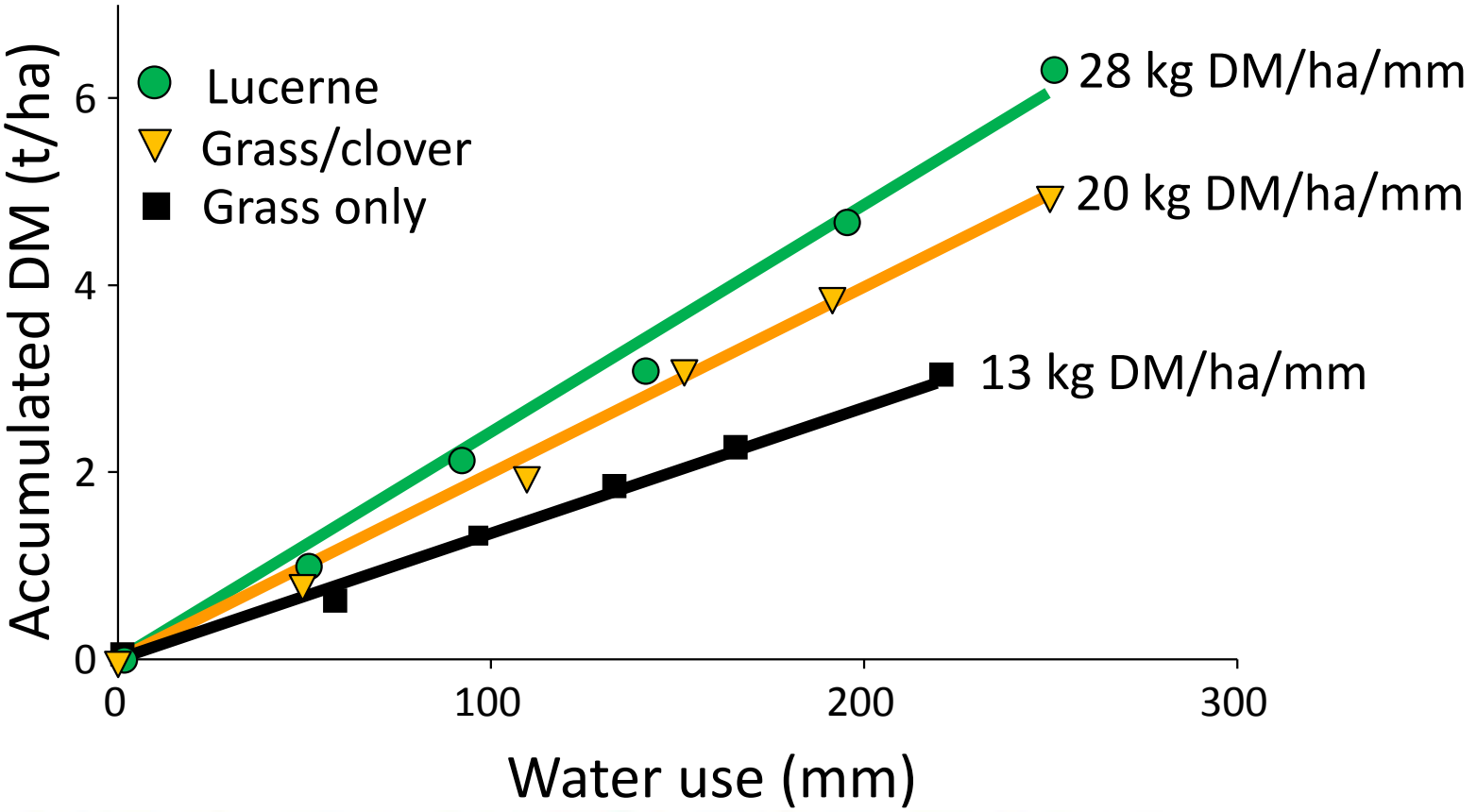
Photo: E.I. Teixeira
Lincoln University

Partitioning to roots



Moot *et al*. 2003

Spring WUE



Moot *et al*. 2008

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

Growing point at the top of the plant

Photo: Doug Avery,
Bonavaree, Marlborough

Photo: HE Brown
Lincoln University

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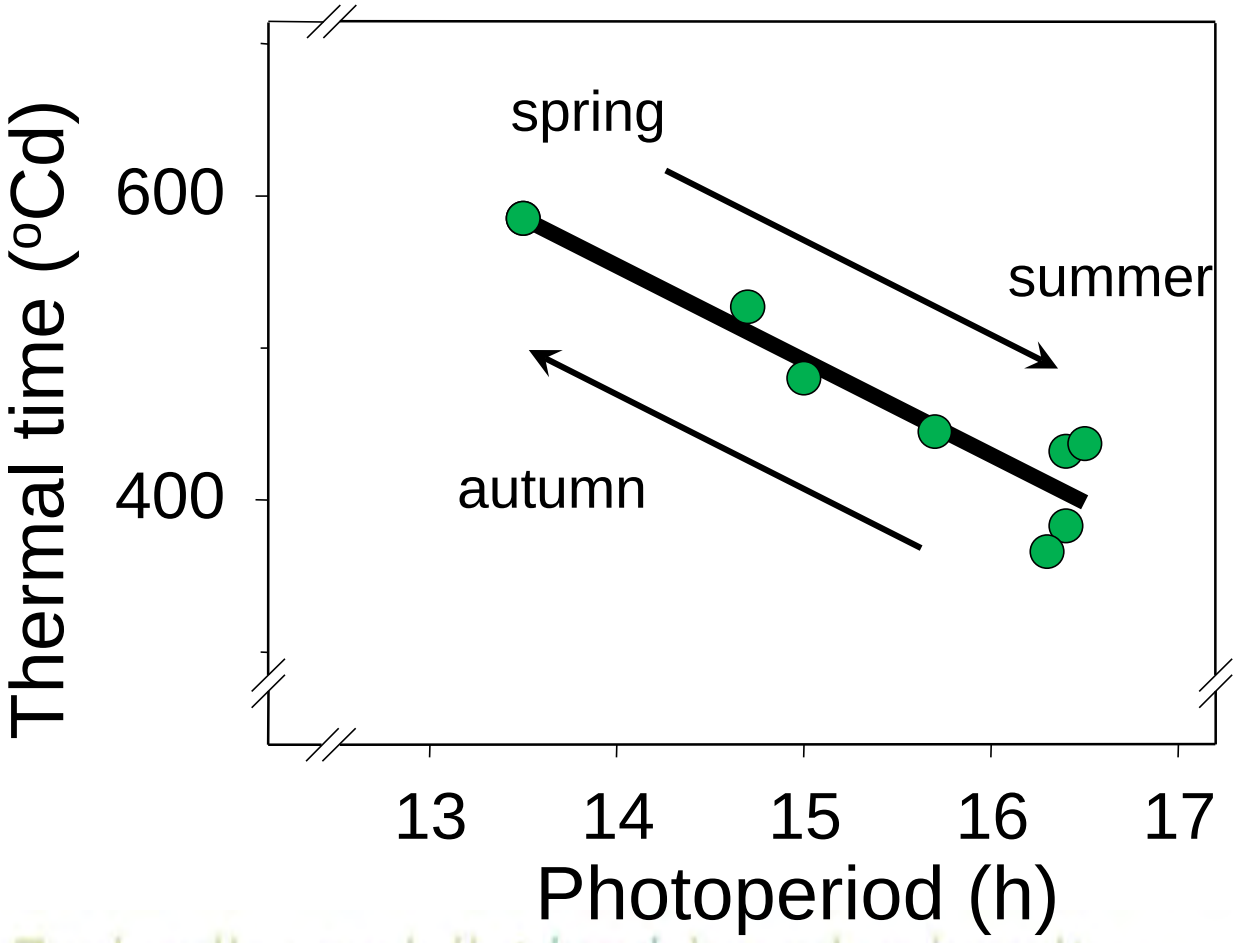
Lucerne development

Reproductive (flowering)

- Long day plant - flowers earlier in summer than spring/autumn due to photoperiod

- Time of flowering is also temperature dependent e.g. 380-550 ° Cd as photoperiod changes (14.5-16.5 h)

