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Te Whare Wānaka o Aoraki

AOTEAROA • NEW ZEALAND

Lucerne

2nd August 2019

Tamworth

Professor Derrick Moot

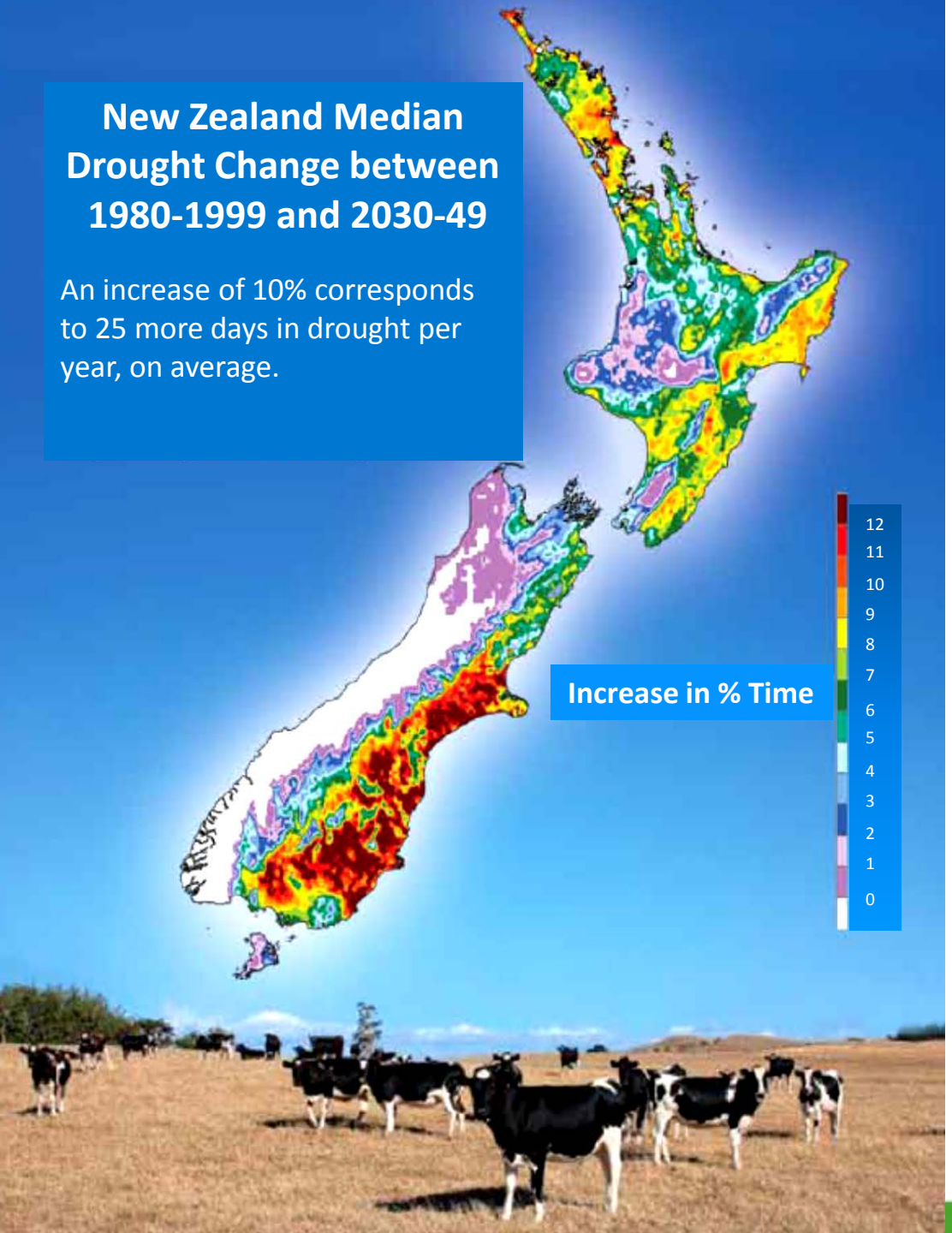
New Zealand's specialist land-based university

Introduction

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

Photo: S Larsen
Lincoln University

85 post grads + 40 visiting interns/scholars



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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

“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

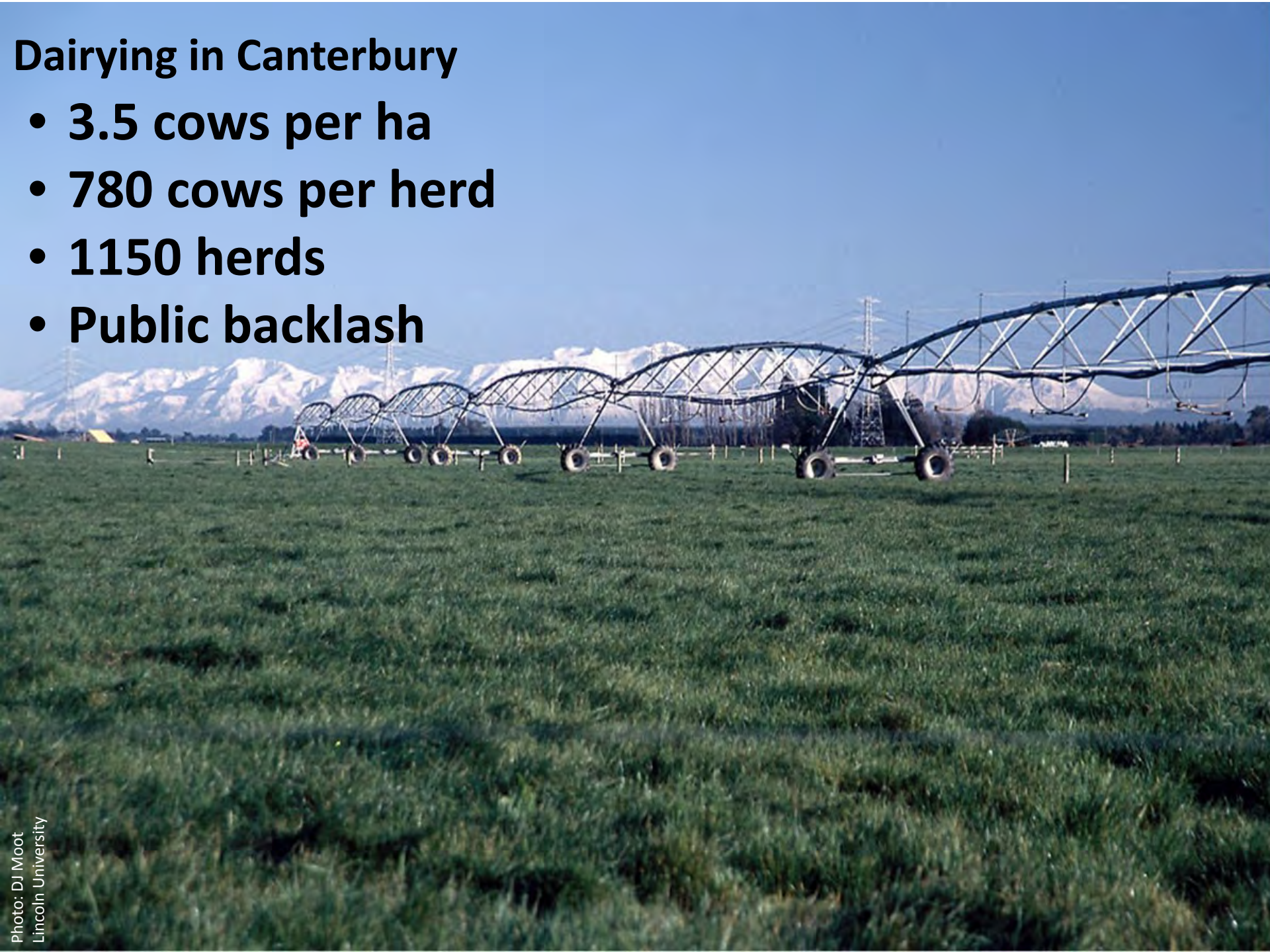


Photo: DJ Moot
Lincoln University

Experiment site

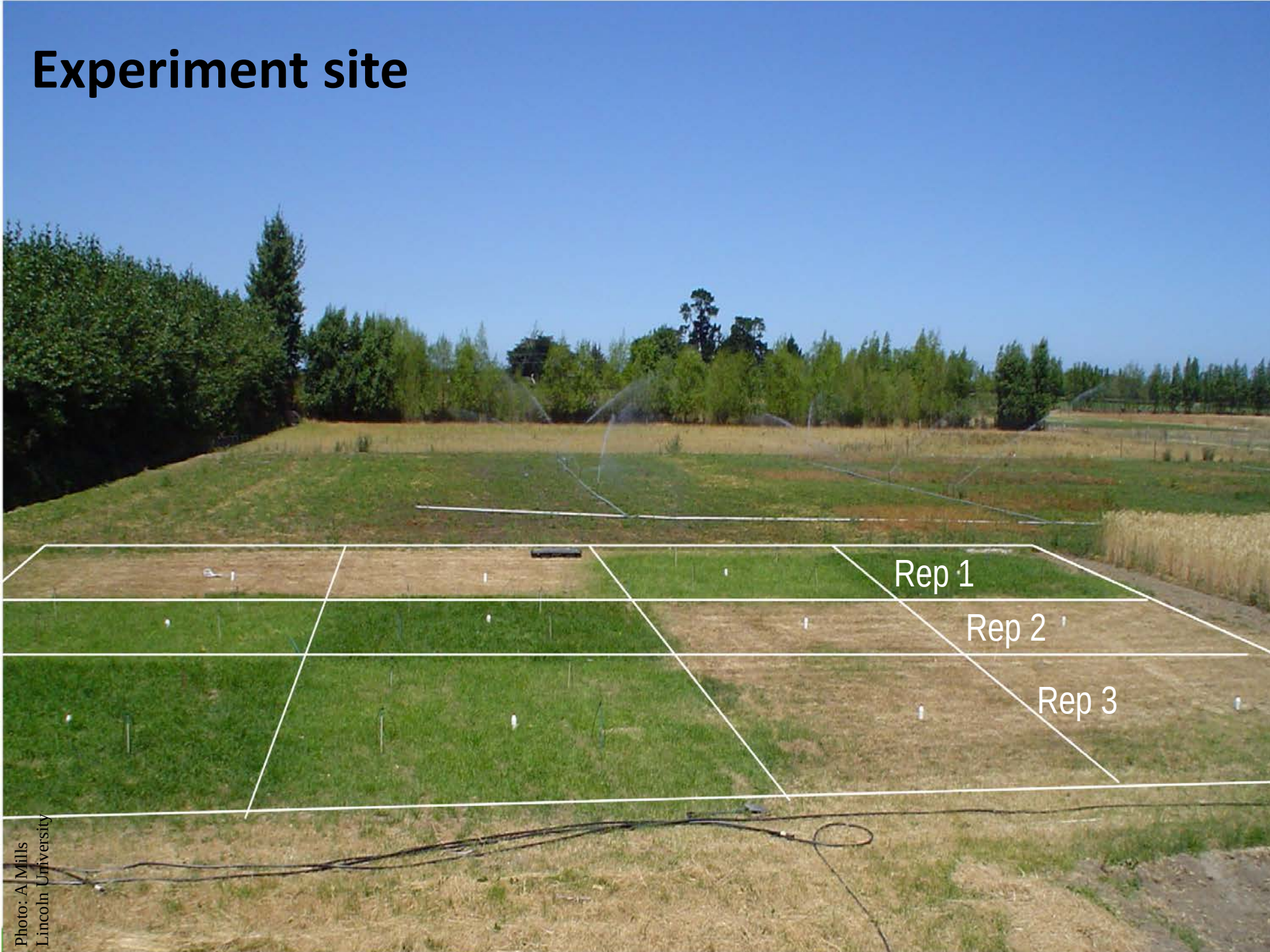
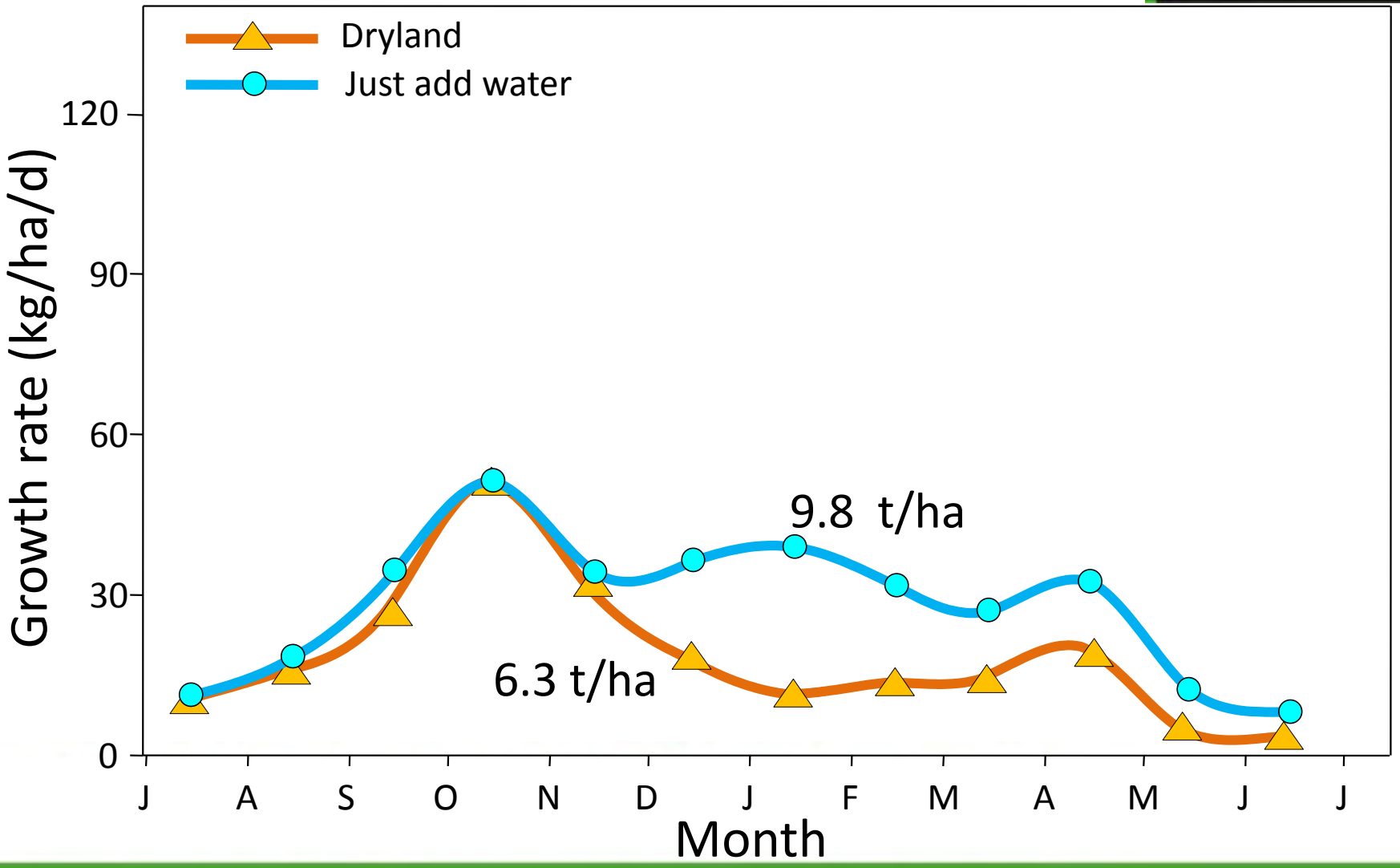


Photo: A Mills
Lincoln University

Growth rates (2 year means)



Mills *et al*. 2006, 2009

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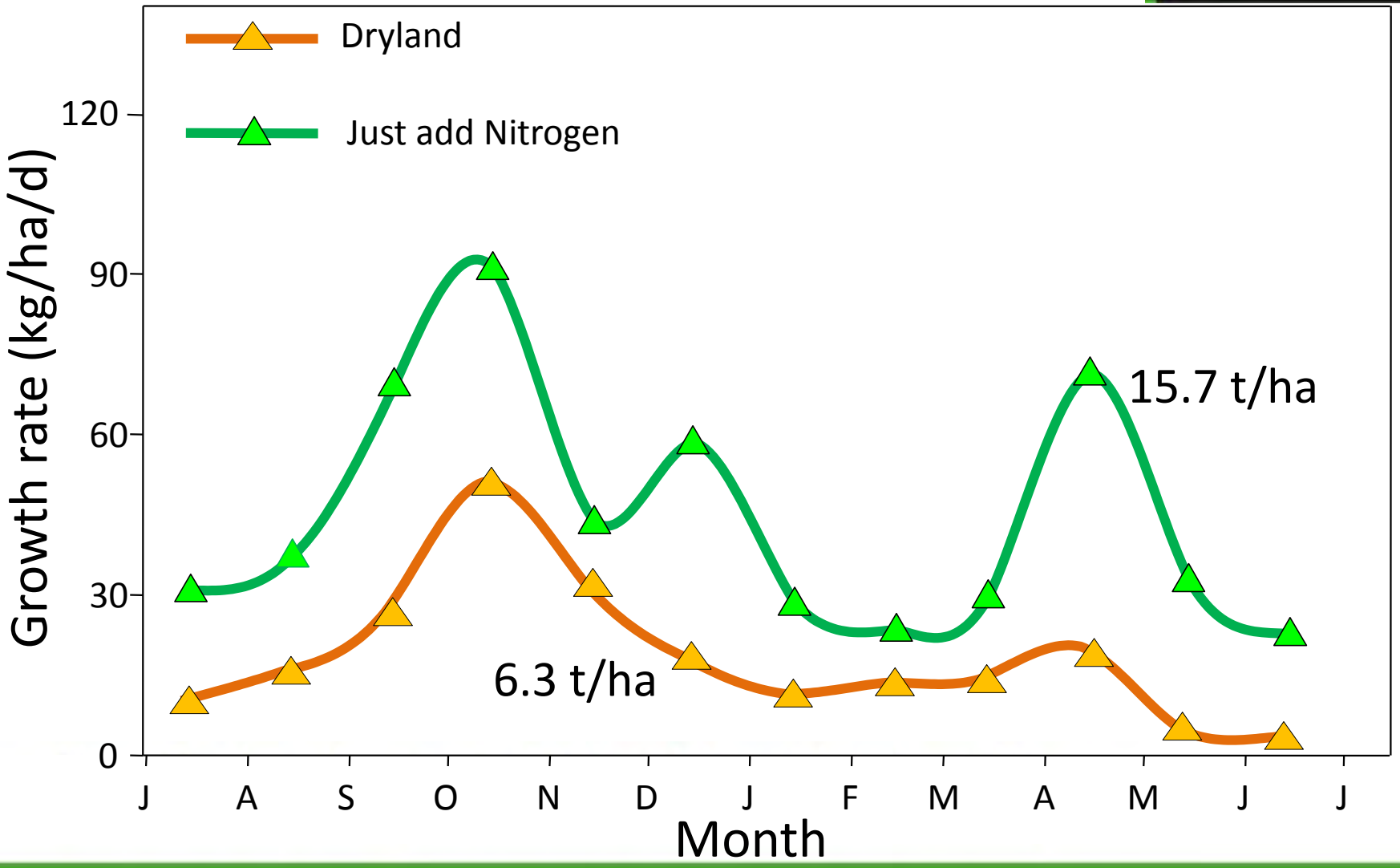