Day-length effect

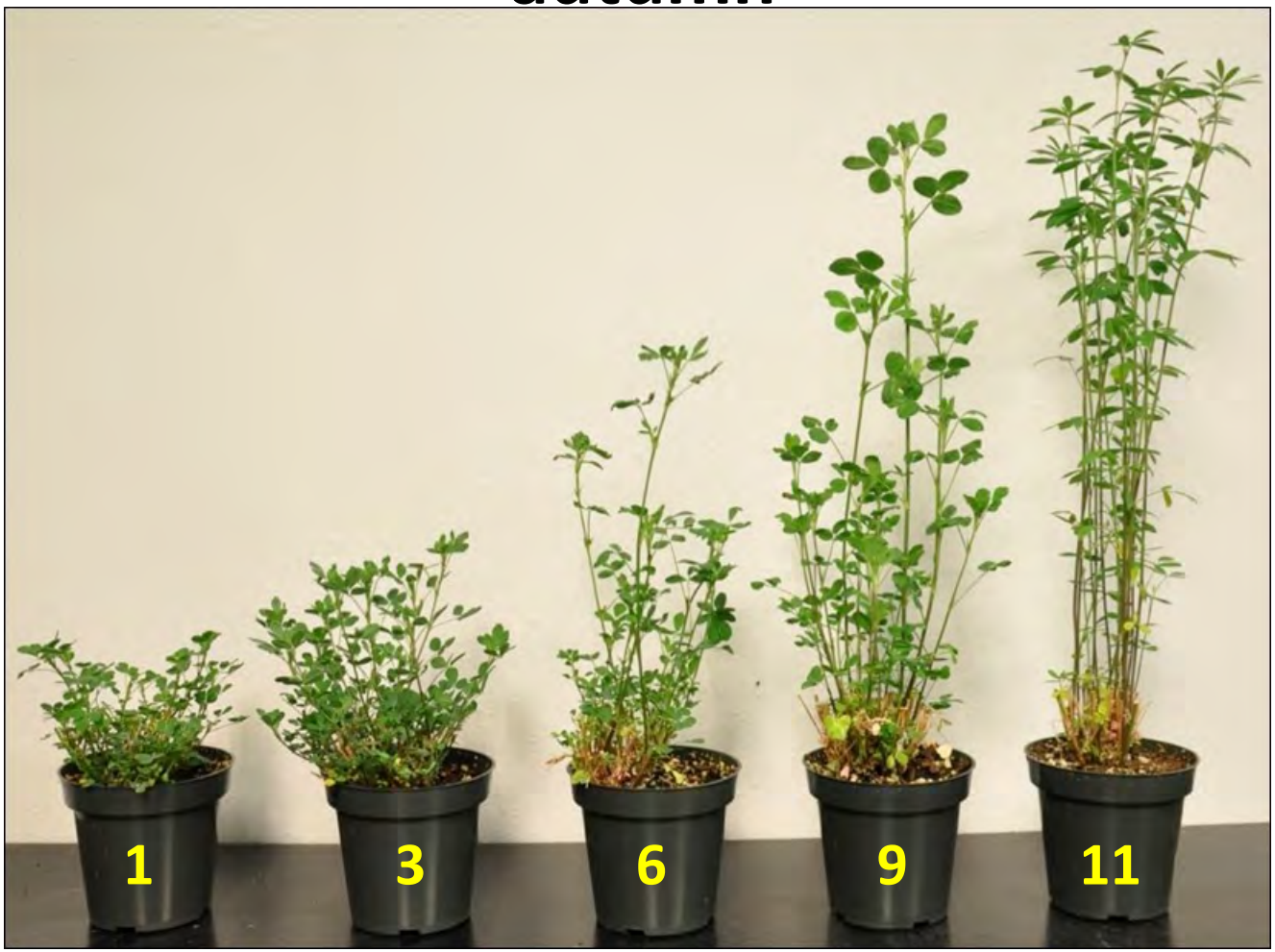


Dissecting Alfalfa Dormancy Using Selection Mapping

Charlie Brummer, Gitanshu Munjal, and Scott Newell
University of California, Davis

Supplied by: Charlie Brummer, UC Davis

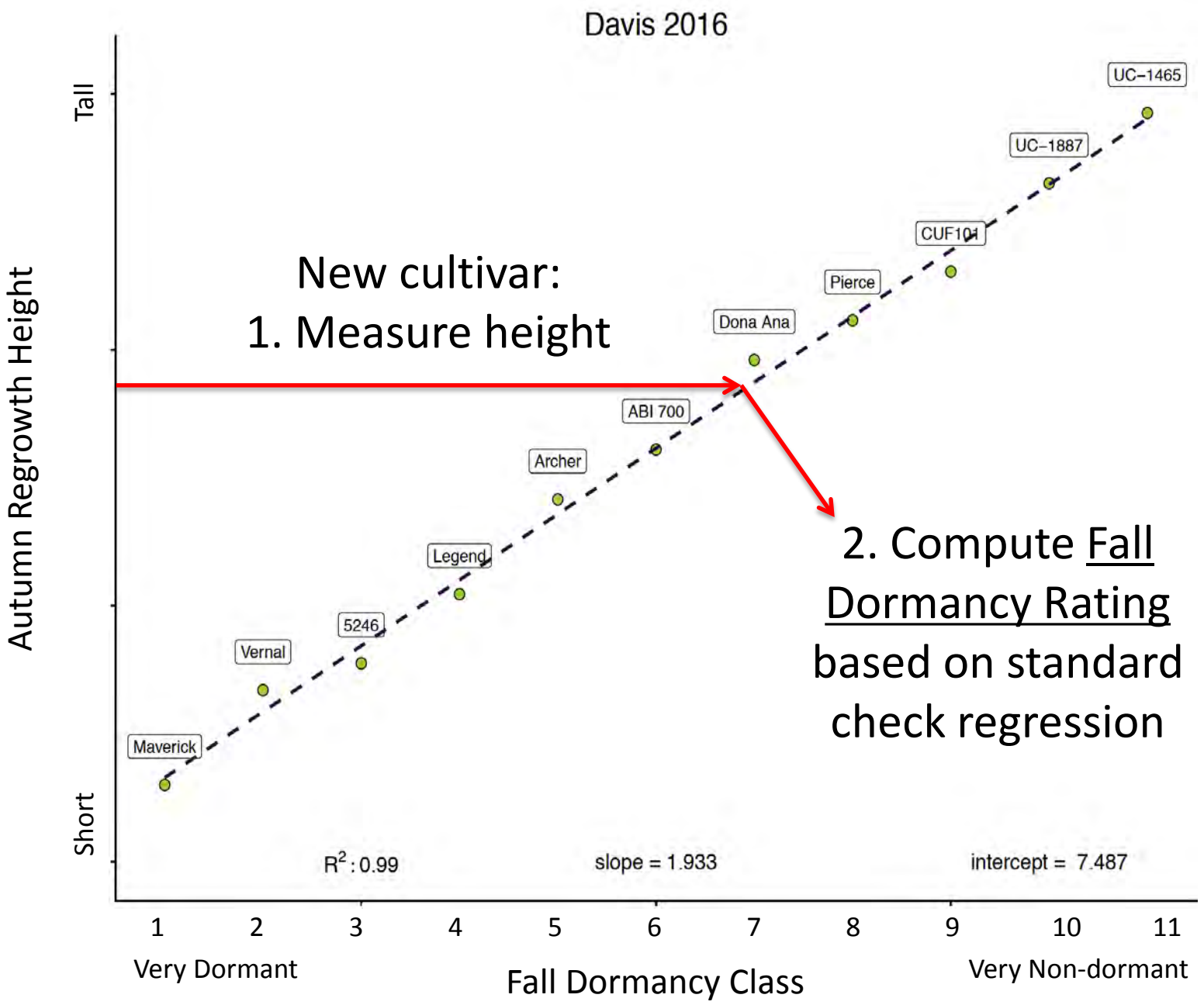
Dormancy is measured by height of regrowth in autumn



Dormancy phenotype observed in five of 11 standard check cultivars when in growth chamber under decreasing temp and photoperiod

Supplied by: Charlie Brummer, UC Davis

Supplied by: Charlie Brummer, UC Davis



Methods

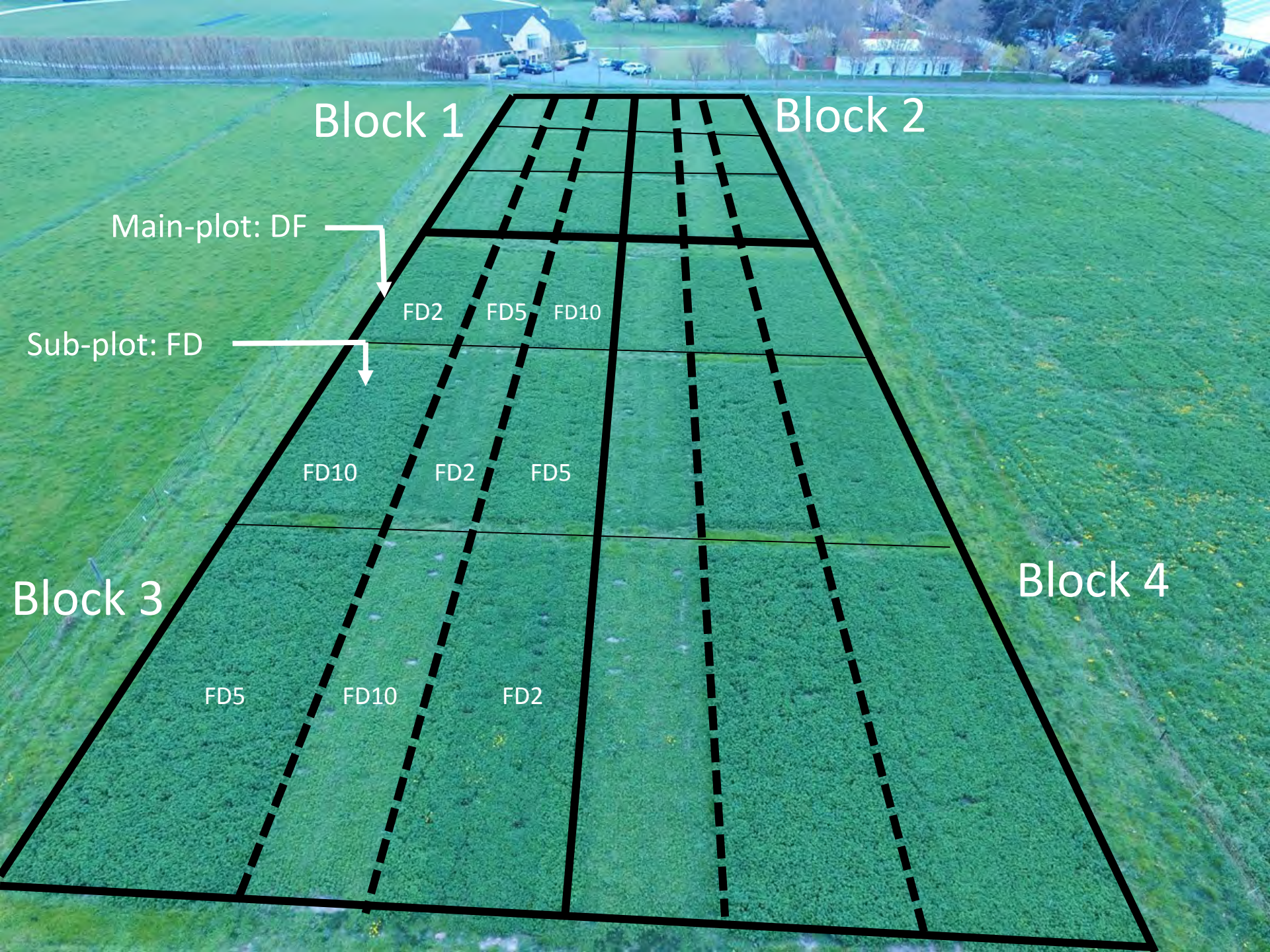
- Three genotypes with different FD ratings

  FD2, FD5 and FD10

- Three defoliation regimes

  DF28, DF42 and DF84

- Split-plot RCB with 4 replicates.
- Exp. duration: October 2014 to January 2017.
- Irrigation when need.


Block 1
Block 2
Main-plot: DF
Sub-plot: FD
FD2
FD5
FD10
FD10
FD2
FD5
Block 3
Block 4
FD5
FD10
FD2

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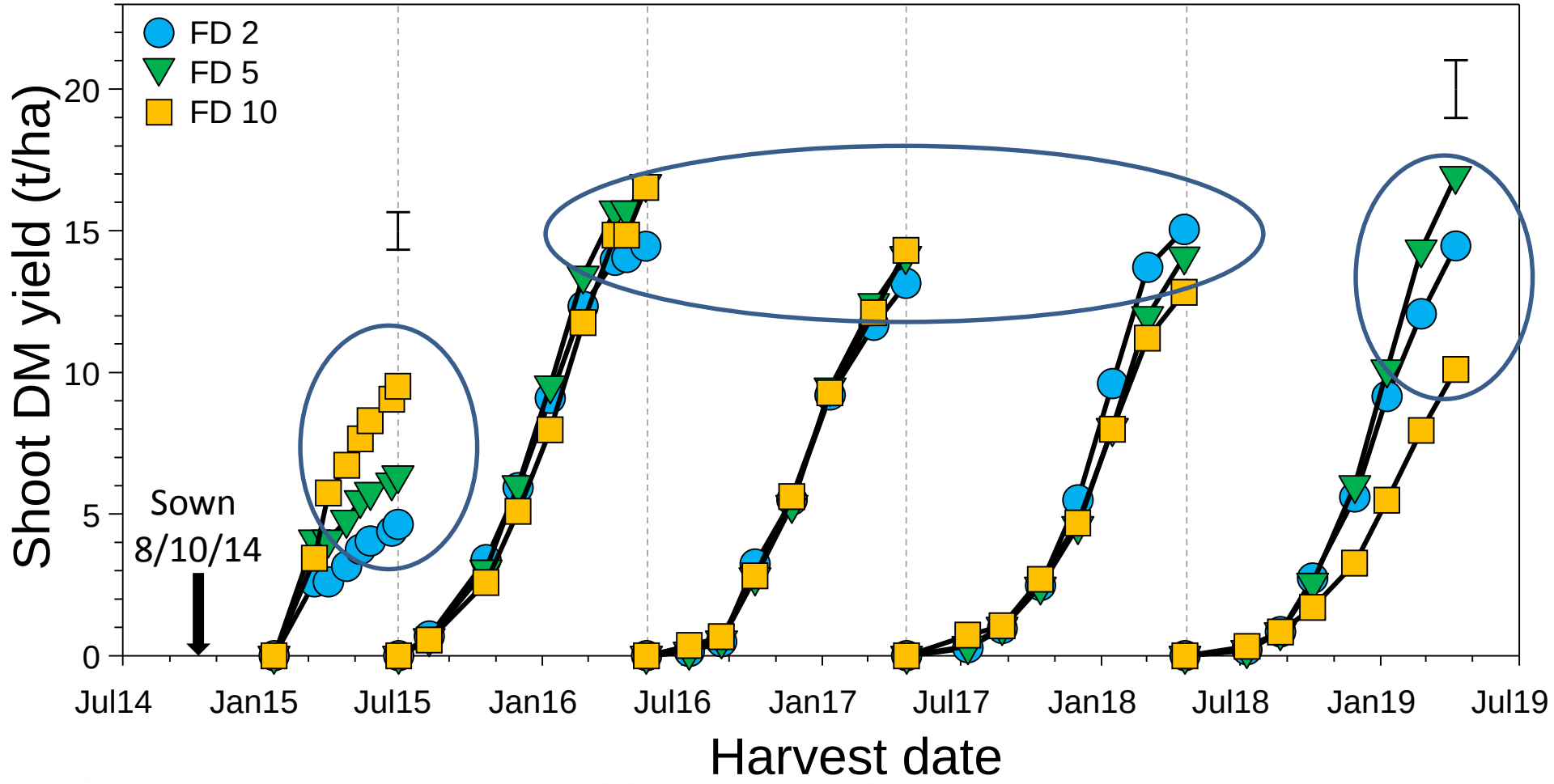
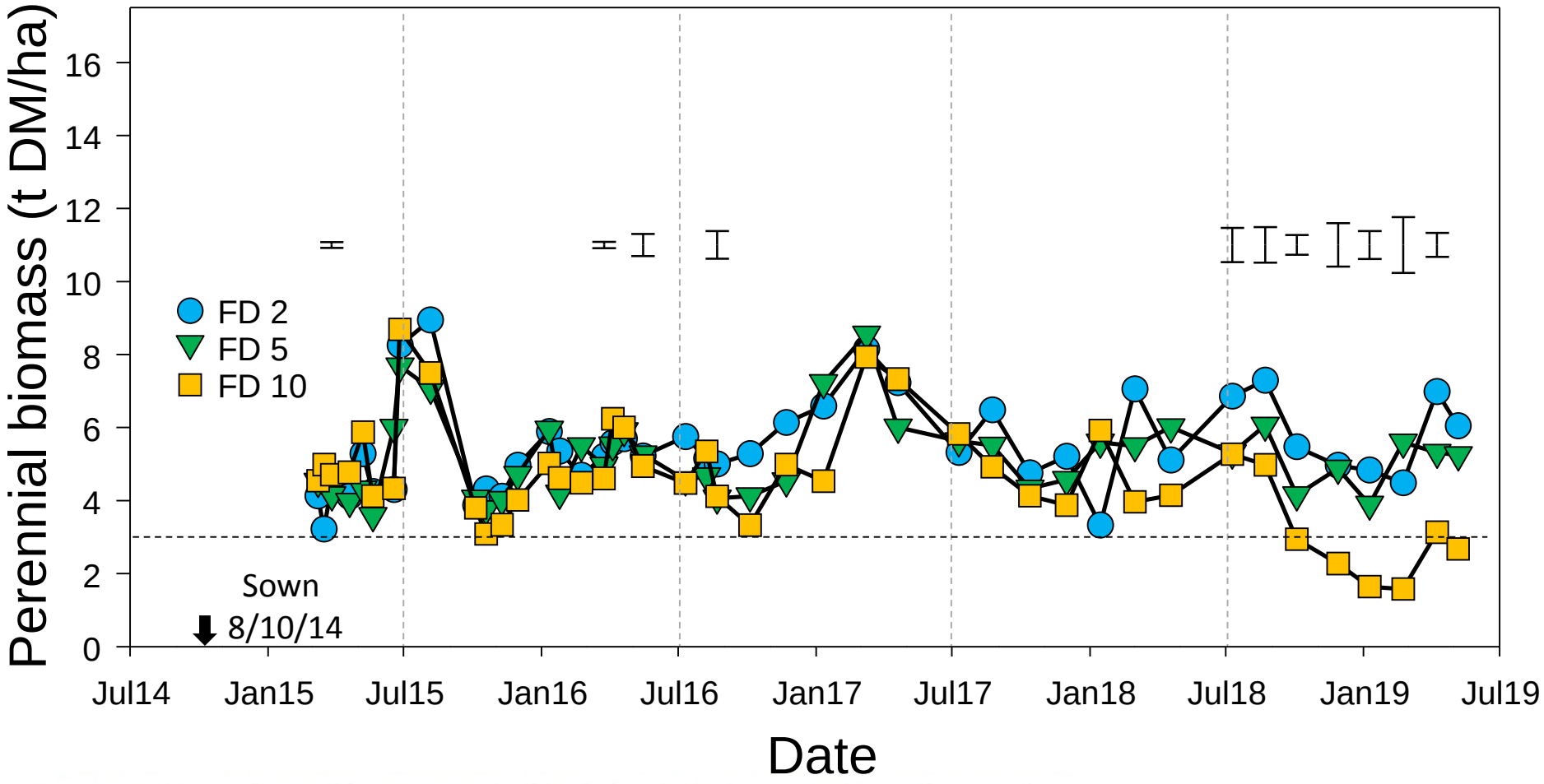
Lucerne shoot yield (42 day regrowth periods)