Mills *et al*. 2006, 2009

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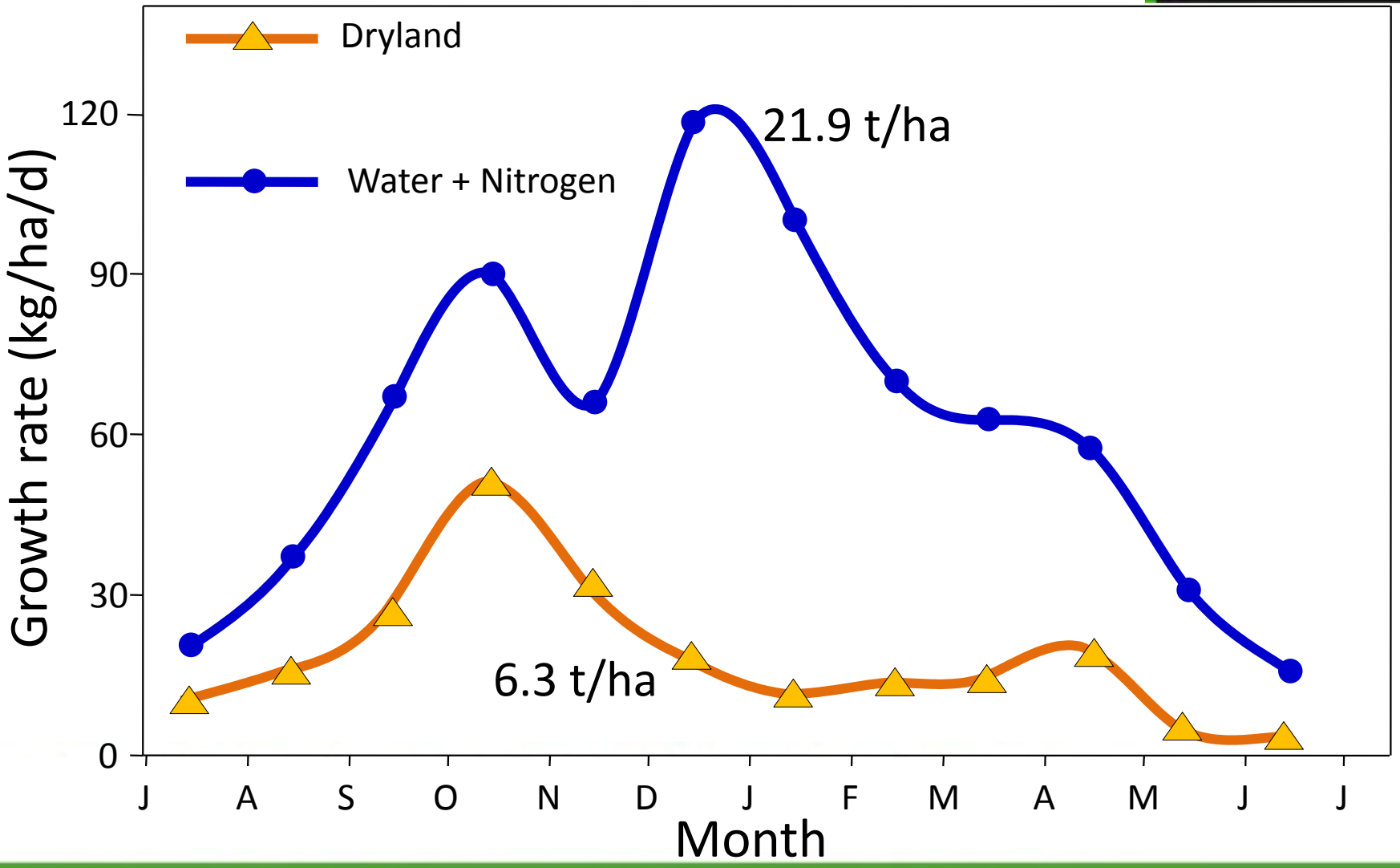
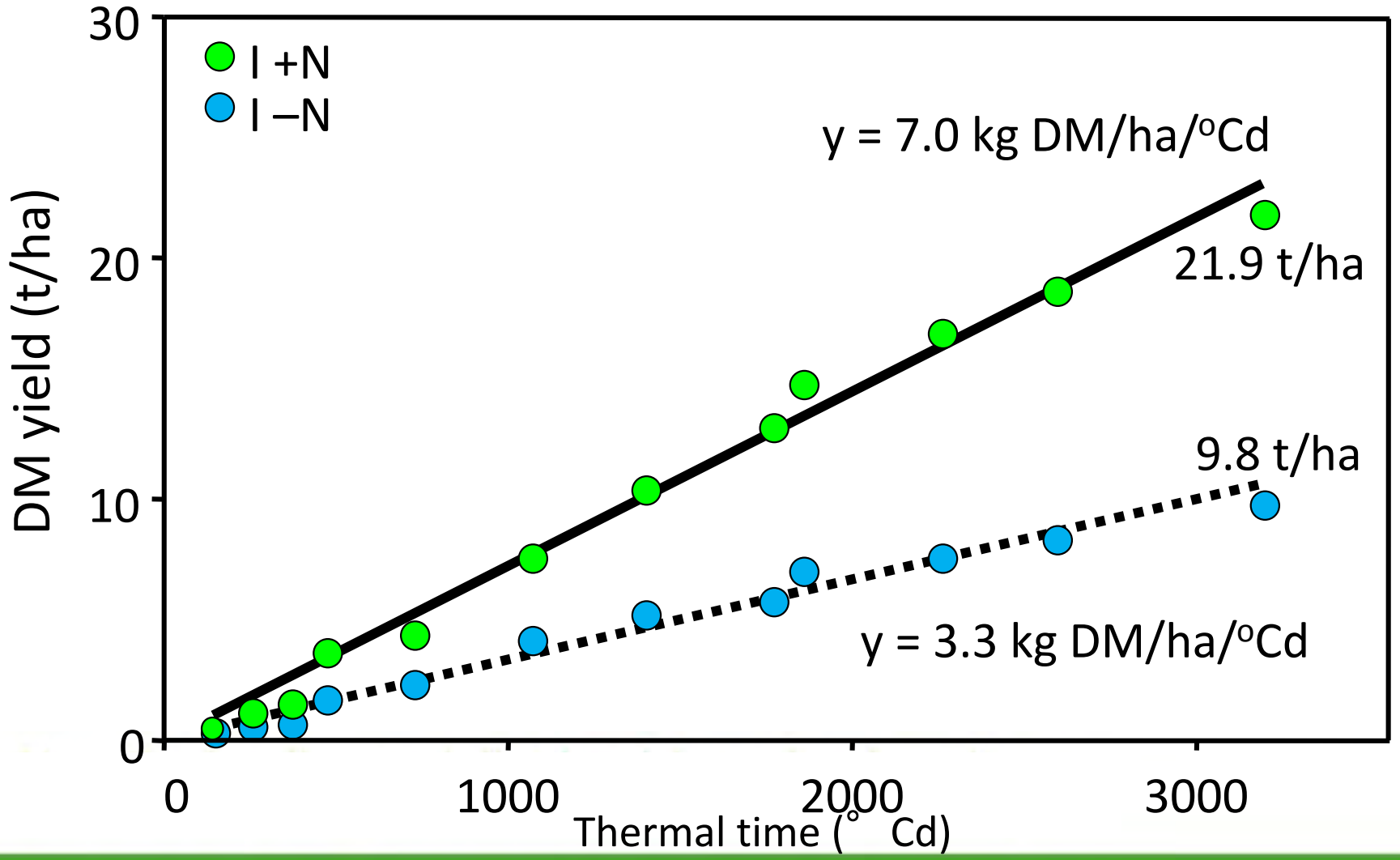