Lucerne perennial biomass (42 day rotation) (crown + root to 0.3 m)



Shoot and perennial organ yields of lucerne genotypes of three fall dormancy levels over five years

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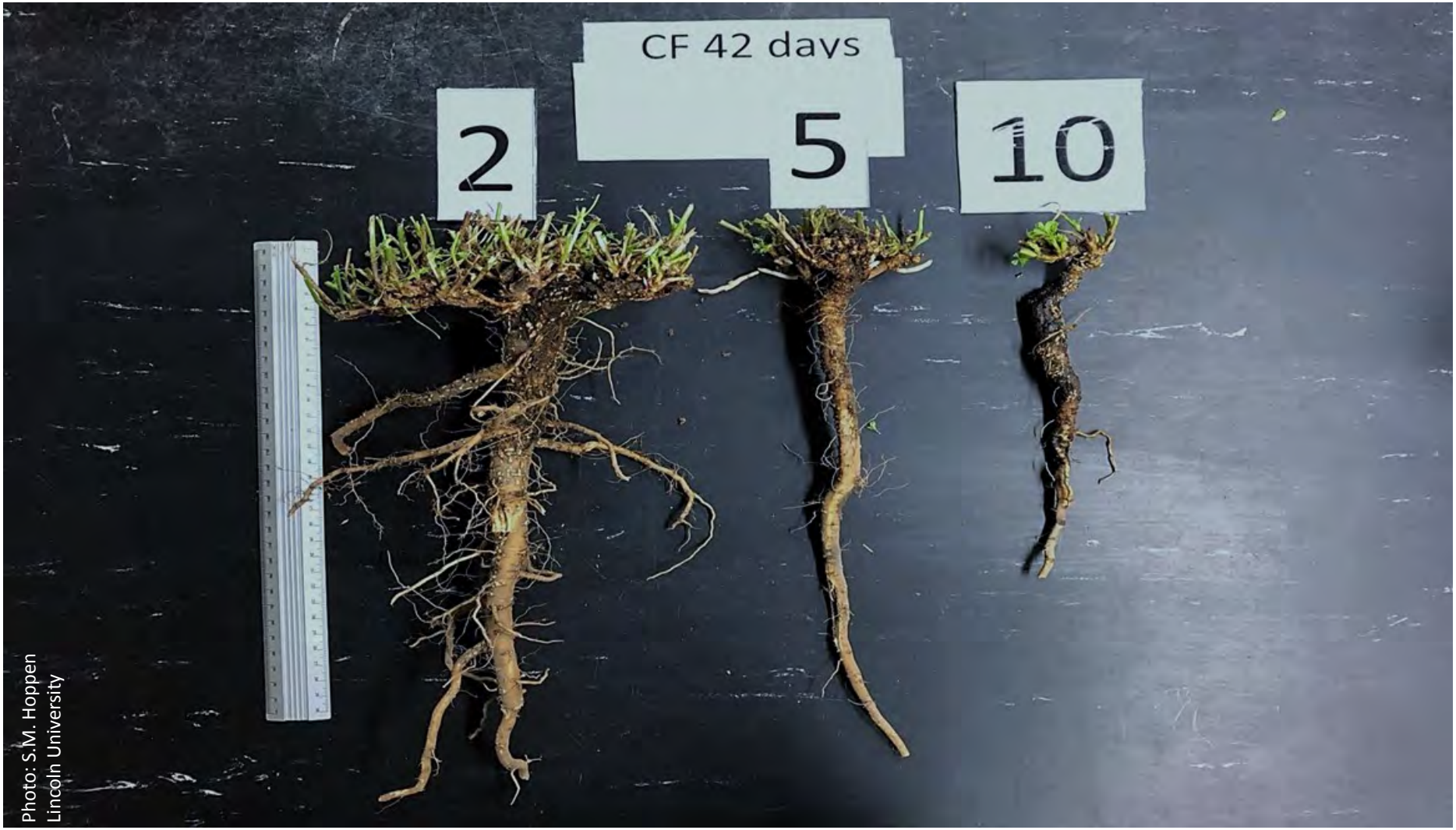


Photo: S.M. Hoppen
Lincoln University

142 plants.m^{-2}

62 plants m^{-2}
(33% of survival)

24 plants m^{-2}
(10% of survival)

Photos: S.M. Hoppen
Lincoln University





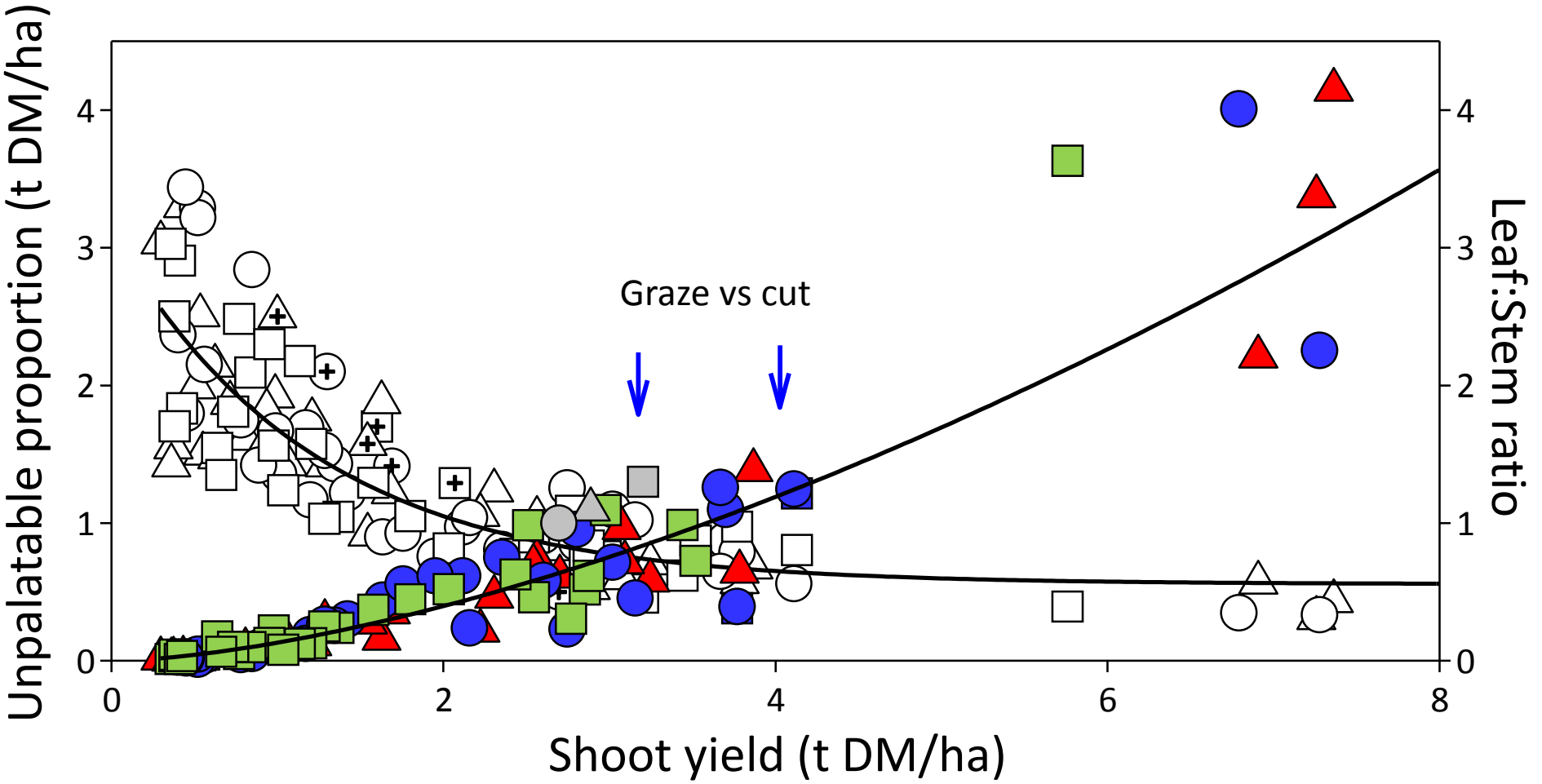

Unpalatable proportion (t DM/ha)
Leaf:Stem ratio
Shoot yield (t DM/ha)
Graze vs cut
0
1
2
3
4
0
2
4
6
8

Photo: M. Smith
Lincoln University

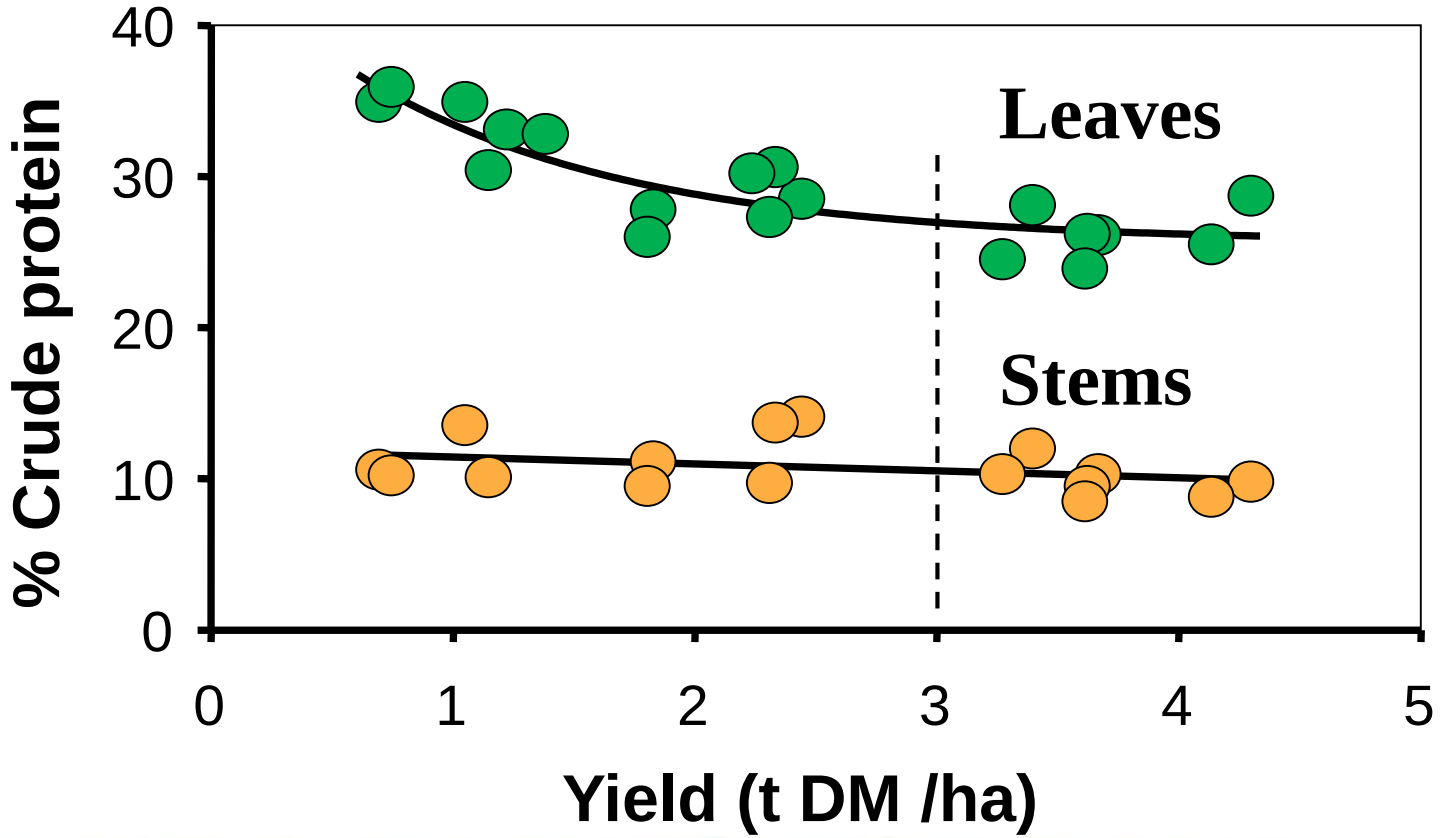
Rotation 1 Pre-graze
Plot 1 (21/9/07)
2.3 t DM/ha
20-25 cm tall