Mills *et al*. 2006, 2009

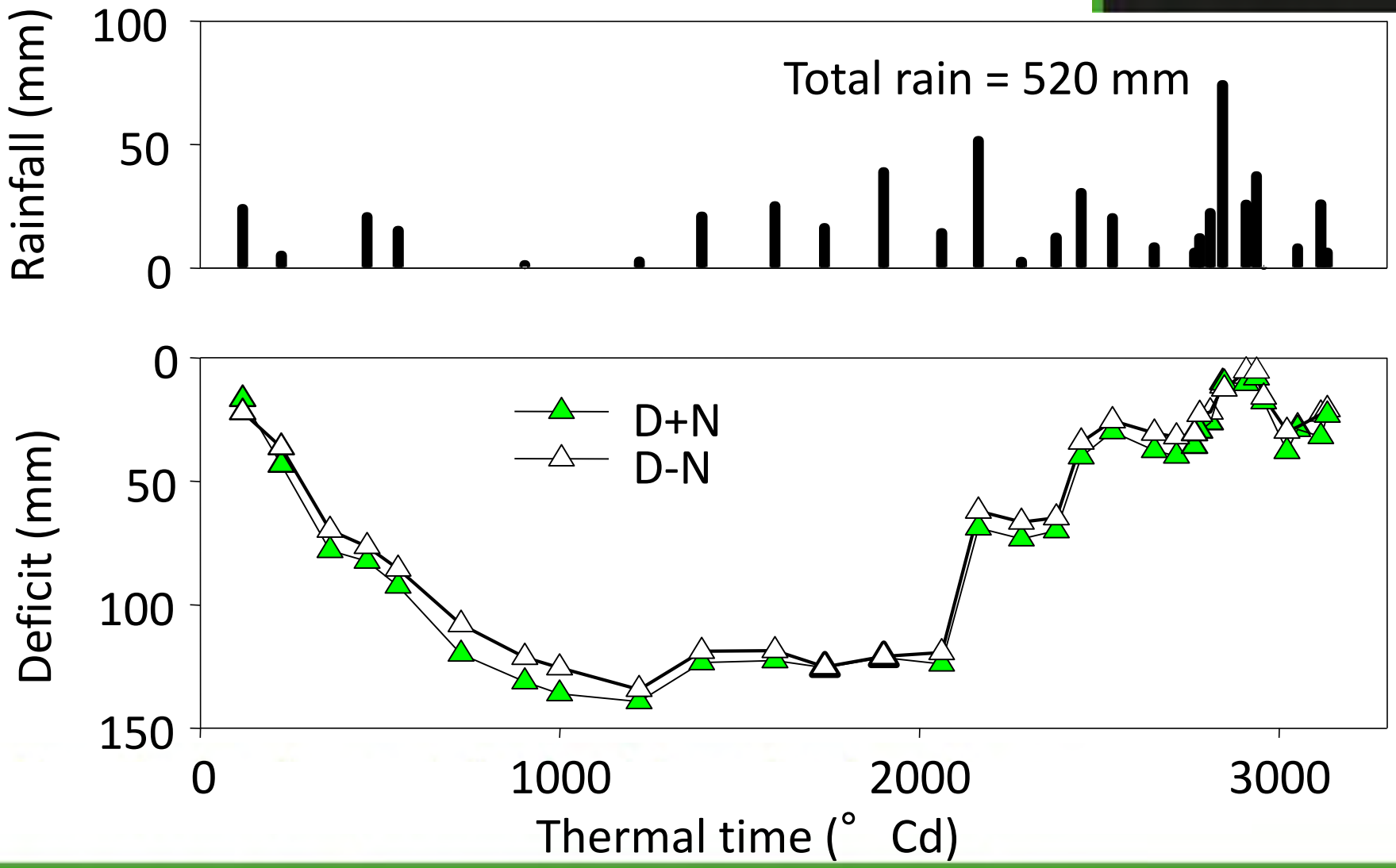
The Nitrogen gap



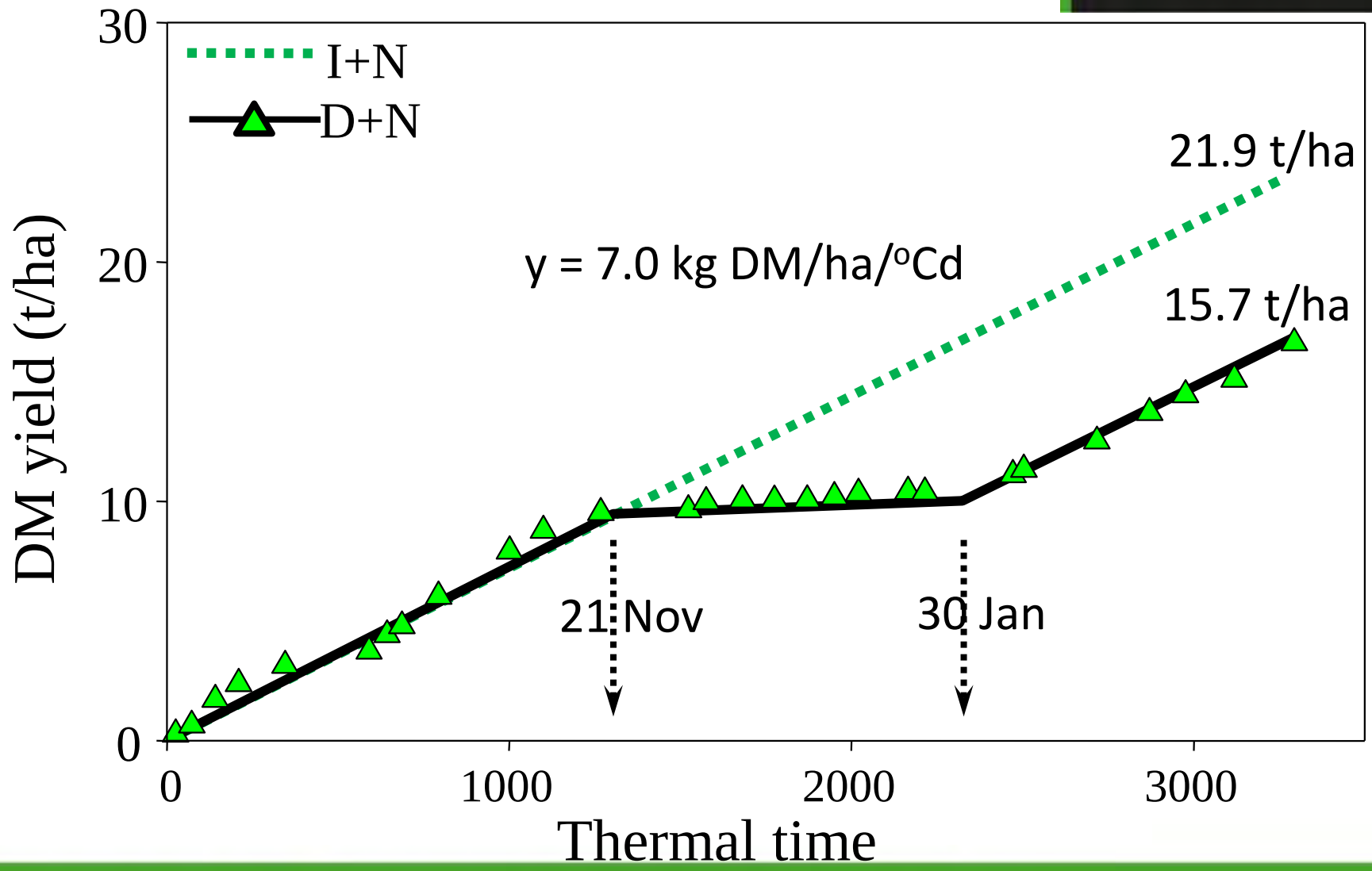
Mills *et al*. 2006; 2009

Summer ⇒ moisture response

Soil moisture deficit 2003/04



Water stress effect on yield

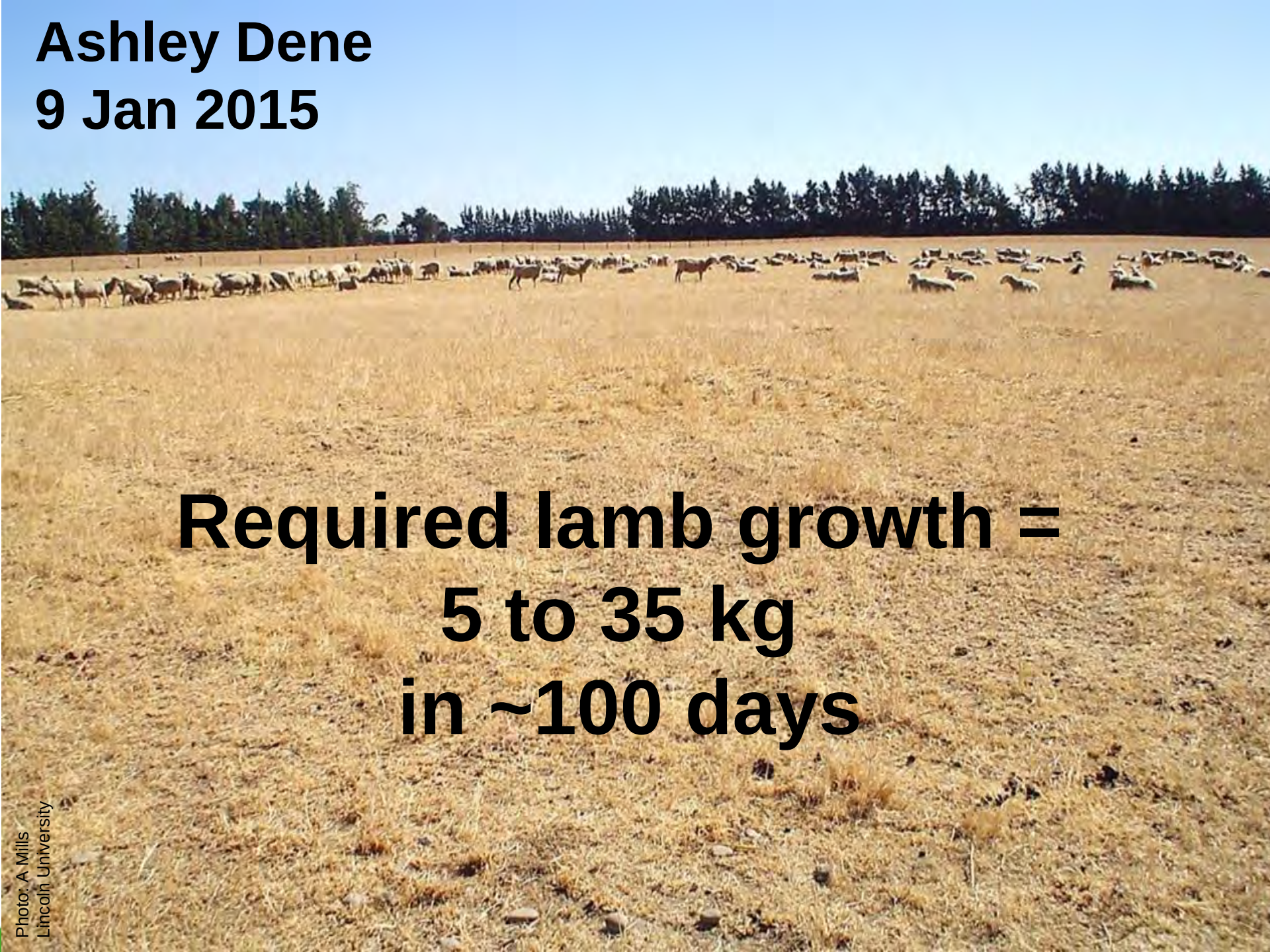


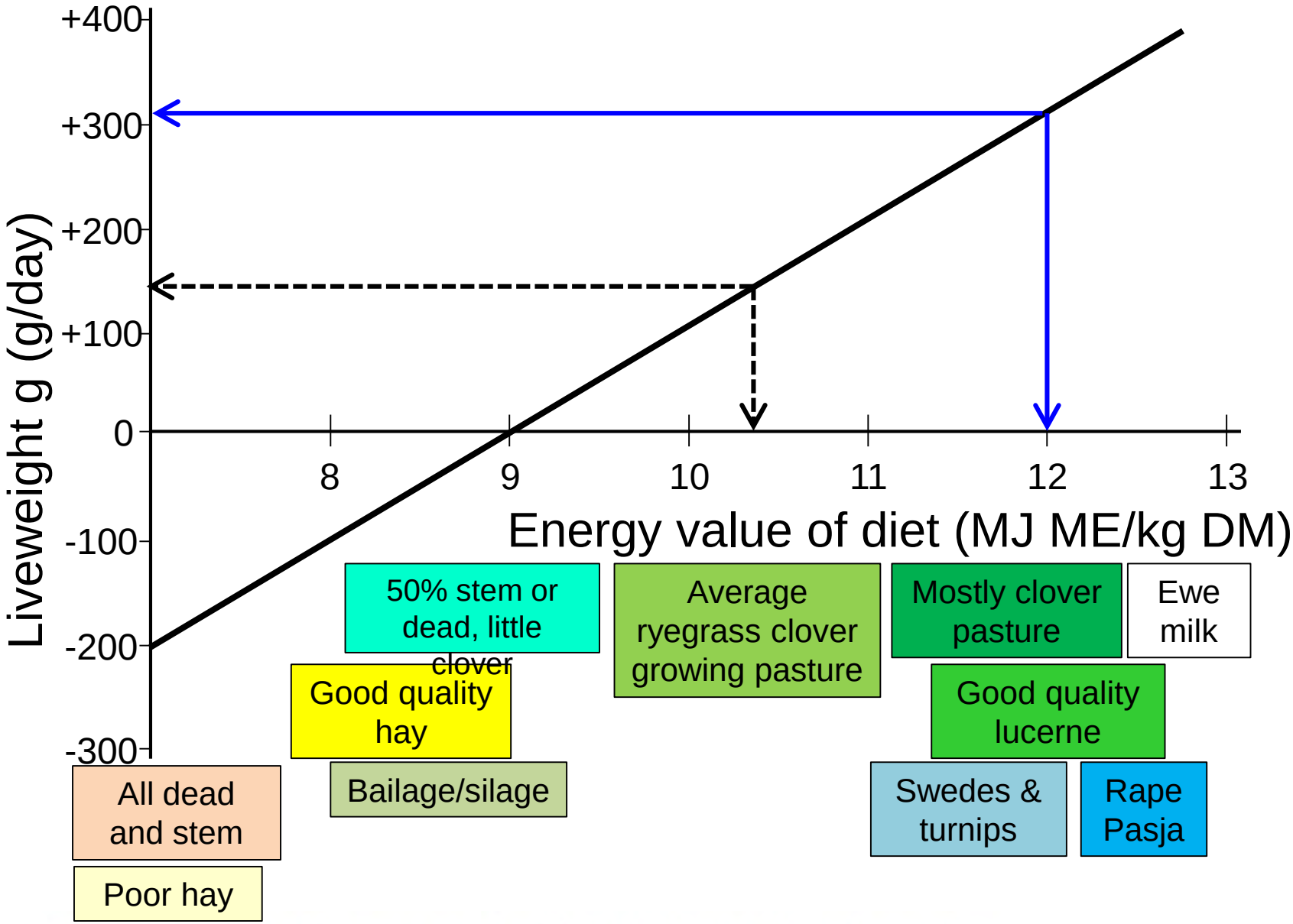
Mills *et al*. 2006

Nitrogen fixation
25-30 kg N/t DM

Photo: DP Monks
Lincoln University

Lucas *et al*. 2010


Ashley Dene
9 Jan 2015
Required lamb growth =
5 to 35 kg
in ~100 days
Photo: A Mills
Lincoln University



Adapted from: Kerr, 2010. 400 Plus. A guide to improved lamb growth

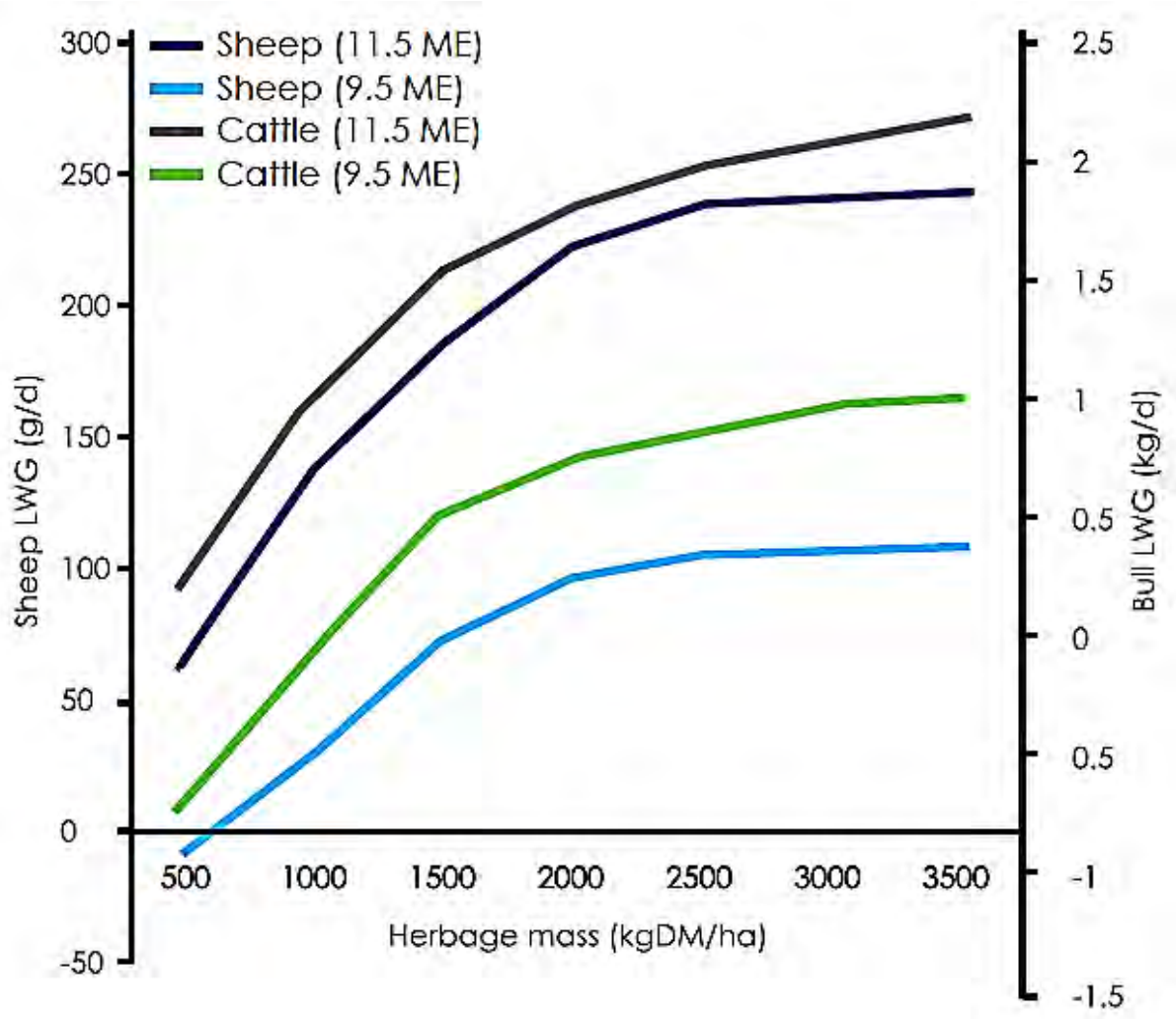
ME 7.2 MJ/kg DM

ME 9.6 MJ/kg DM

ME 10.9 MJ/kg DM

Courtesy C. Matthew

Generalised relationship between pasture herbage mass and live weight gain of animals



Beef + Lamb New Zealand. 2012. Pasture quality: Principles and management / The Q-Graze manual. Accessed 29/09/2017.
http://www.beeflambnz.com/knowledge-hub/factsheets/pasture-quality-q-graze

Energy requirement (MJ ME) for lamb growth from 25 to 35 kg liveweight

Lamb growth rate (g/hd/d)	Energy per lamb per day	Days on farm	Energy consumed per lamb
100	13	100	1300
200	17	50	850
300	22	33	726

MJ ME: megajoules of metabolisable energy

Sheep prefer 70% legume, 30% grass

Photo: Jo Grigg
Tempello' Marlborough

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:

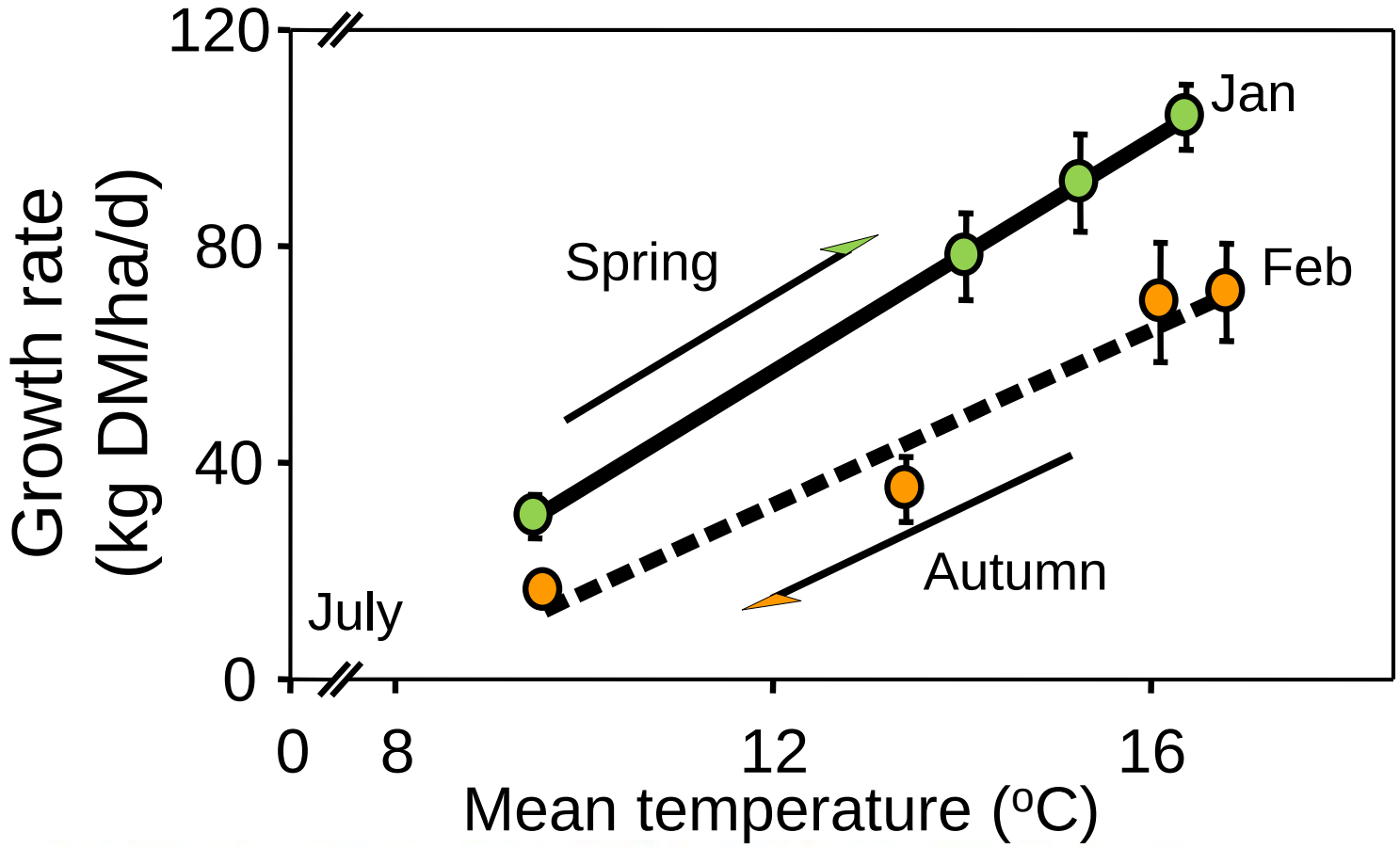
is the ‘age’ or maturity of the regrowth crop e.g. leaf appearance, flowering