Photos: Richard Cookson

System 2 – High SR – housing or partial housing

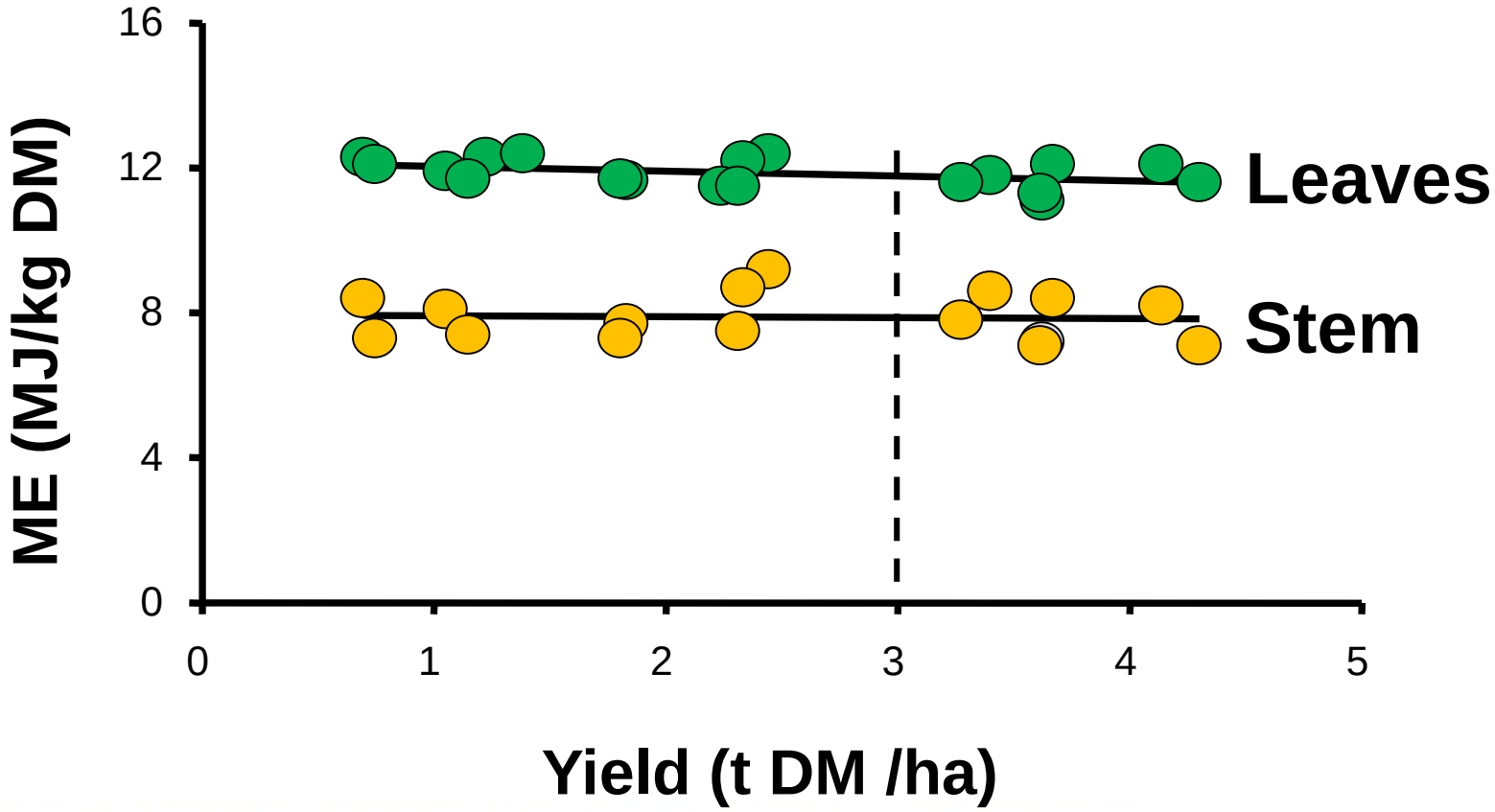
Photo: DJ Moot
Lincoln University

Crude protein of lucerne



Brown & Moot 2004

Metabolisable energy of lucerne

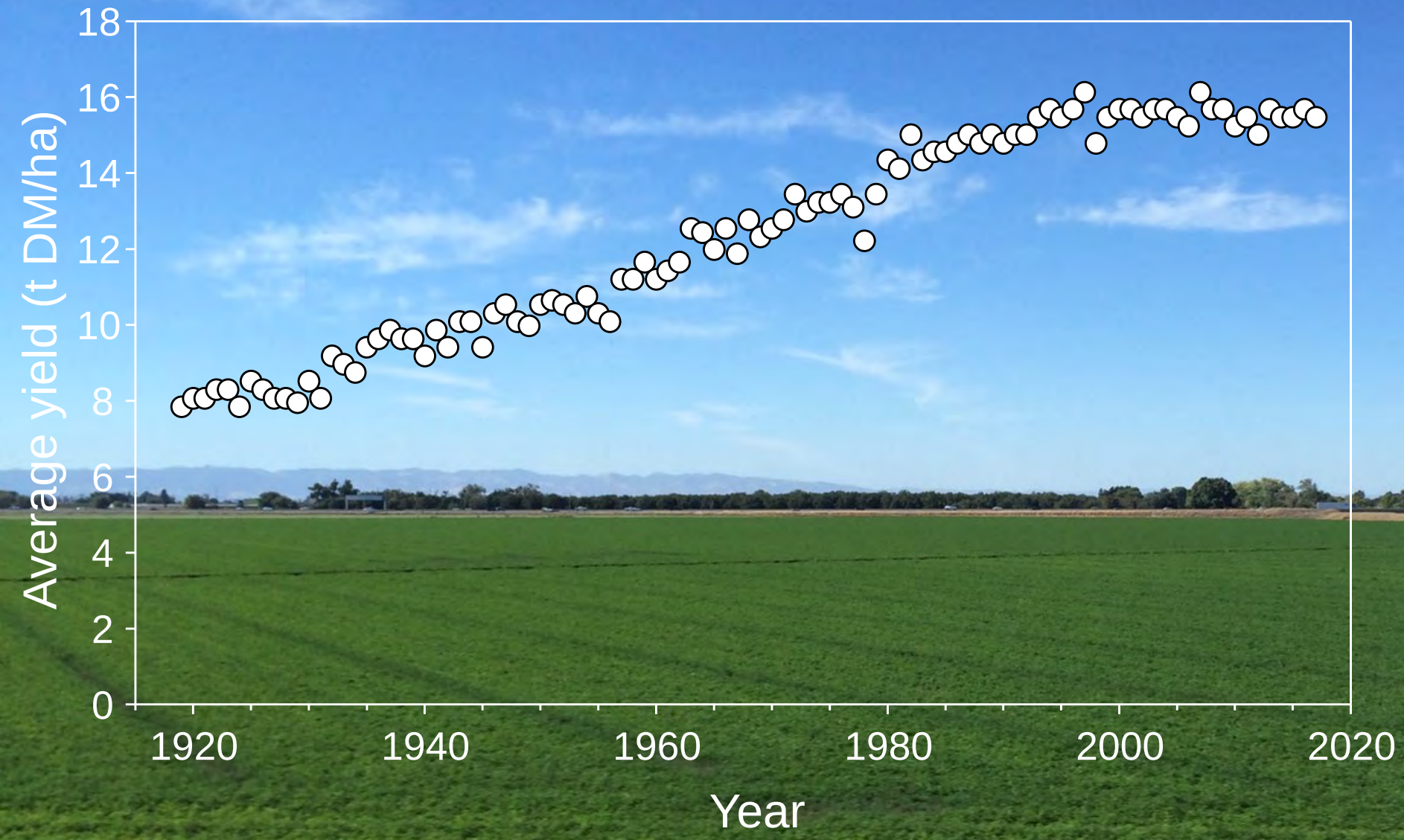


Brown & Moot 2004

Breeding yield and quality?

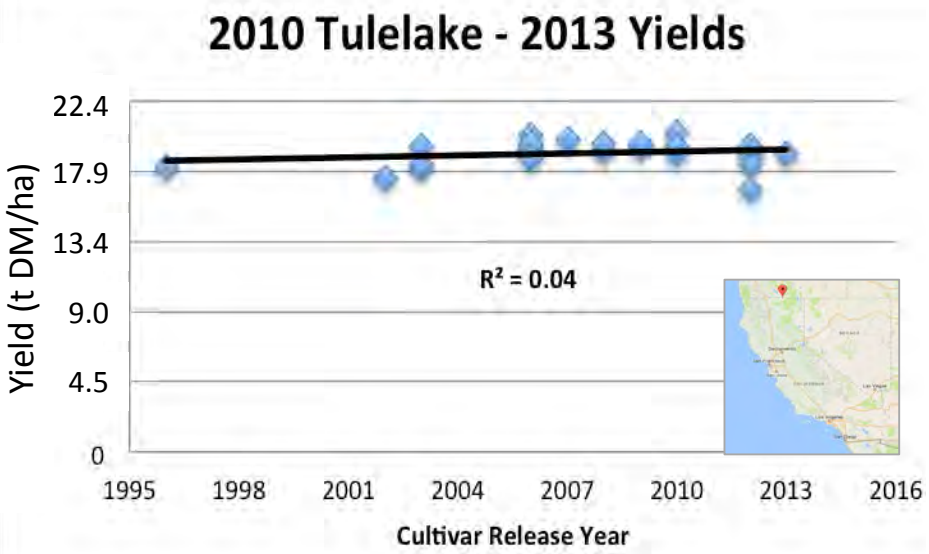
Supplied by: Charlie Brummer, UC Davis

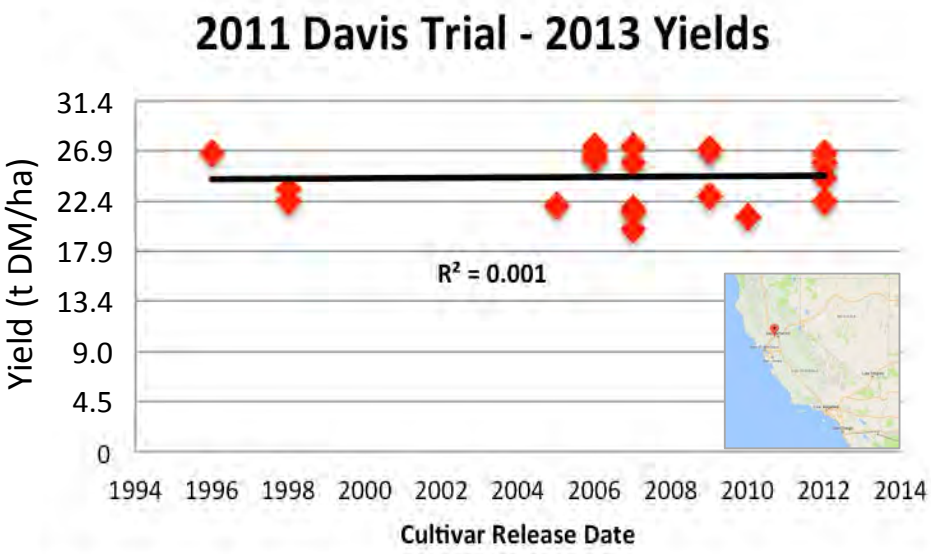
California - average lucerne yield
(USDA Ag Statistics)

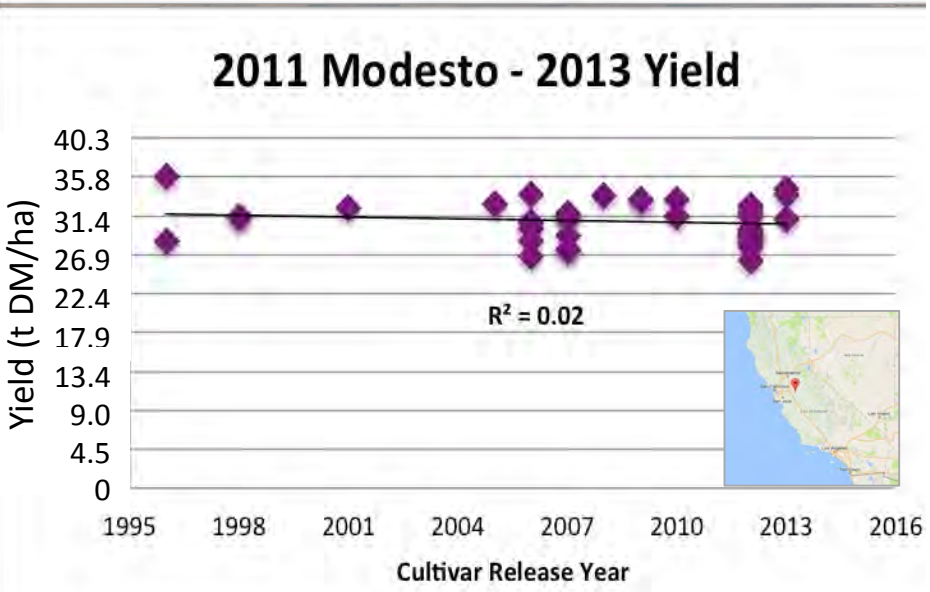


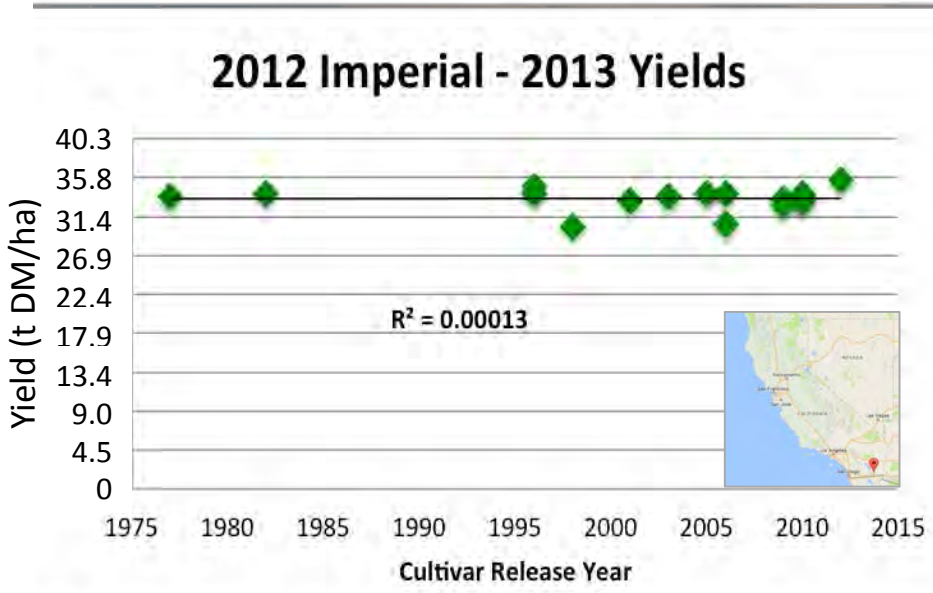
Supplied by: Charlie Brummer, UC Davis

Yield vs. Year of Cultivar Release

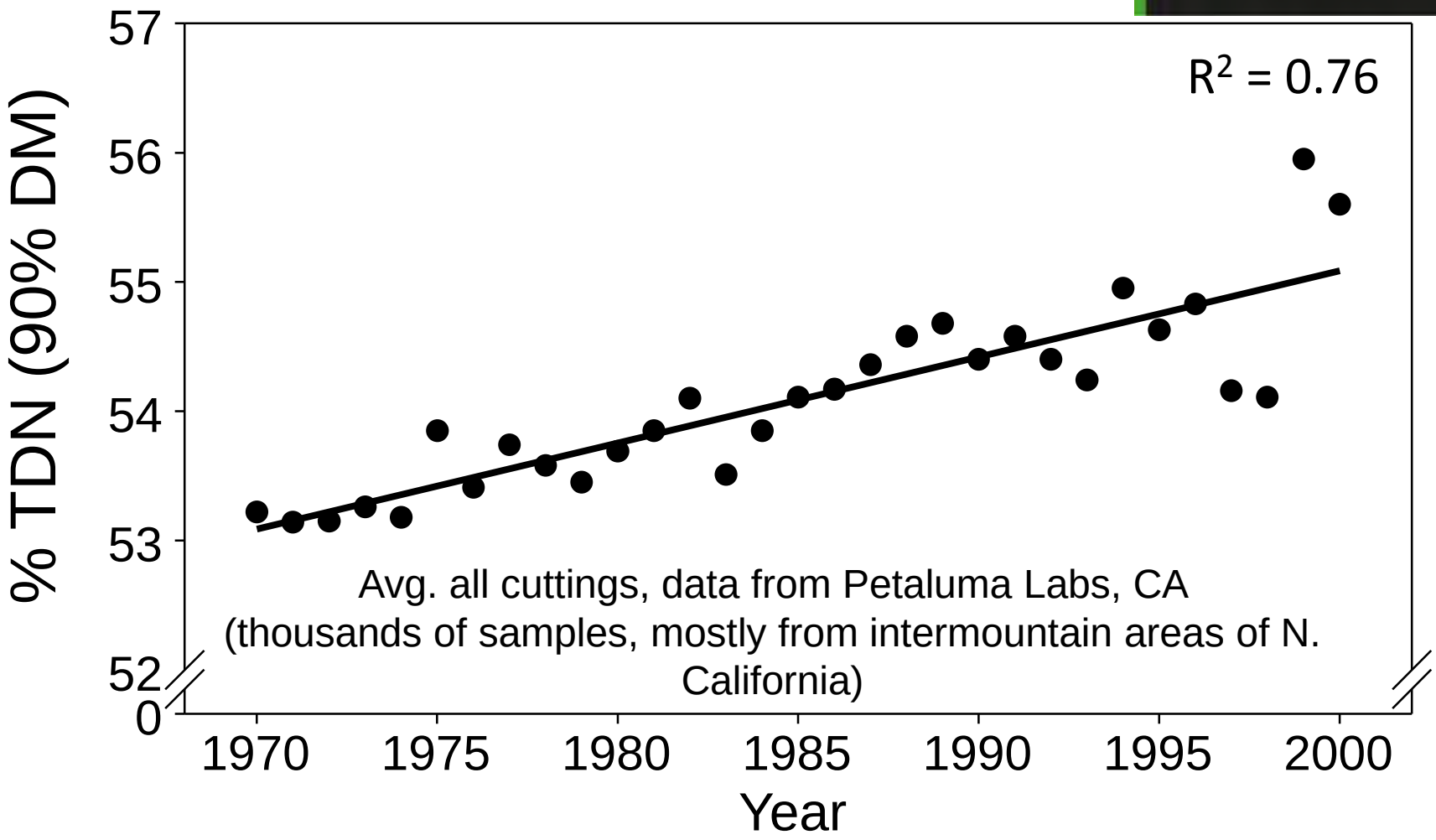








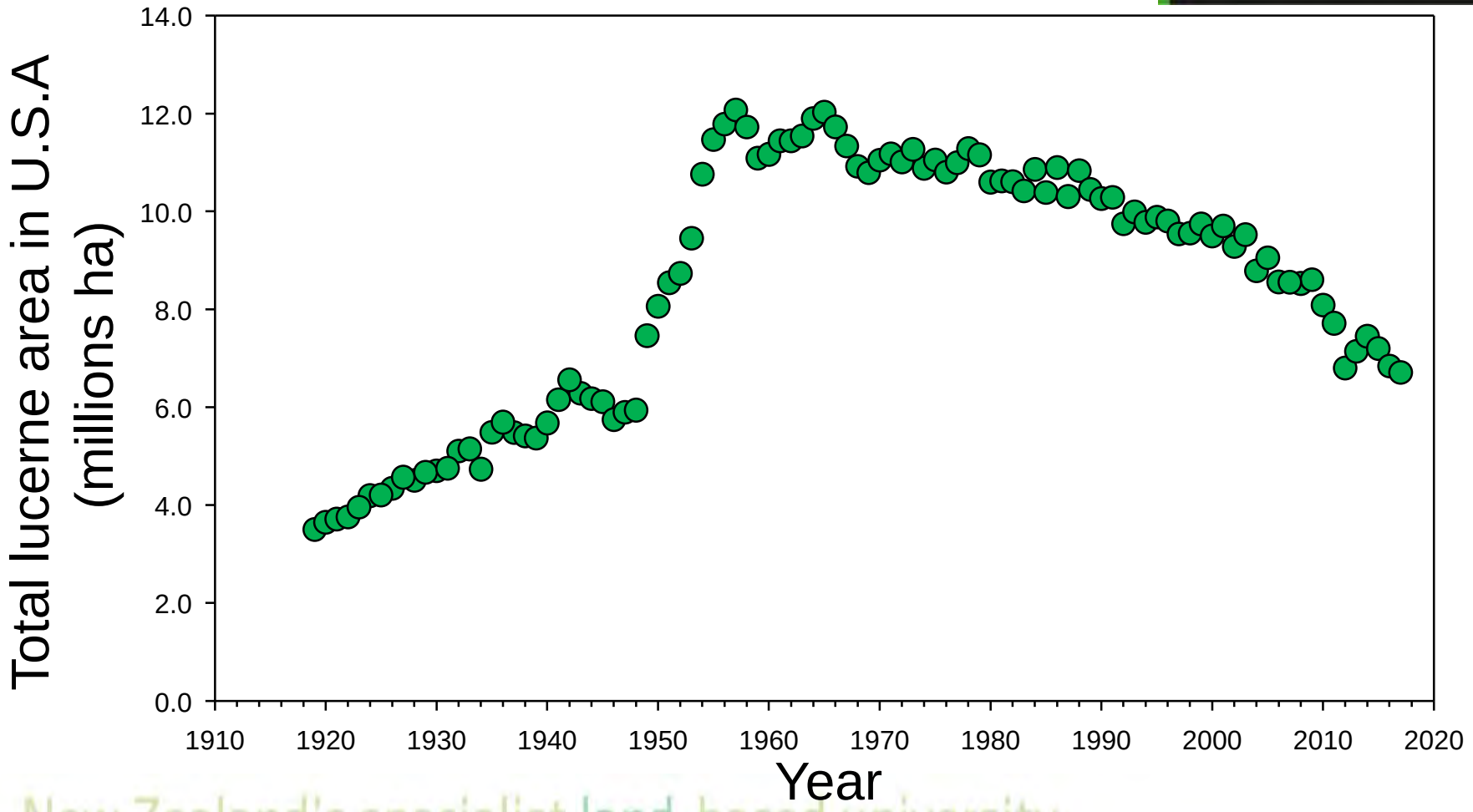
Lucerne Hay Quality Has Improved



Reflects earlier harvesting … and lower yield

Supplied by: Charlie Brummer, UC Davis

Area of lucerne in U.S.A



Modified from data supplied by: Charlie Brummer, UC Davis

Irrigation

Supplied by: Charlie Brummer, UC Davis

Photo: KM Pollock
Lincoln Unviersity

Fertilizer

- **Higher requirement from cutting than grazing**
  - **2% K = 20 kg/ha/t DM removed**

- **50% K super = 80 kg/ha/t DM removed**

Or

- **KCL = 40kg/ha/t DM removed + P and S from super**

Photo: DJ Moot
Lincoln University

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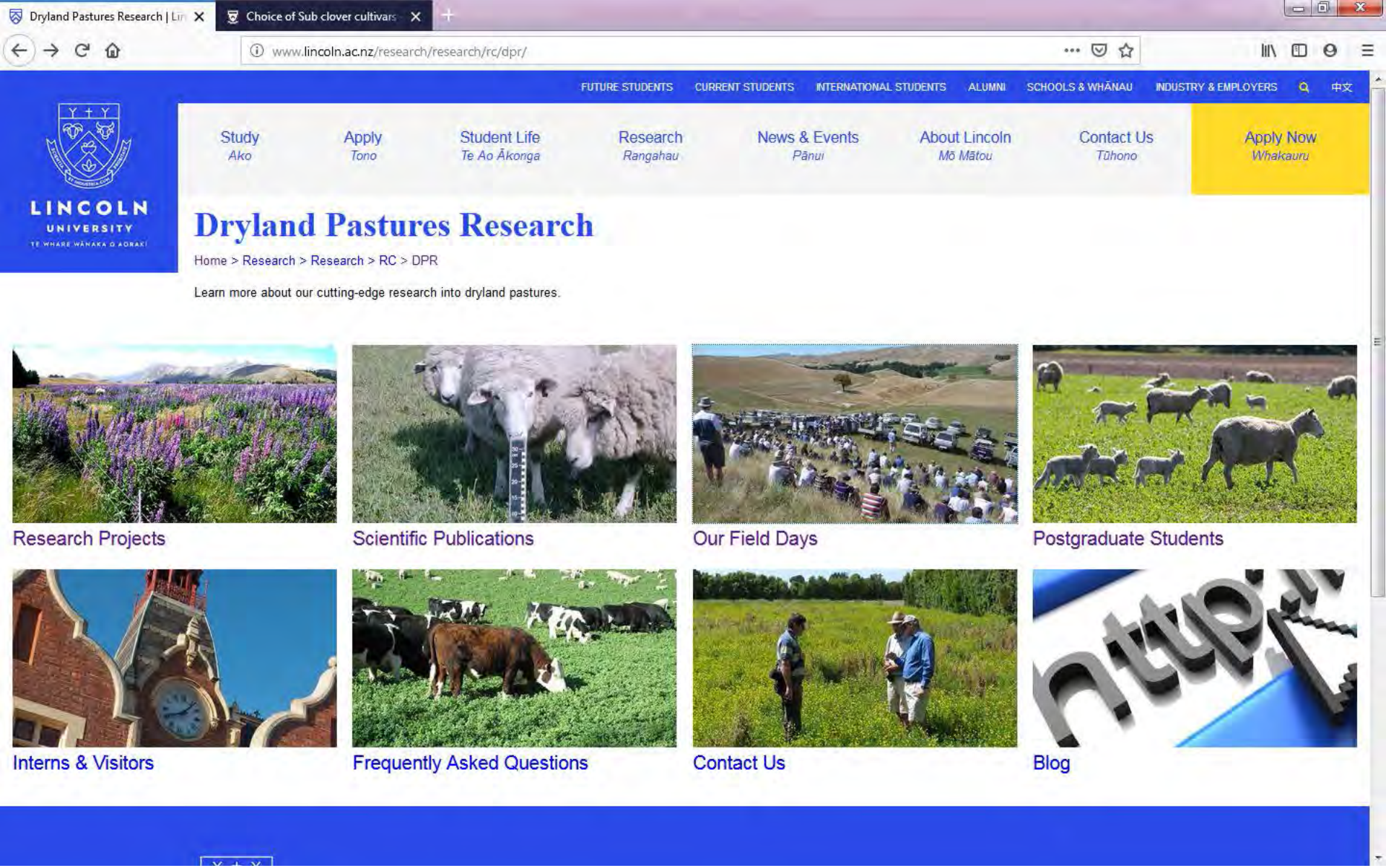
Conclusions

- All plants are N deficient except legumes
- Lucerne growth is seasonal
- Lucerne yield and quality are linked
- Management of lucerne trumps genetics
- Cut ~4 tonne (40-45 cm) for yield and quality
- Irrigation should be lots and infrequently
- Remember K fertilizer!



Website: www.lincoln.ac.nz/dryland
Blog: https://blogs.lincoln.ac.nz/dryland
Facebook: **@DrylandPasturesResearch**

References

Addiscott, T.M. 2005. Nitrate, Agriculture and the Environment. CABI International, Wallingford, 279 pp.

Brown, H. E. 2004. Understanding yield and water use of dryland forage crops in New Zealand. Ph.D thesis, Lincoln University, Lincoln, Canterbury. 288 pp.

Brown, H.E. and Moot, D.J. 2004. Quality and quantity of chicory, lucerne and red clover production under irrigation. Proceedings of the New Zealand Grassland Association 66: 257-264.