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

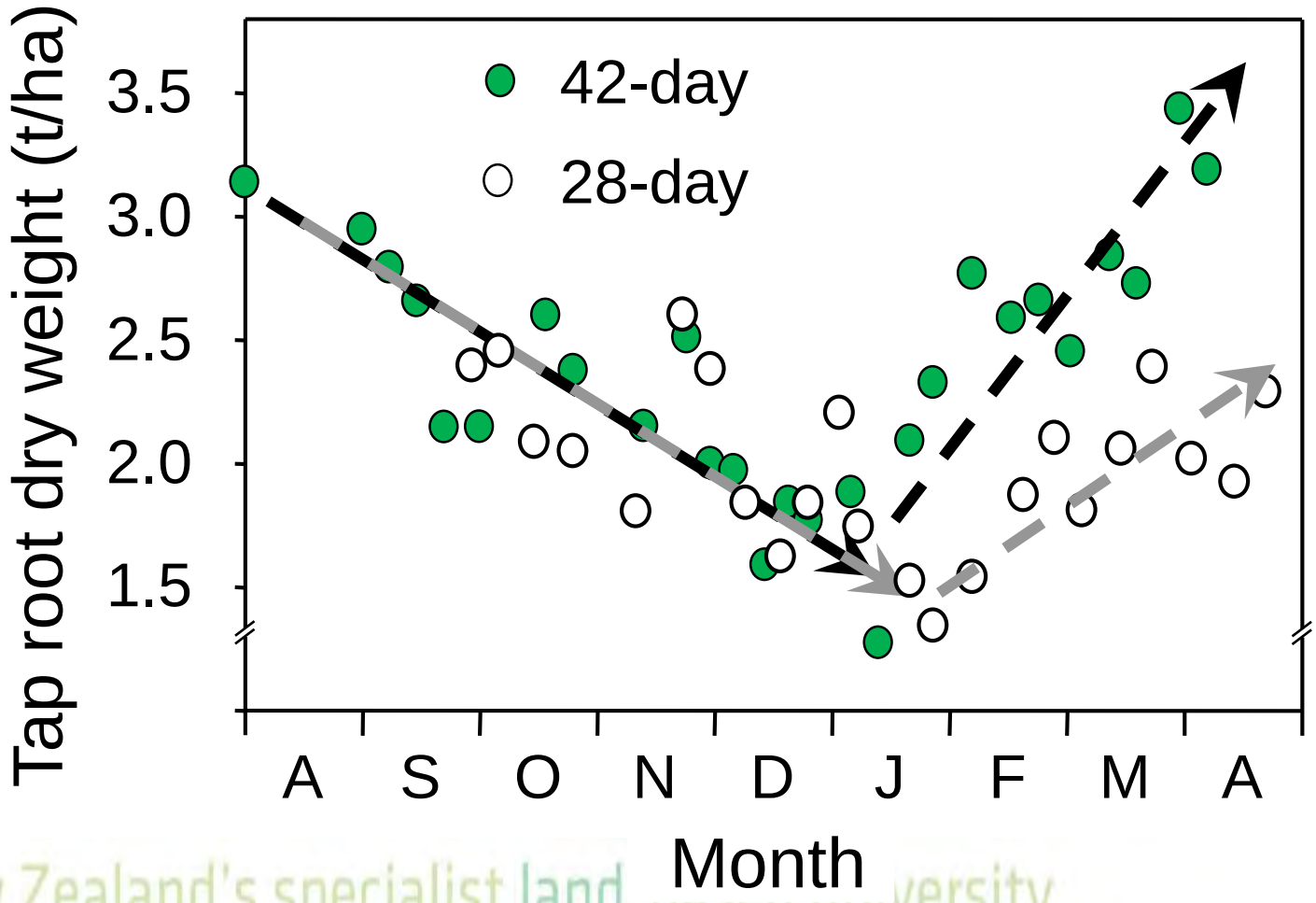
4 days grazing

25 days resting

3 days grazing

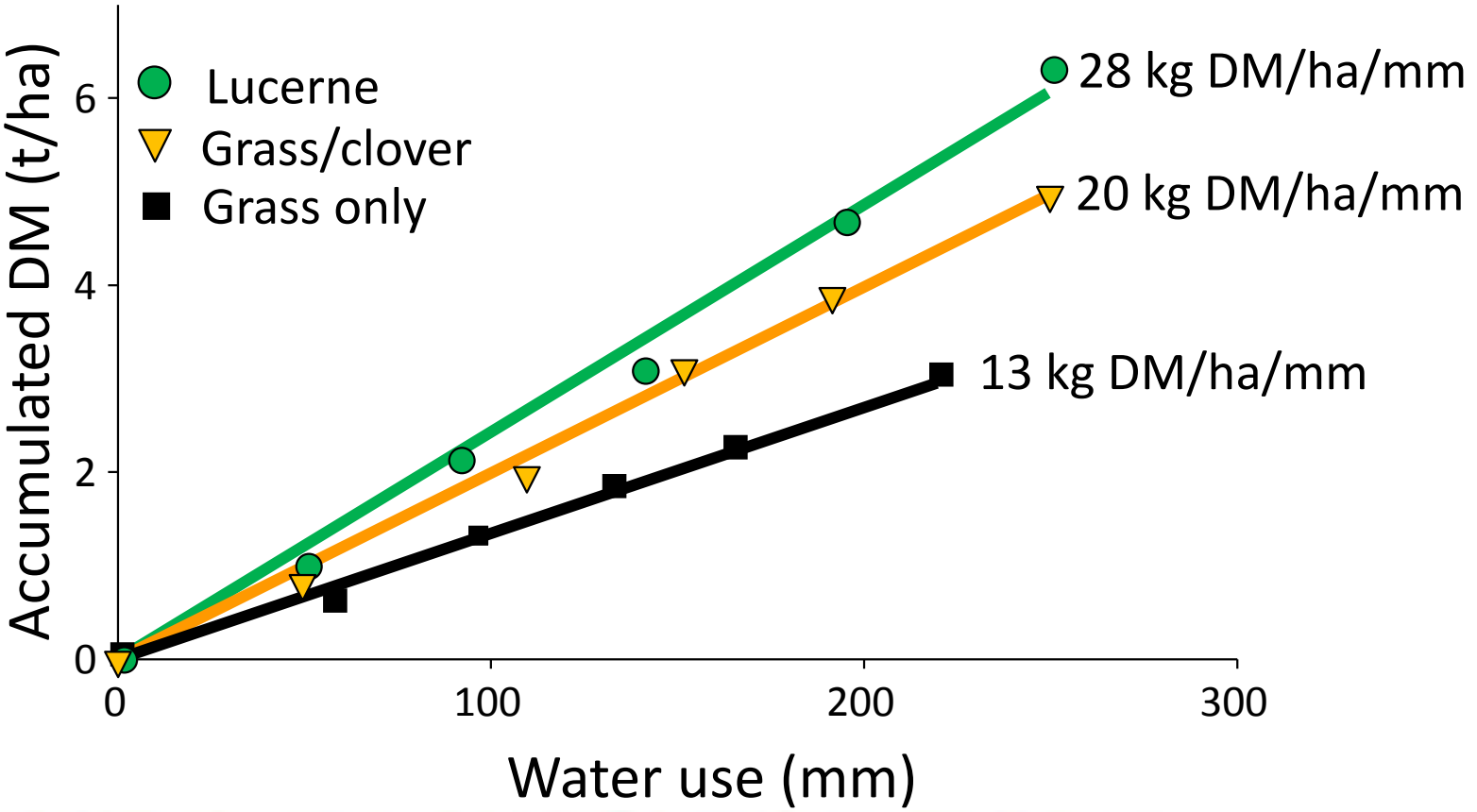
Photo: E.I. Teixeira
Lincoln University

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

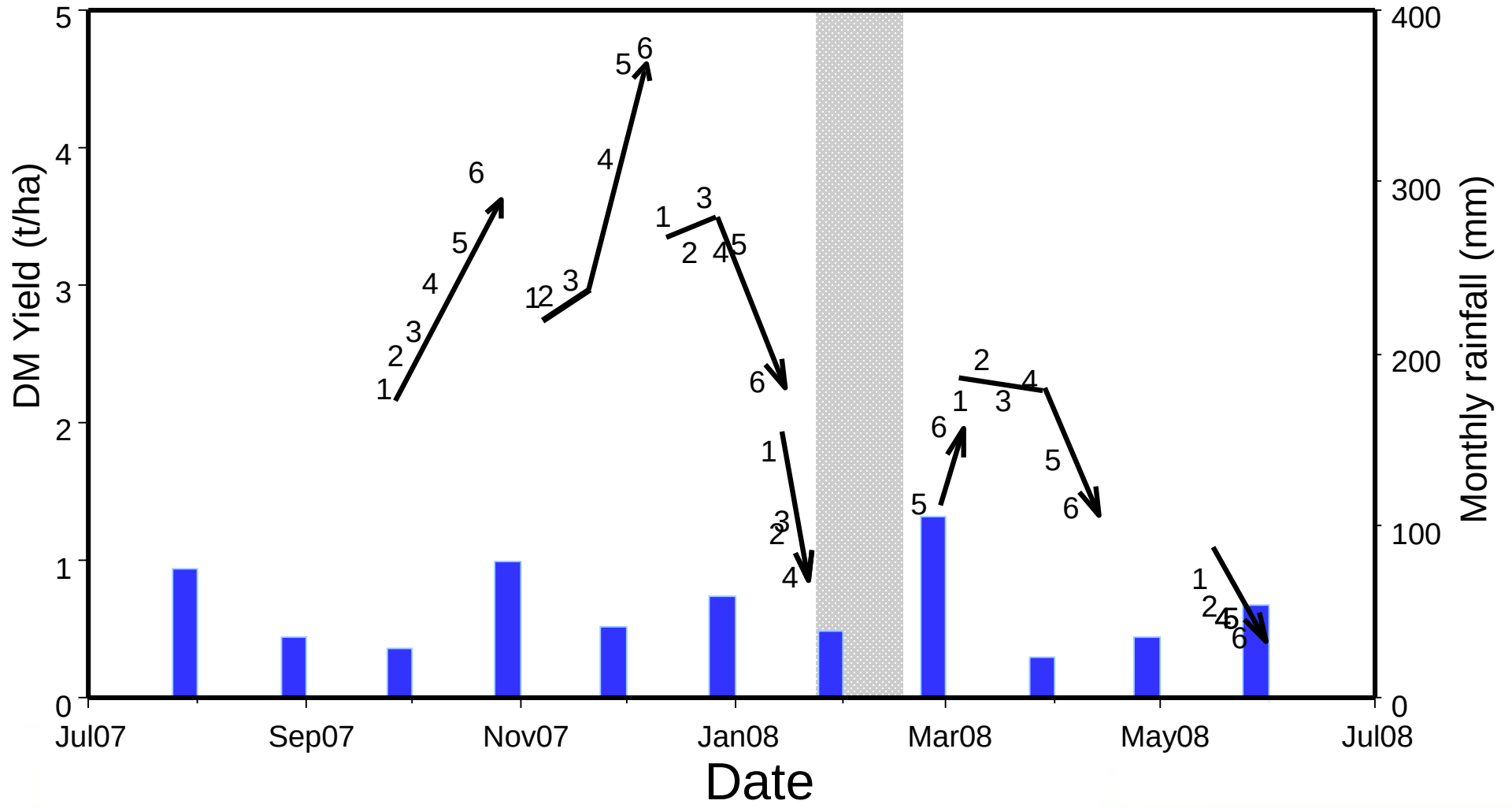
Growing point at the top of the plant

Photo: Doug Avery,
Bonavaree, Marlborough

Spring grazing at ‘Bonavaree’, Marlborough

14 ewes + twins/ha

MaxClover – 38-42 day rotation



Moot & Smith 2011

High numbers for 7-10 days

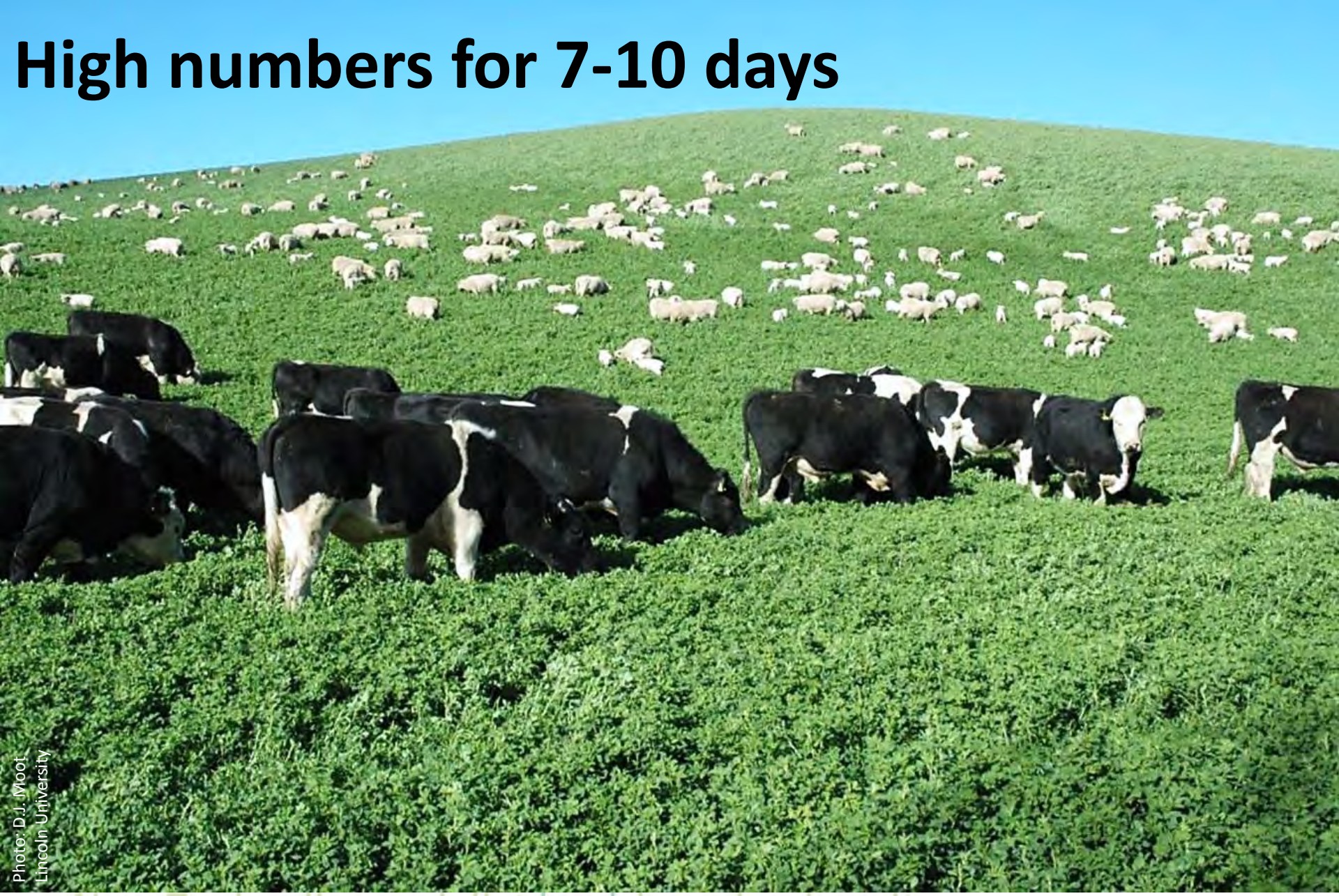


Photo: D.J. Moot
Lincoln University

Case study – Bonavaree farm, Marlborough

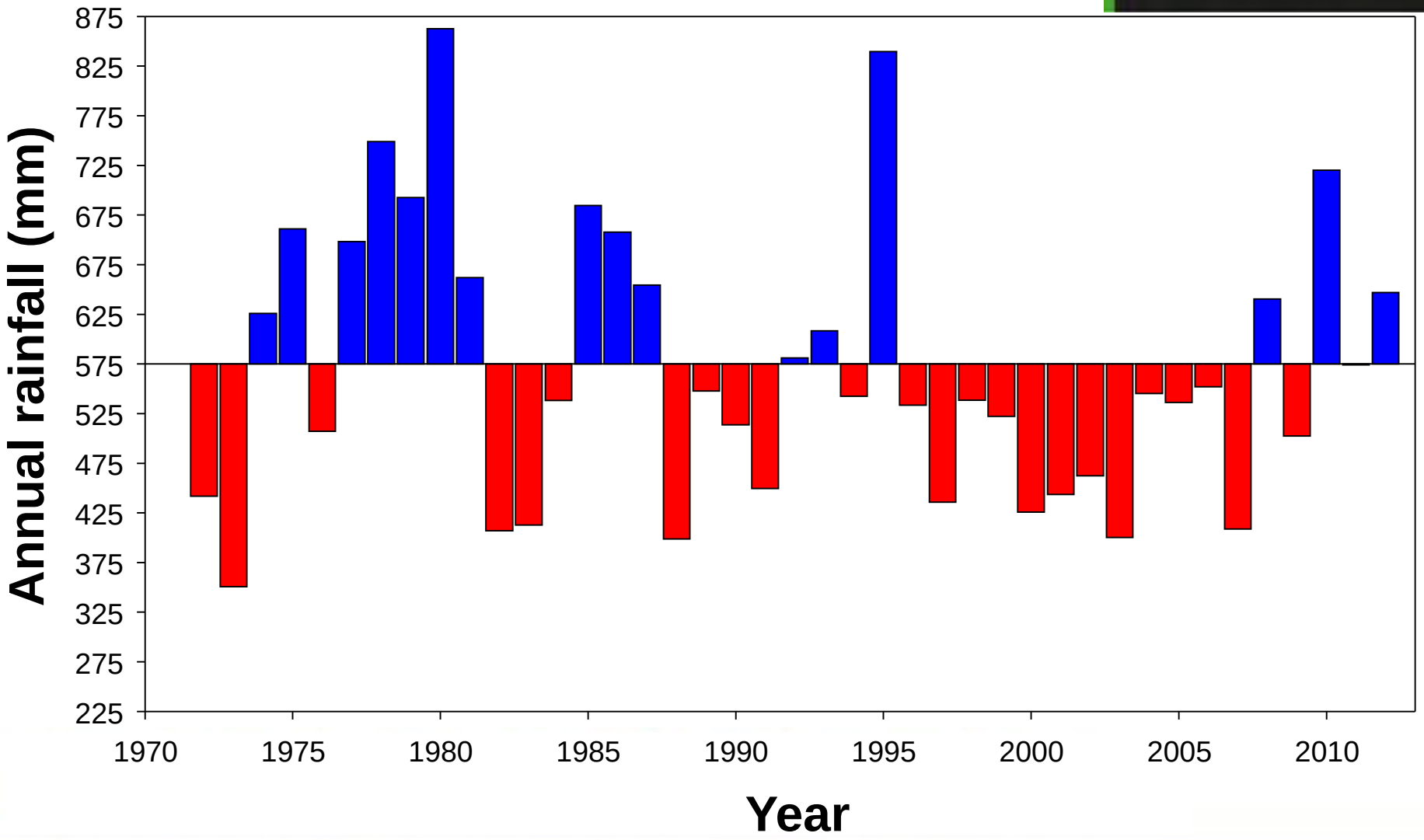
Over grazed – high erosion risk

Financially – no return

Dryland lucerne conversion

Photo: Doug Avery
'Bonavaree', Marlborough

Annual rainfall at ‘Bonavaree’



Data sourced from NIWA, Cliflo database

Doug and Fraser Avery “Bonavaree”

Photo: Doug Avery, Bonavaree, Marlborough

Photo: D.J. Moot
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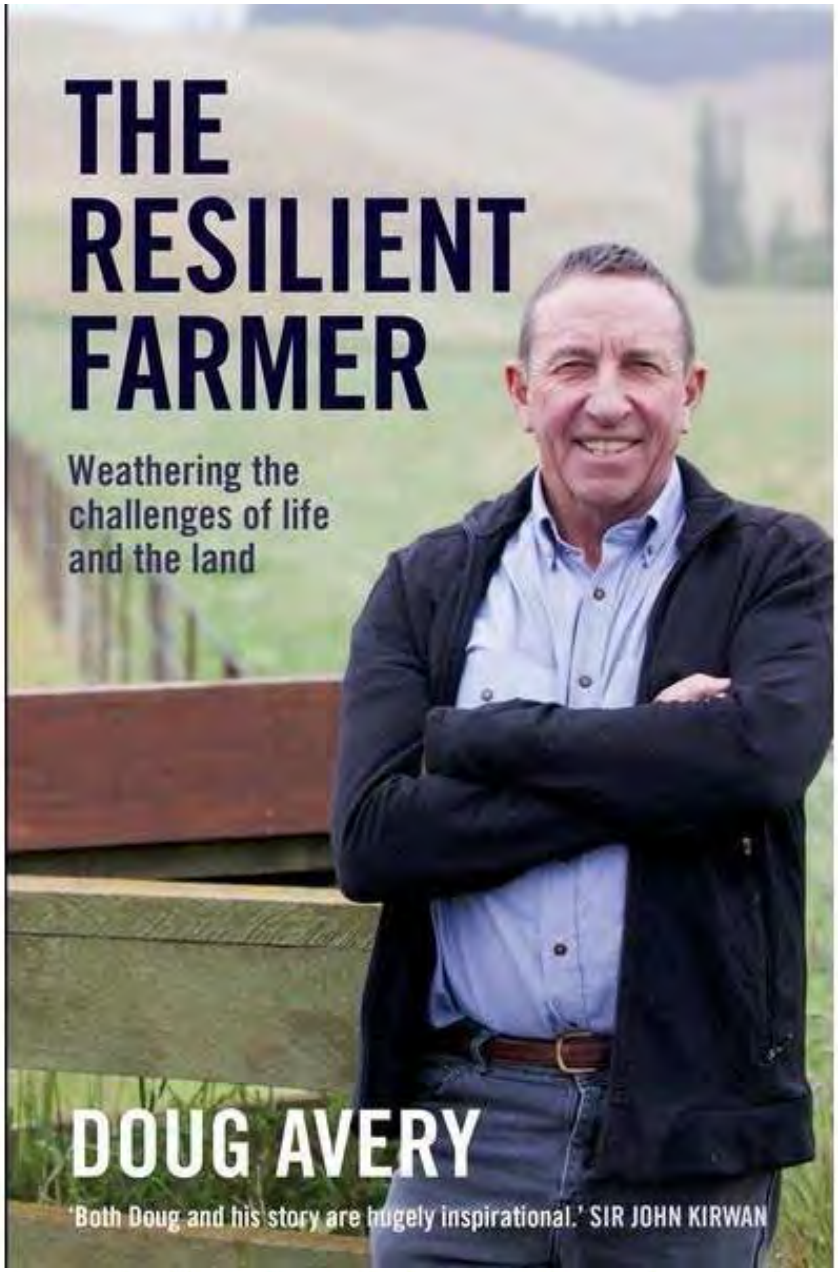
‘Bonavaree’ production change over 10 years