Brown, H.E., Moot, D.J. and Pollock, K.M. 2003. Long term growth rates and water extraction patterns of dryland chicory, lucerne and red clover. In: D.J. Moot (Editor), D.J. Moot (Ed.). Legumes for Dryland Pastures. Proceedings of a New Zealand Grassland Association Symposium. 18-19 November 2003. New Zealand Grassland Association. **Research & Practice Series** Lincoln University, New Zealand, pp. 91-99.

Brown, H.E., Moot, D.J. and Pollock, K.M. 2005. Herbage production, persistence, nutritive characteristics and water use of perennial forages grown over 6 years on a Wakanui silt loam. New Zealand Journal of Agricultural Research 48: 423-429.

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. 2007. Understanding constraints to cocksfoot (*Dactylis glomerata* L.) based pasture production, PhD thesis, Lincoln University, Canterbury. Online access: http://researcharchive.lincoln.ac.nz/dspace/bitstream/10182/32/1/mills_phd.pdf. 202 pp.

Mills, A., Moot, D.J. and Jamieson, P.D. 2009. Quantifying the effect of nitrogen of productivity of cocksfoot (*Dactylis glomerata* L.) pastures. *European Journal of Agronomy*, **30**, 63-69.

Mills, A., Moot, D.J. and McKenzie, B.A. 2006. Cocksfoot pasture production in relation to environmental variables. *Proceedings of the New Zealand Grassland Association*, **68**, 89-94.

Moot, D.J., Brown, H.E., Teixeira, E.I. and Pollock, K.M. 2003. Crop growth and development affect seasonal priorities for lucerne management. , D.J Moot (Ed.). Legumes for Dryland Pastures. Proceedings of a New Zealand Grassland Association Symposium. 18-19 November 2003. New Zealand Grassland Association. **Research & Practice Series No. 11**, Lincoln University, New Zealand, pp. 201-208.

Moot, D.J., Brown, H.E., Pollock, K. and Mills, A. 2008. Yield and water use of temperate pastures in summer dry environments. Proceedings of the New Zealand Grassland Association 70: 51-57.

Ta, H. T. 2018. Growth and development of lucerne with different fall dormancy ratings. Online: https://hdl.handle.net/10182/10332. Ph.D thesis, Lincoln University, Lincoln. 160 pp.