	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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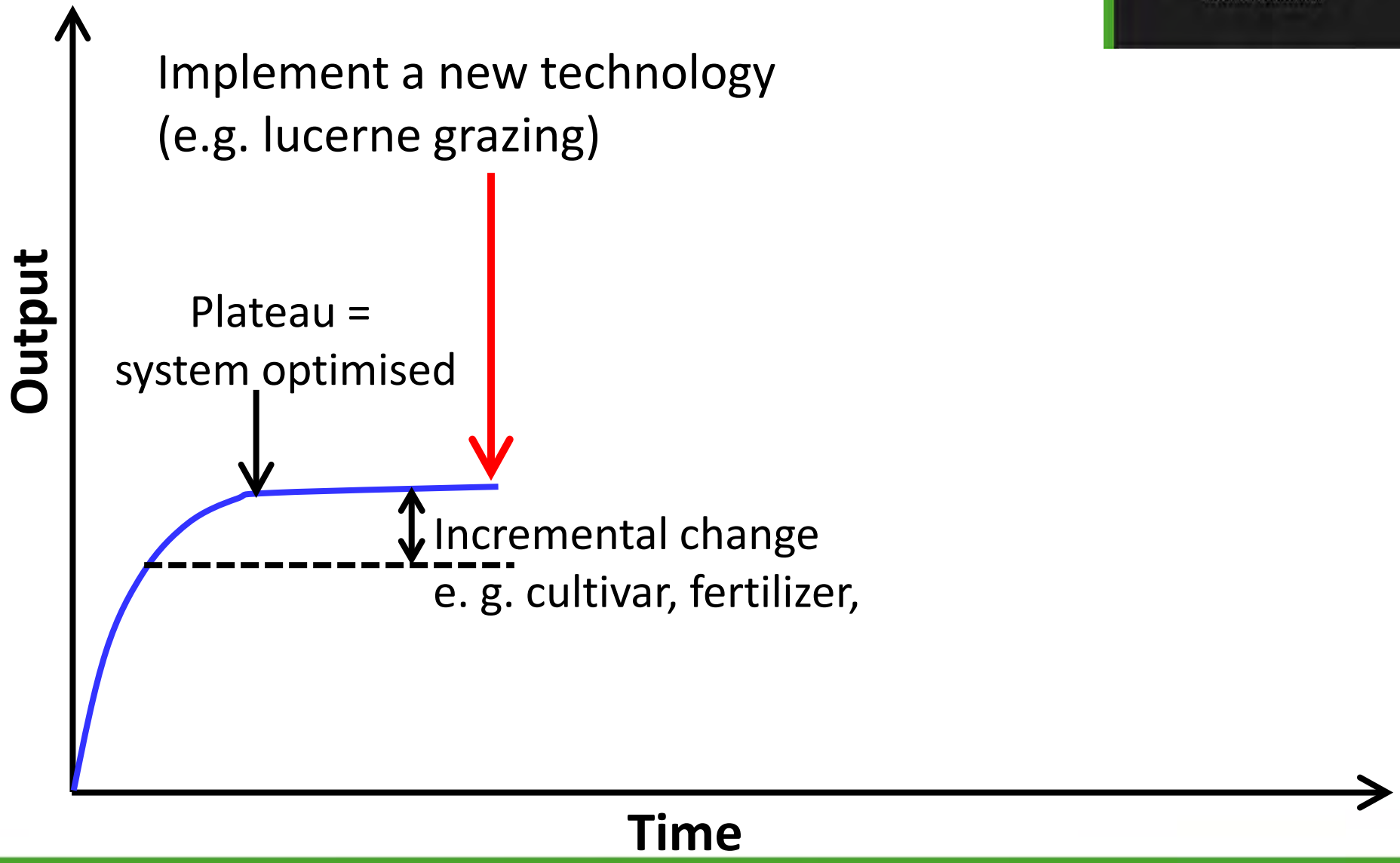
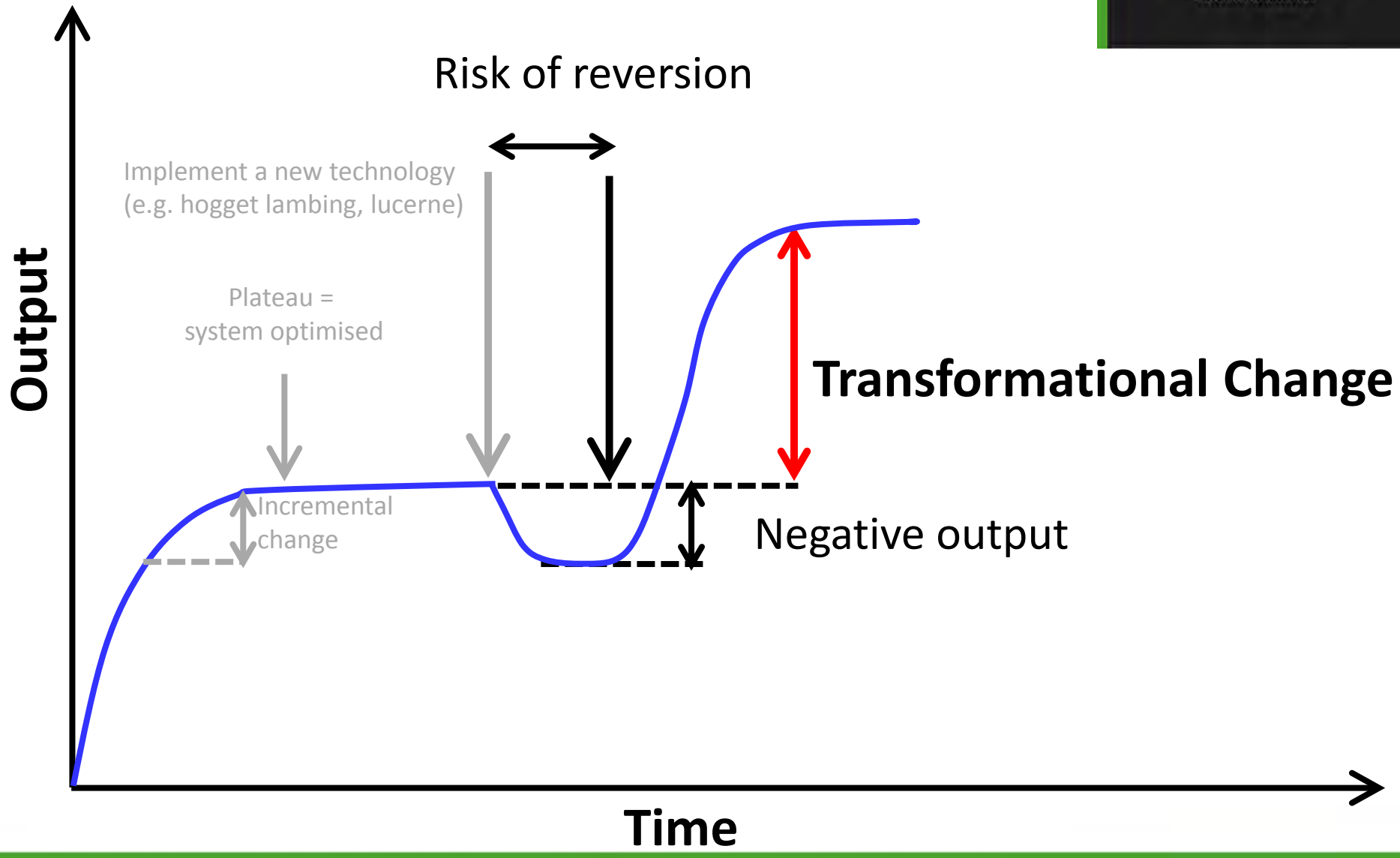
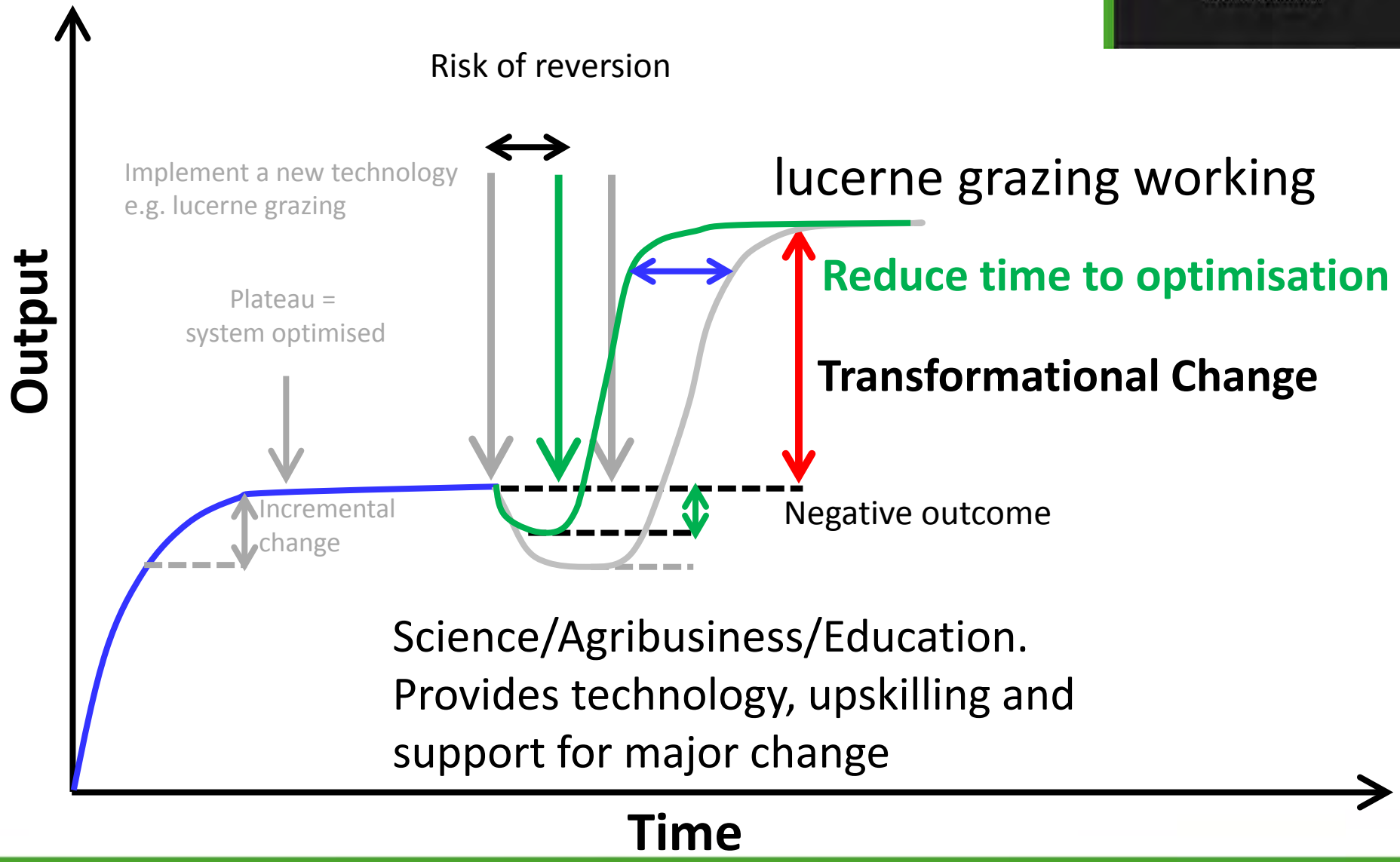
Pathway to change



System optimisation



Pathway to change



Science/Agribusiness/Education.
Provides technology, upskilling and support for major change

400 mm rainfall environment

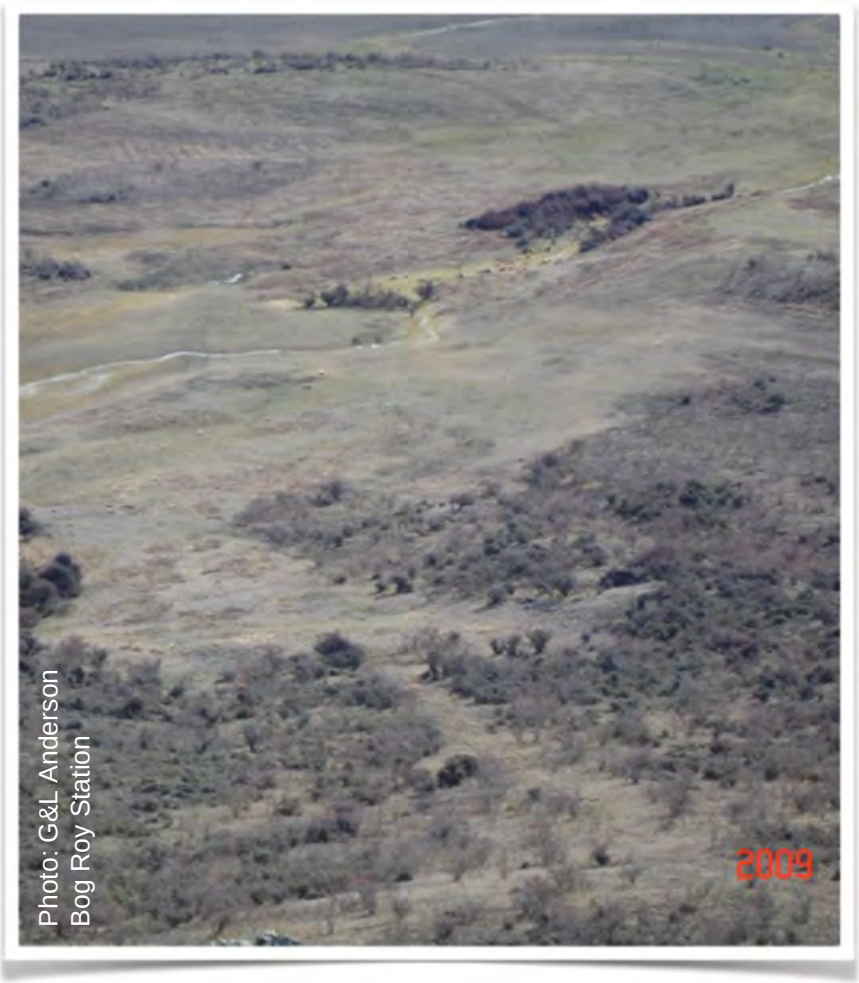
Photo: DJ Moot
Lincoln University

Old System

- Set-stocked
- Constant grass chasing
- Hill country in decline
- 100 day supplement winter feeding
- Peak feed demand and supply misaligned

Moot et al. 2018

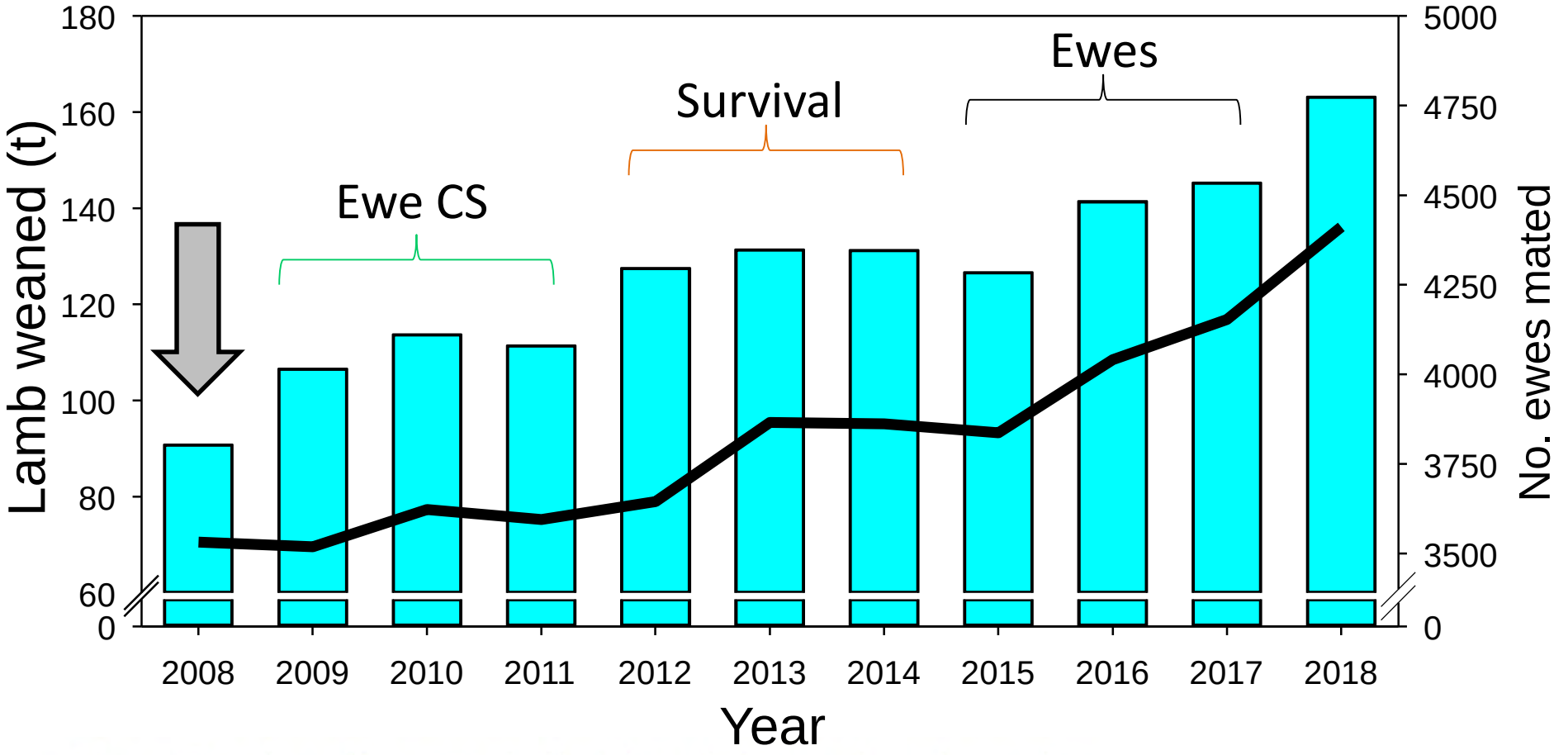
Landscape farming



Landscape farming – Bog Roy Station

Photo: DJ Moot
Lincoln University

Change in LWt produced at Bog Roy



Moot et al. 2019

5th September 2011 – Cave, South Canterbury

Photo: D.J. Moot
Lincoln University

Photo: HE Brown
Lincoln University

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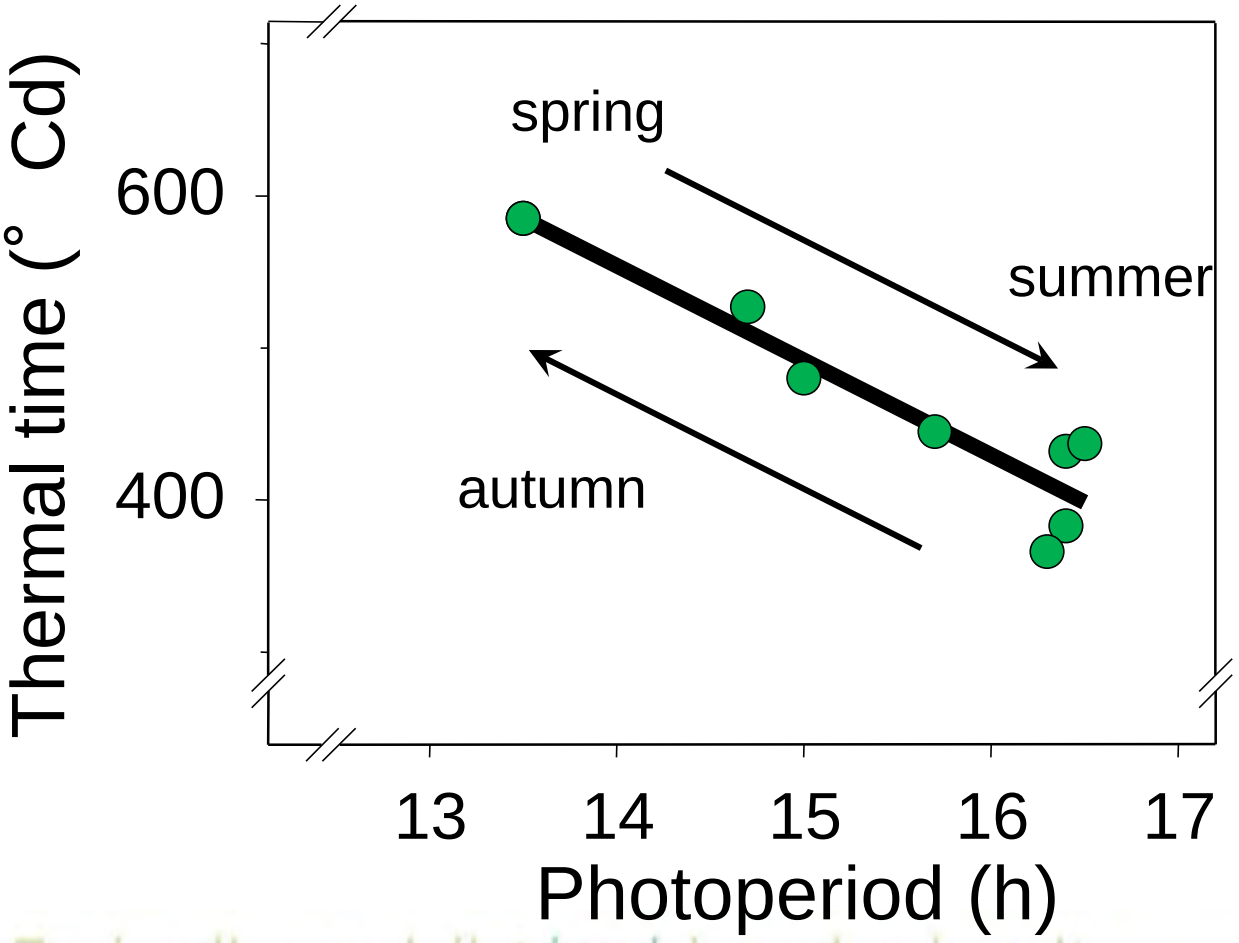
Lucerne development

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 ^{o}Cd as photoperiod changes (14.5-16.5 h)

Day-length effect

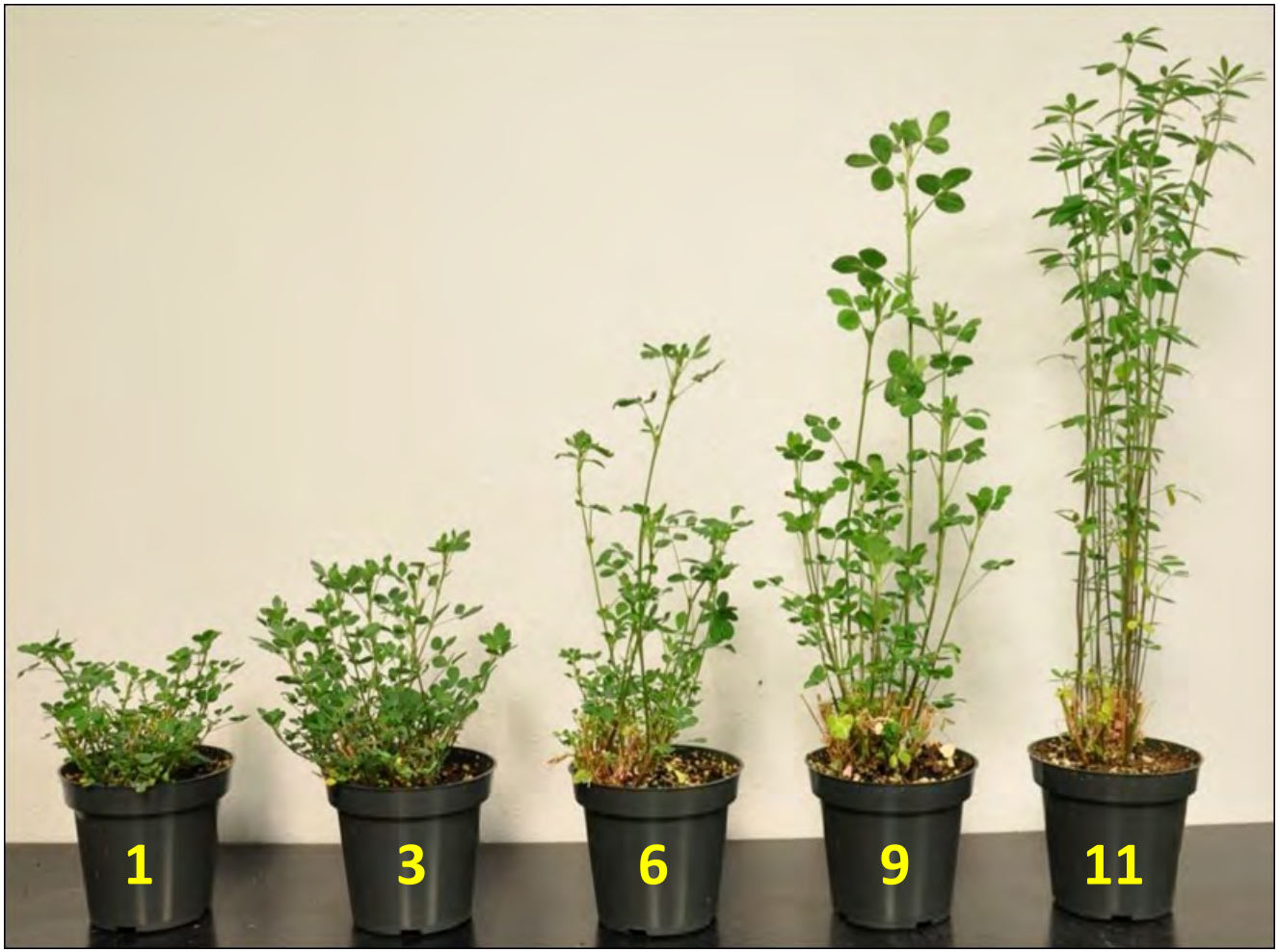


Dissecting Alfalfa Dormancy Using Selection Mapping

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

Supplied by: Charlie Brummer, UC Davis

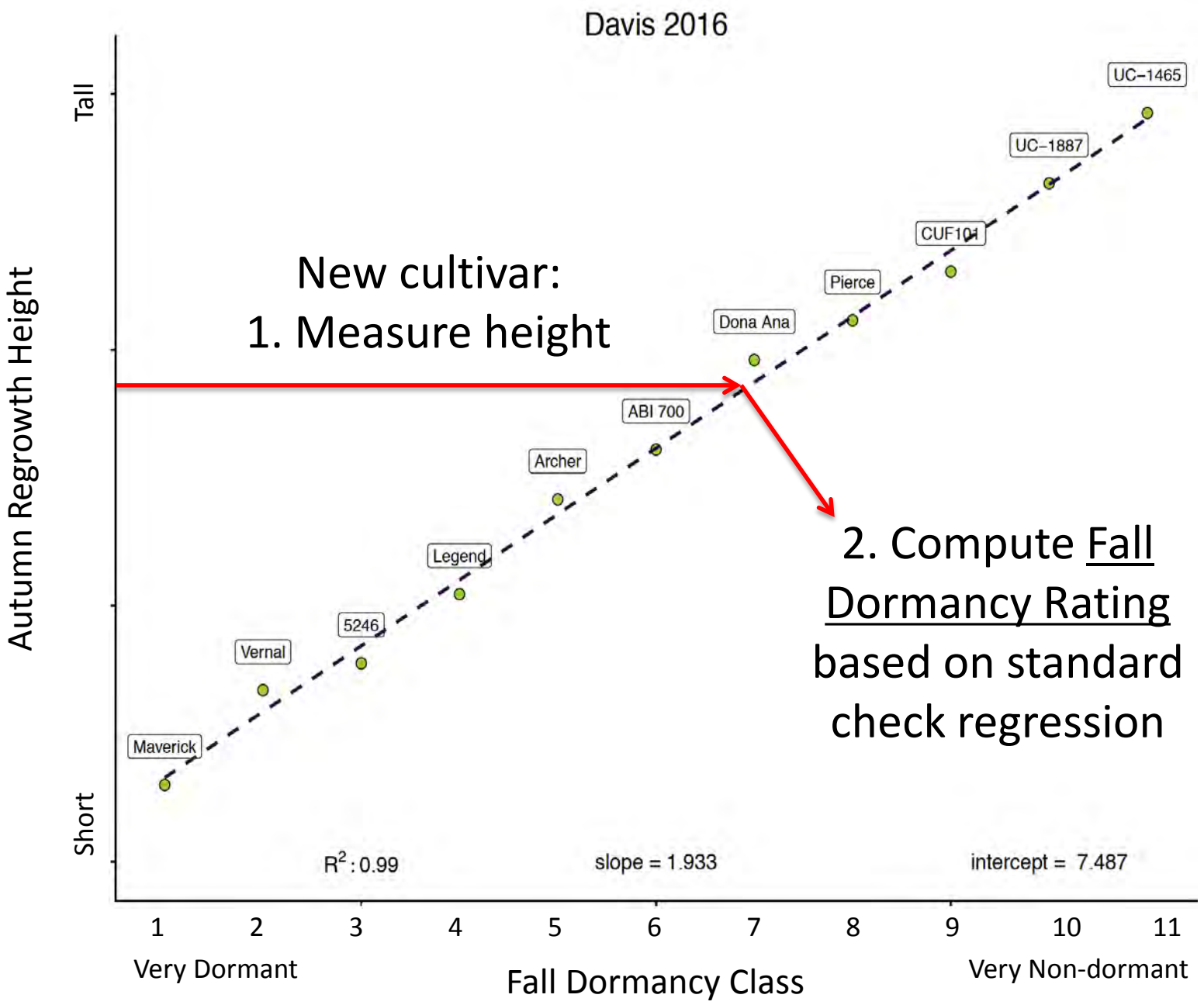
Dormancy is measured by height of regrowth in autumn



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

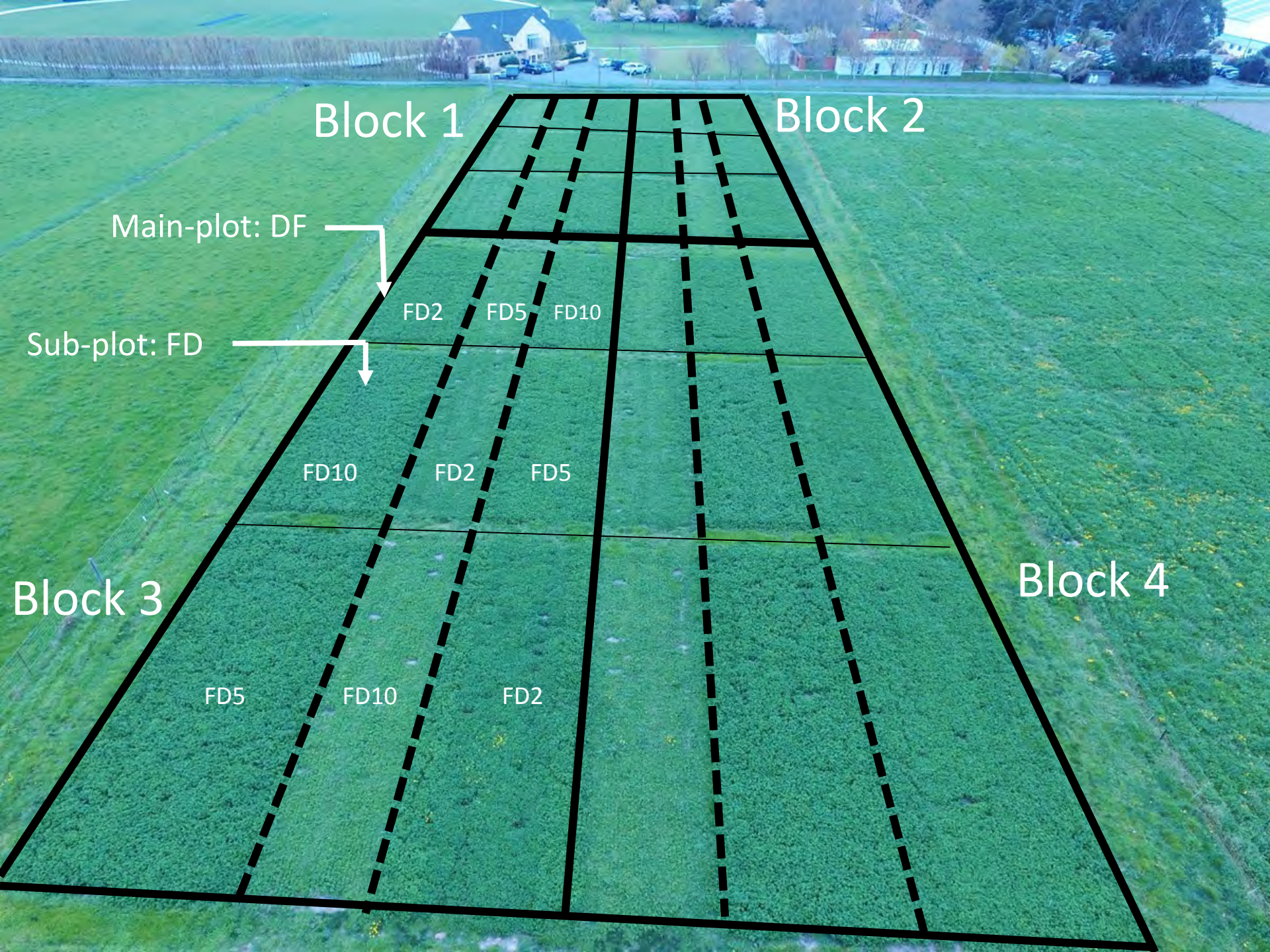
- Three genotypes with different FD ratings

  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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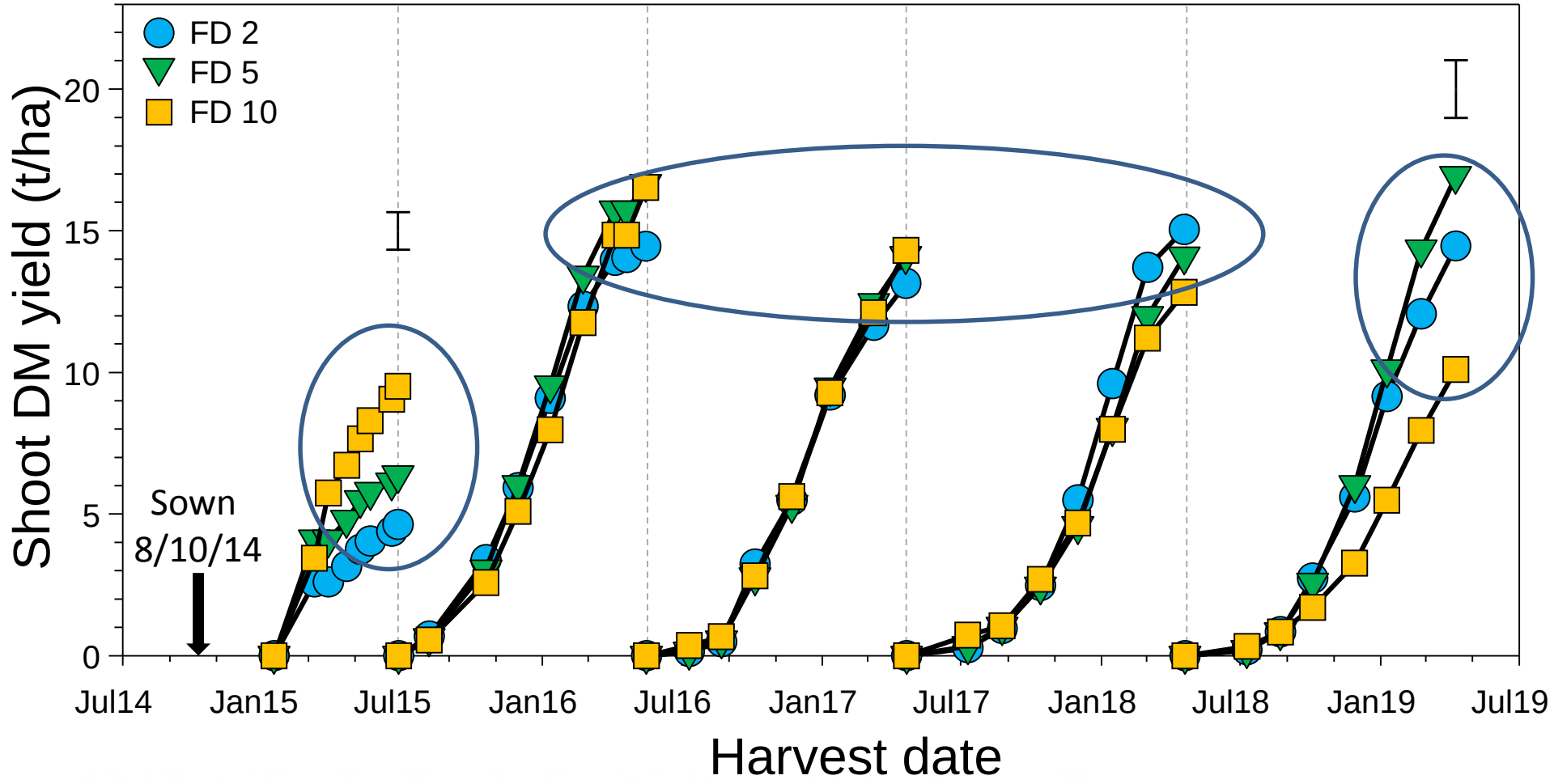
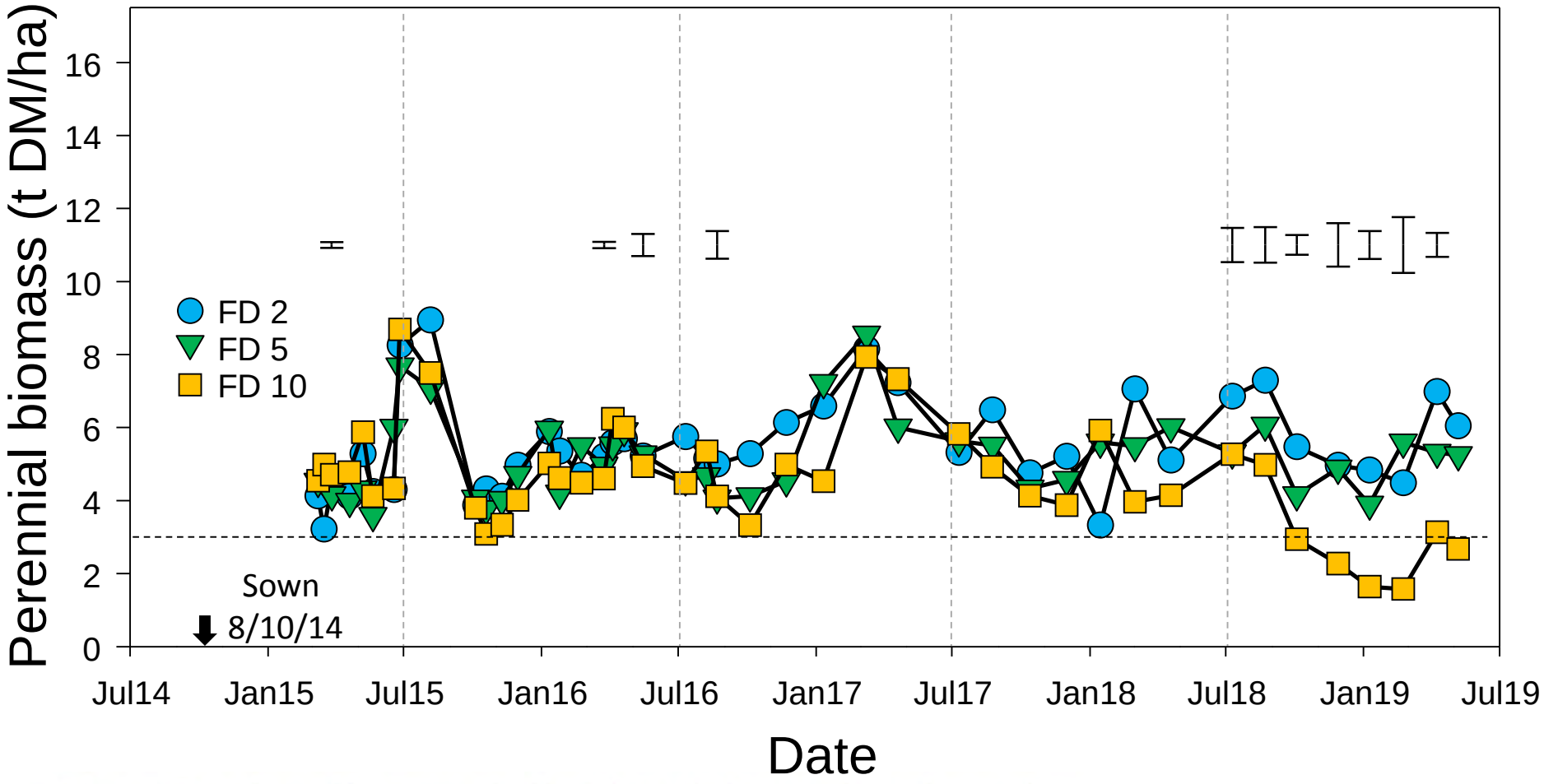
Lucerne shoot yield (42 day regrowth periods)



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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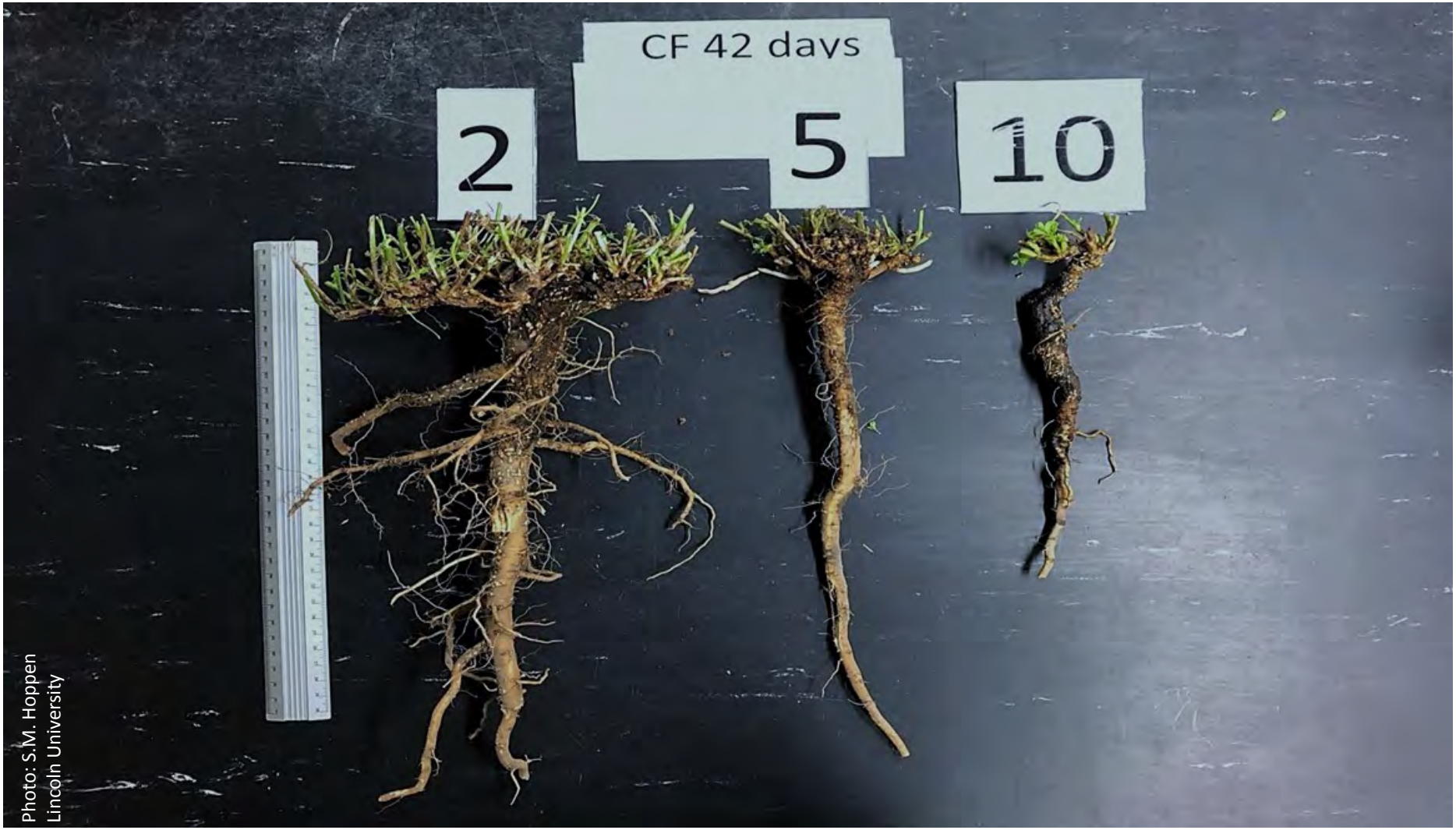


Photo: S.M. Hoppen
Lincoln University

142 plants/m^2

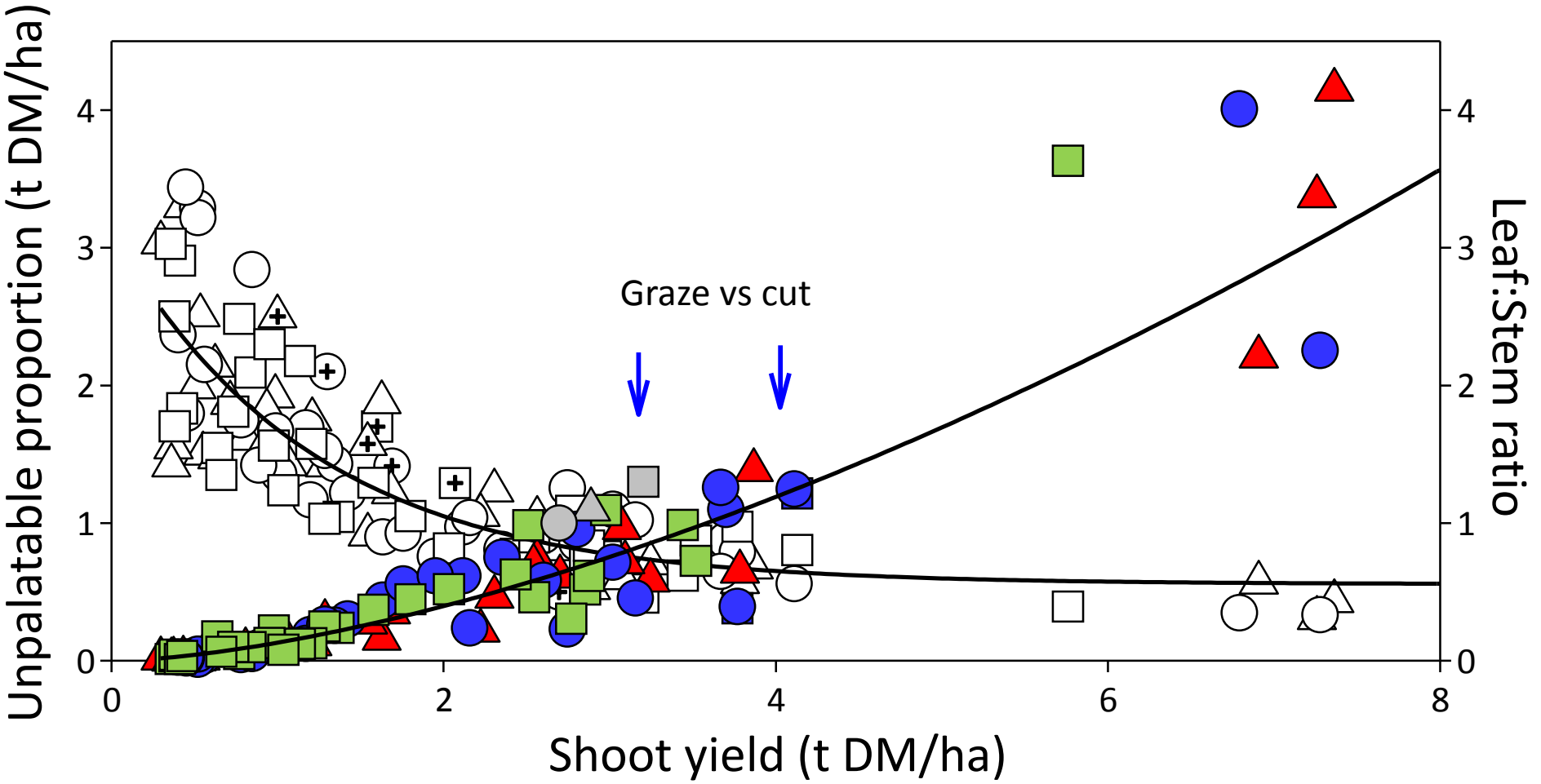
62 plants/m^2
(33% survival)

24 plants/m^2
(10% survival)

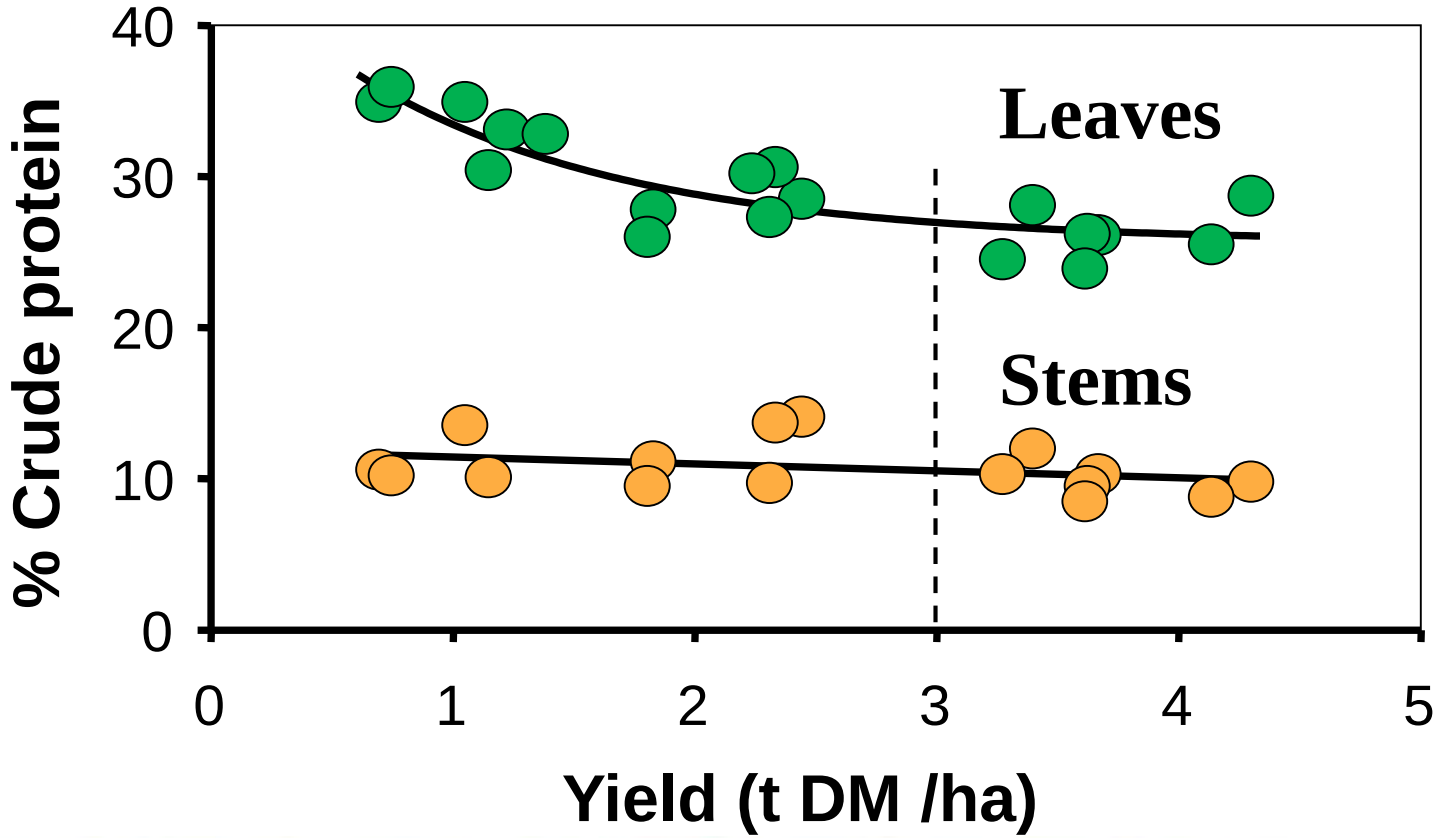
Photos: S.M. Hoppen
Lincoln University





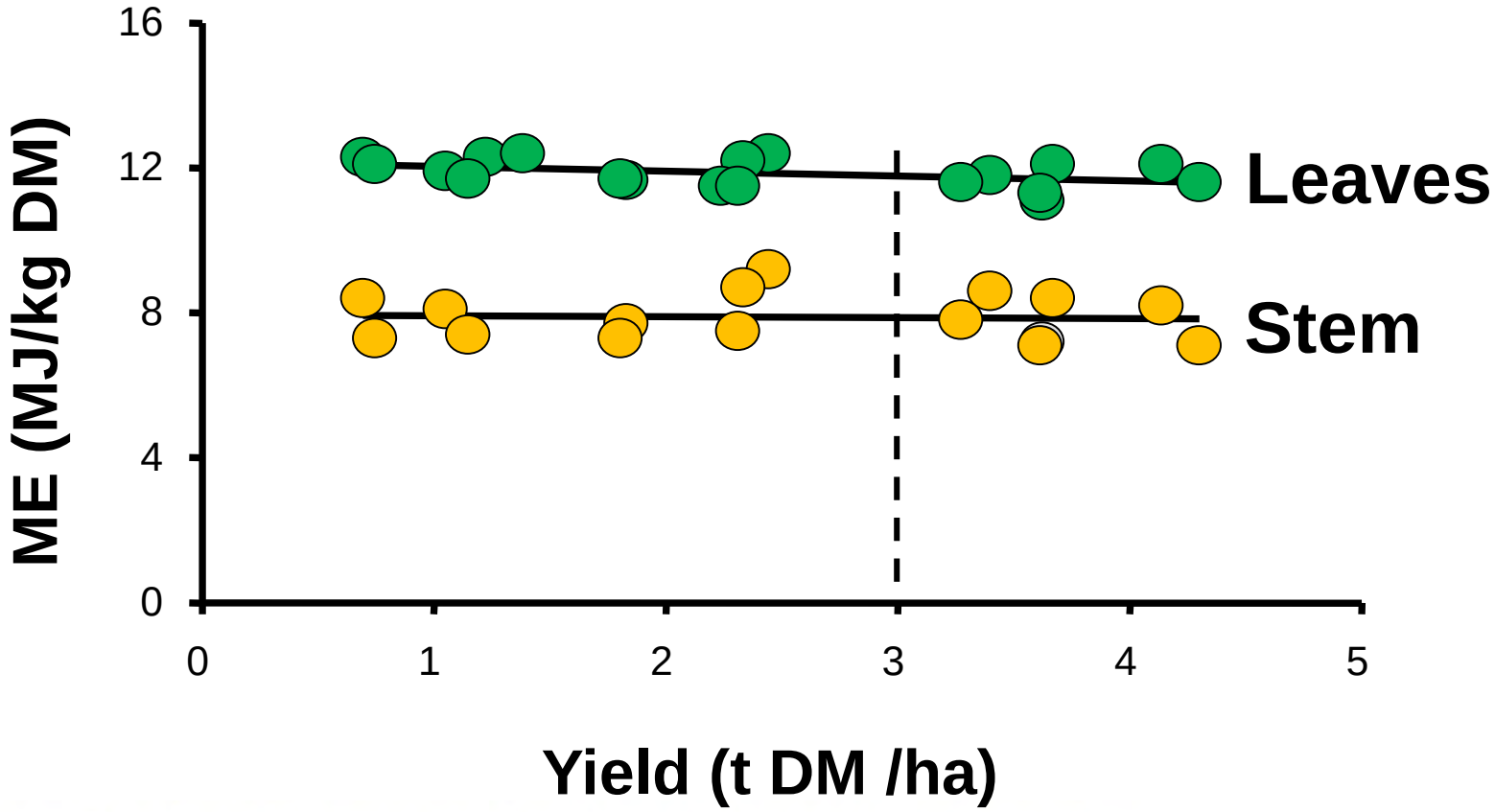

Unpalatable proportion (t DM/ha)
Leaf:Stem ratio
Shoot yield (t DM/ha)
Graze vs cut
0
1
2
3
4
0
2
4
6
8

Crude protein of lucerne



Brown & Moot 2004

Metabolisable energy of lucerne



Brown & Moot 2004

Photo: M. Smith
Lincoln University

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

System 2 – High SR – housing or partial housing

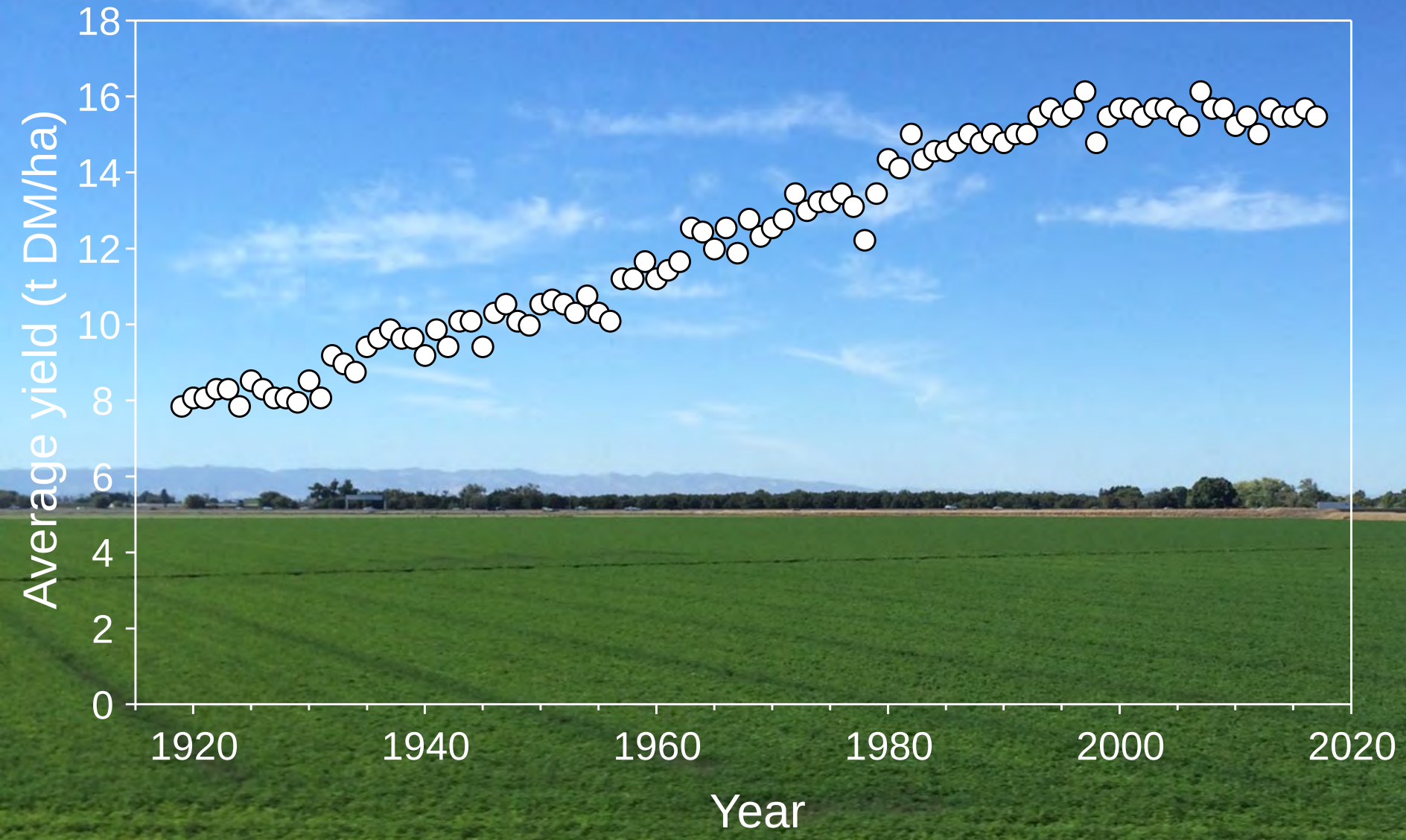
Photo: DJ Moot
Lincoln University

Photos: Richard Cookson

Breeding yield and quality?

Supplied by: Charlie Brummer, UC Davis

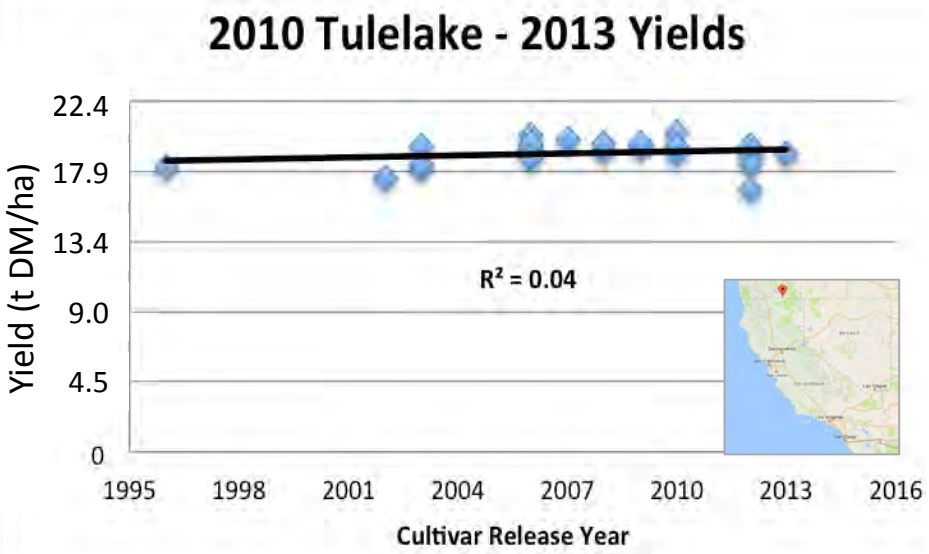
California - average lucerne yield
(USDA Ag Statistics)

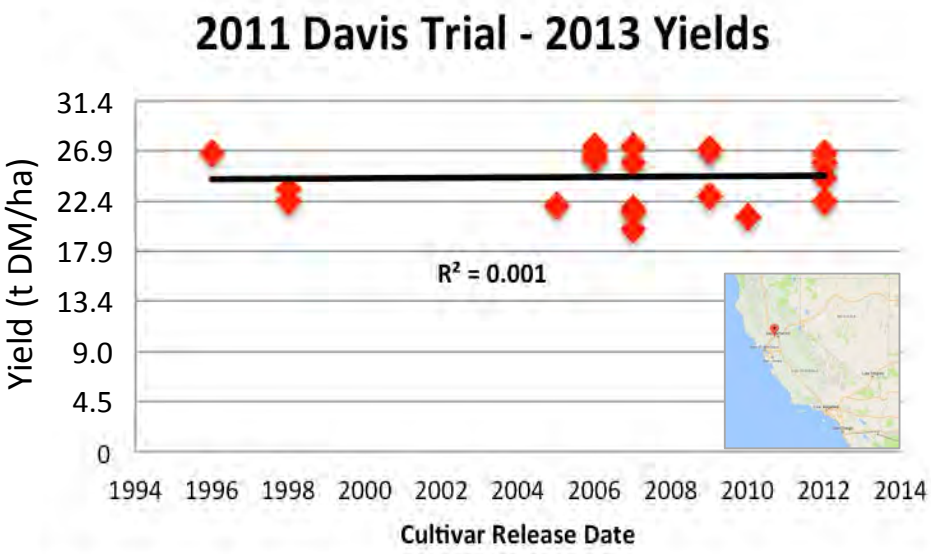


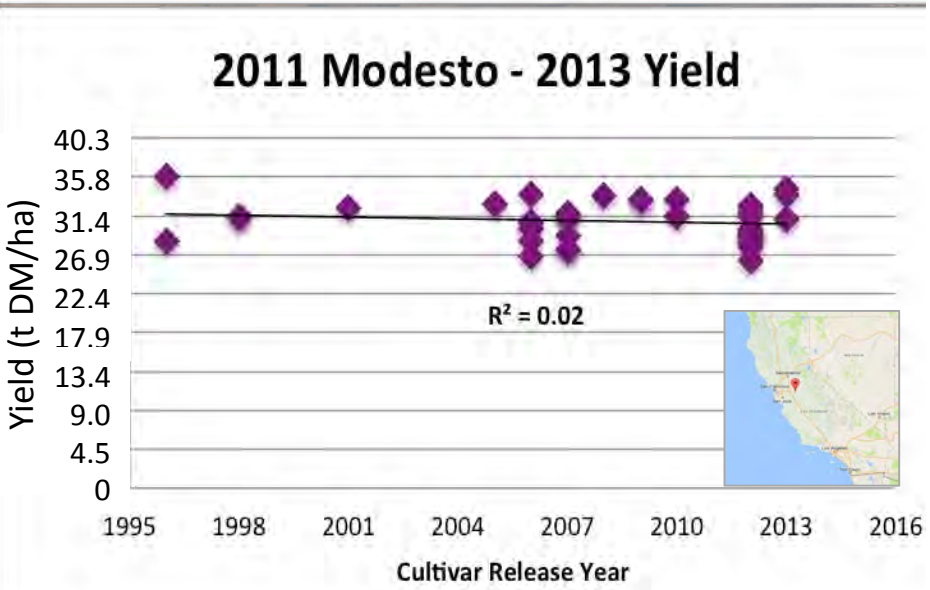
Supplied by: Charlie Brummer, UC Davis

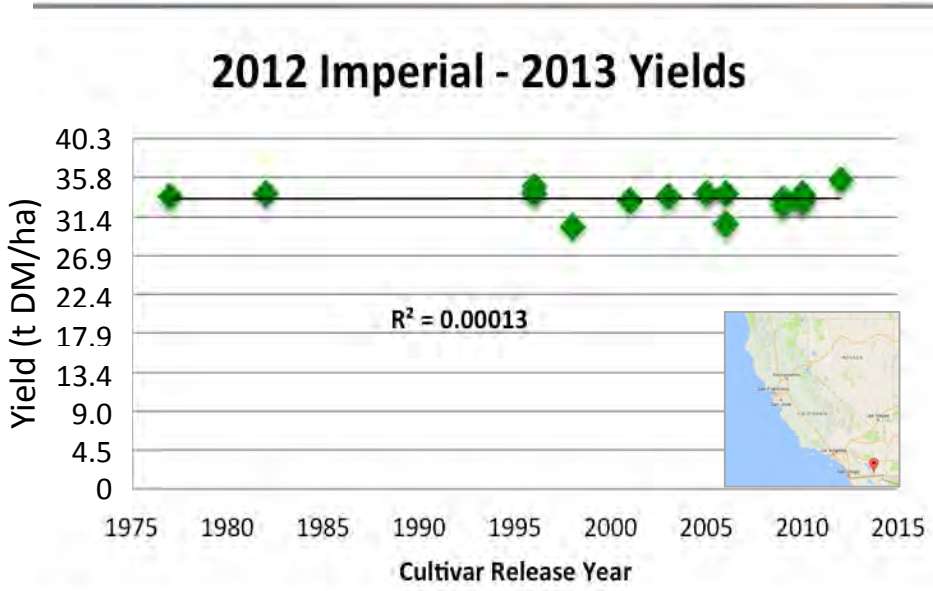
Supplied by: Charlie Brummer, UC Davis

Yield vs. Year of Cultivar Release

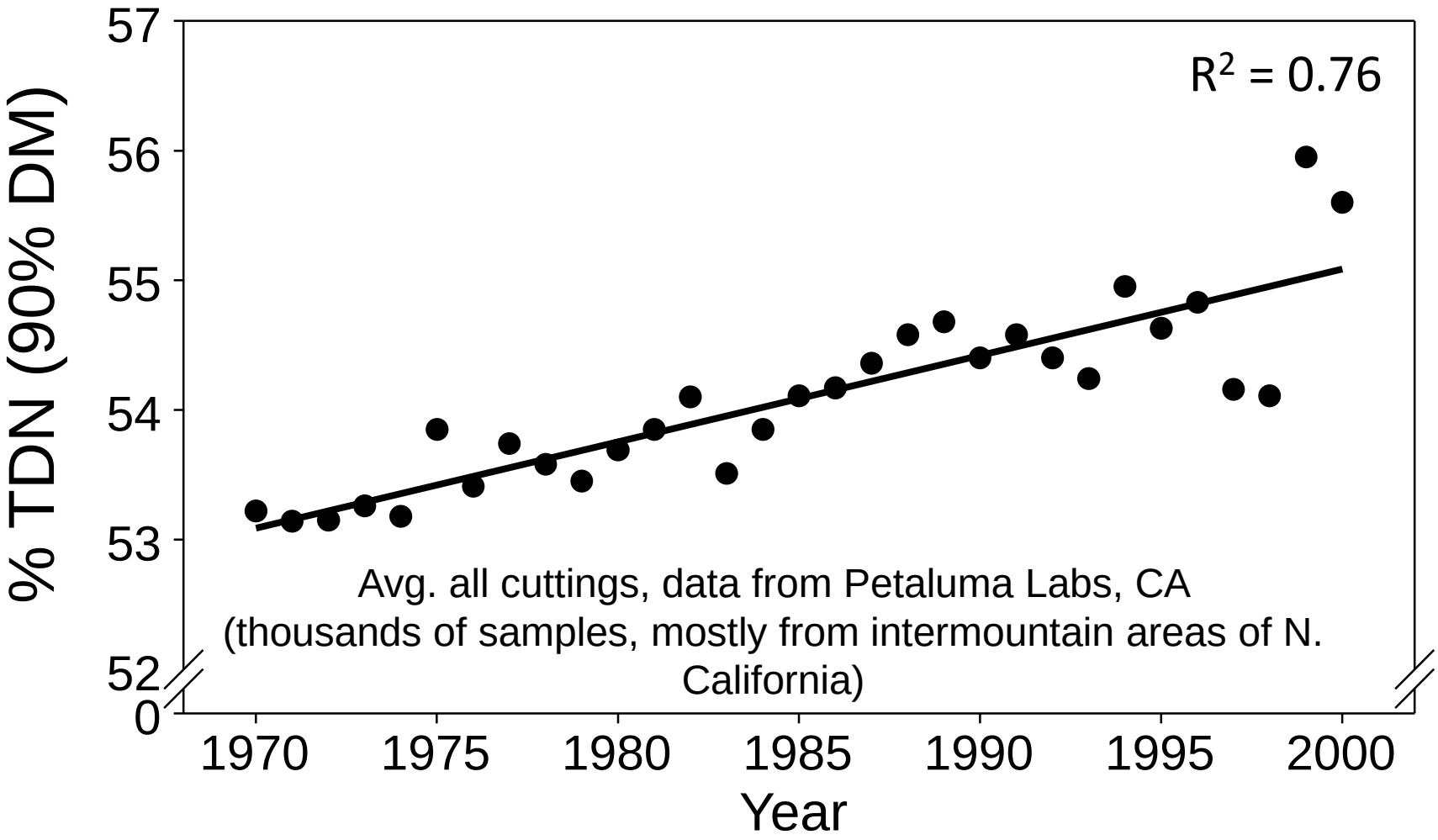








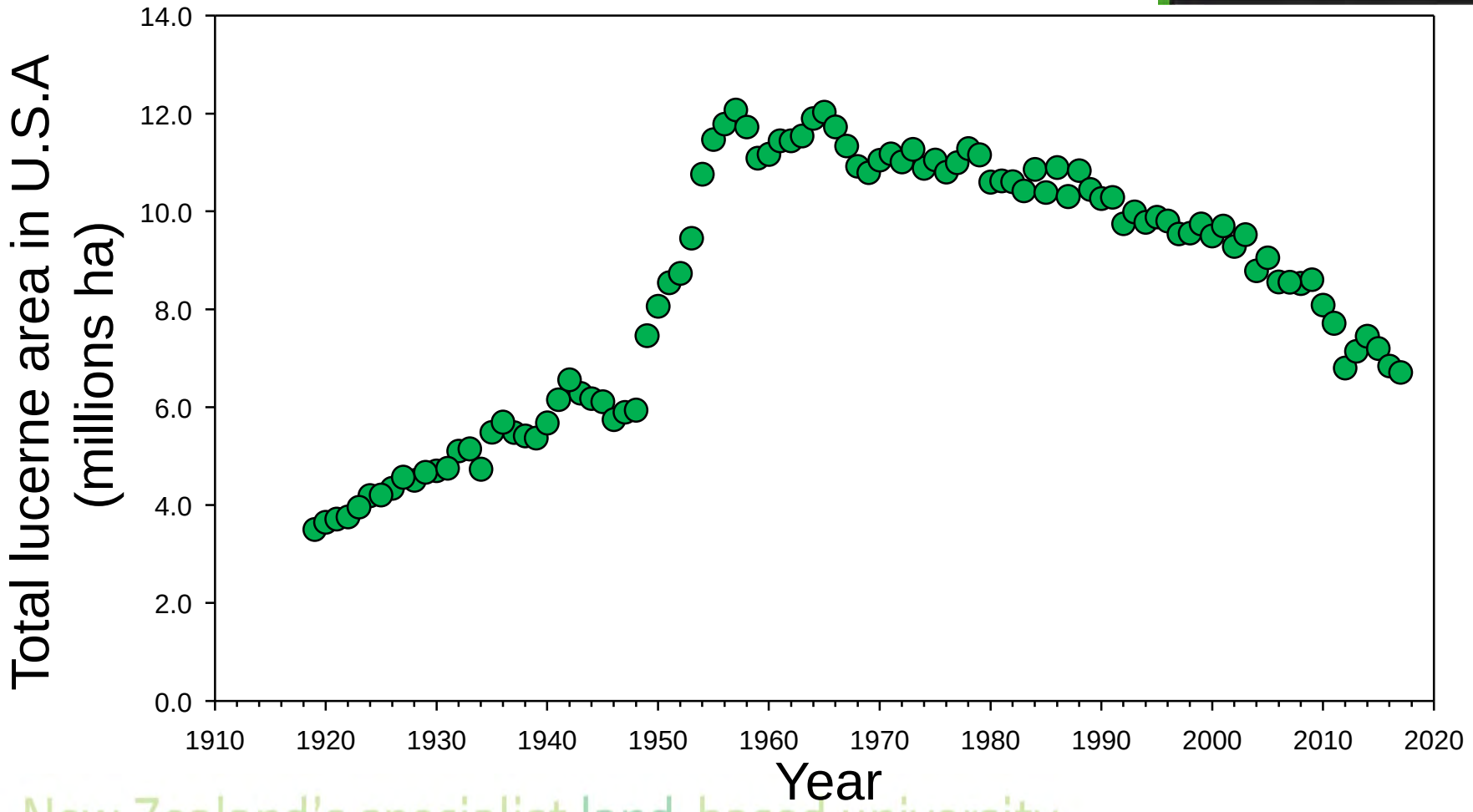
Lucerne Hay Quality Has Improved



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 Scheduling Affects Yield

Supplied by: Charlie Brummer, UC Davis

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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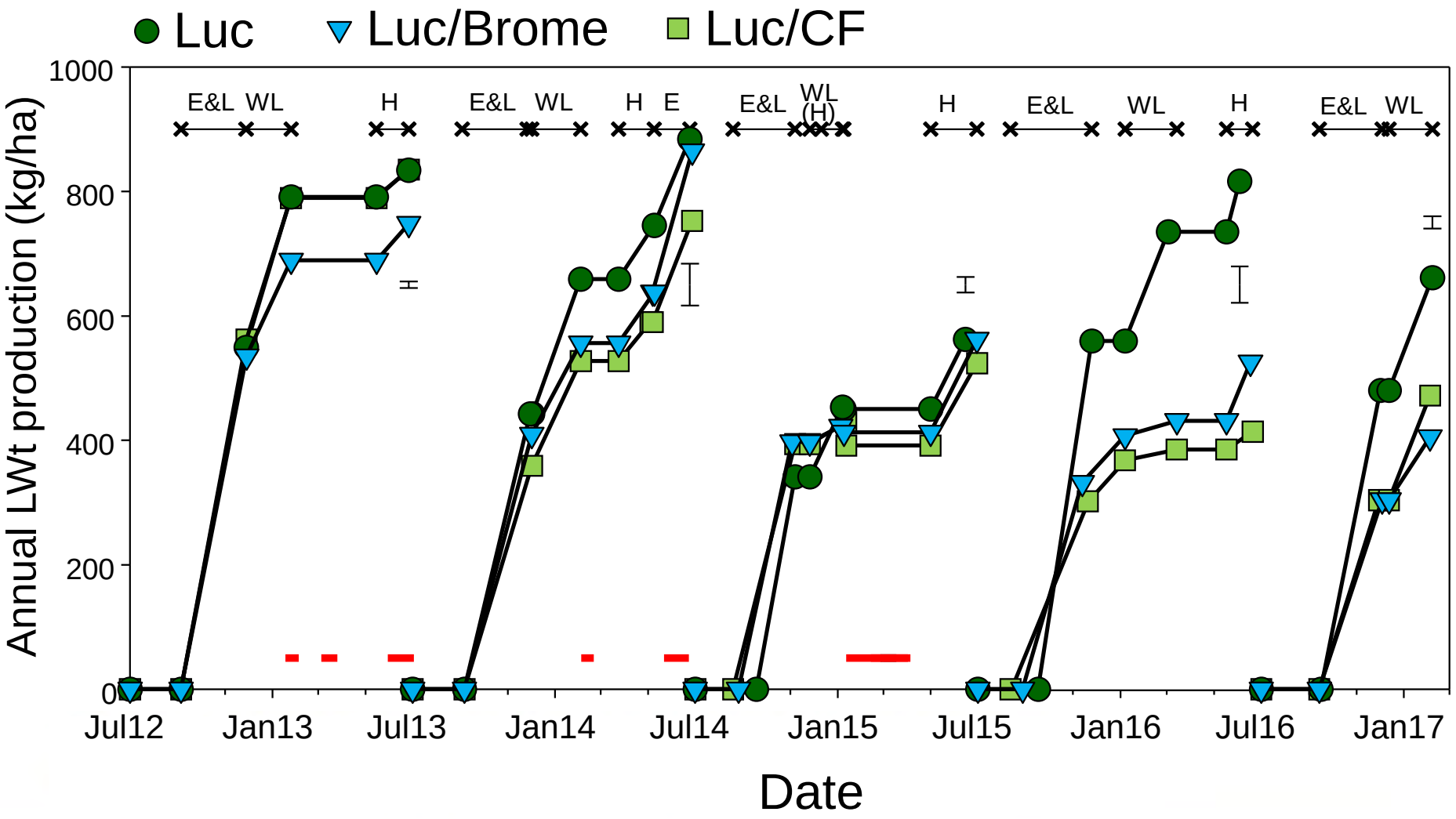
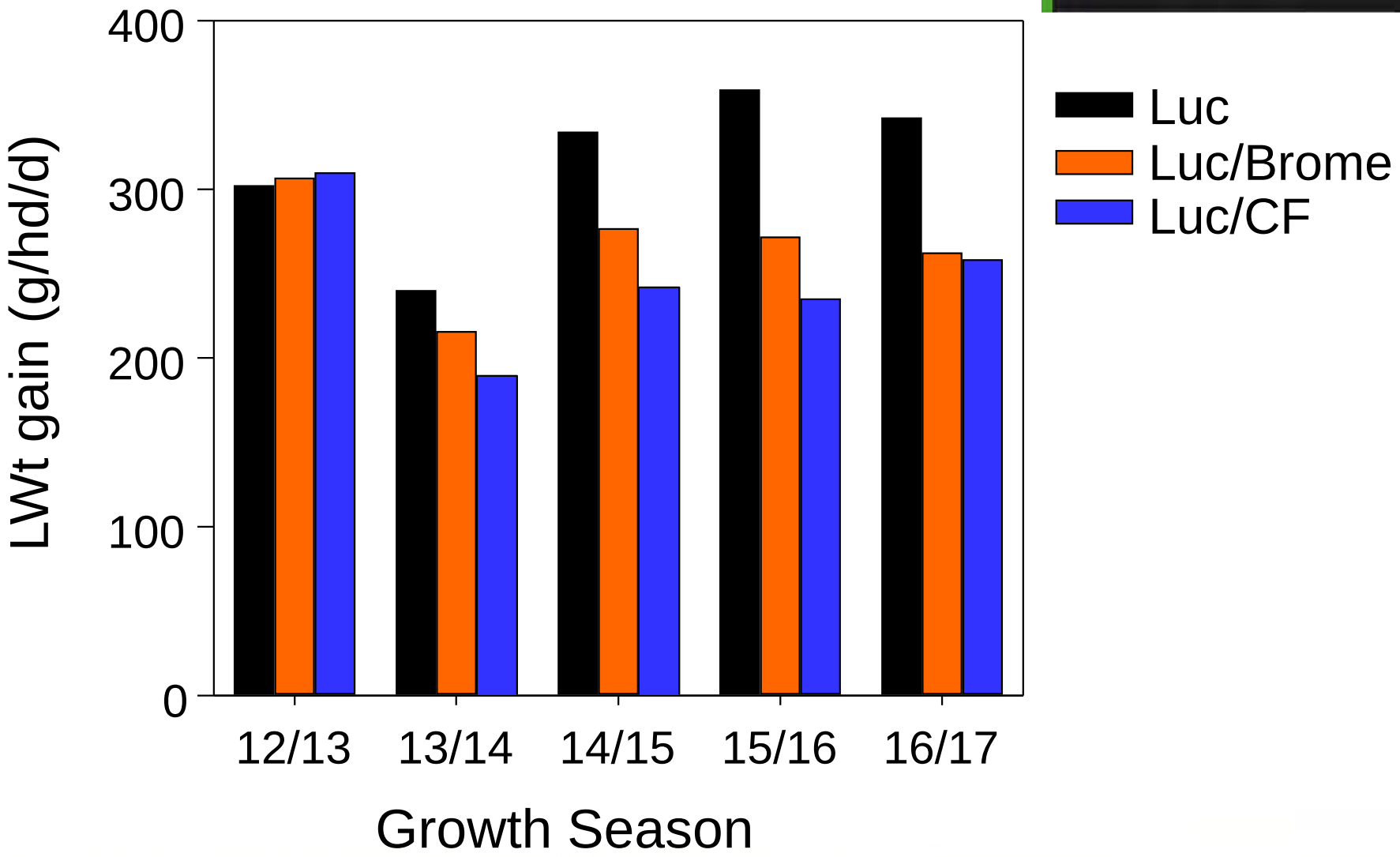
MaxLucerne annual LWt production



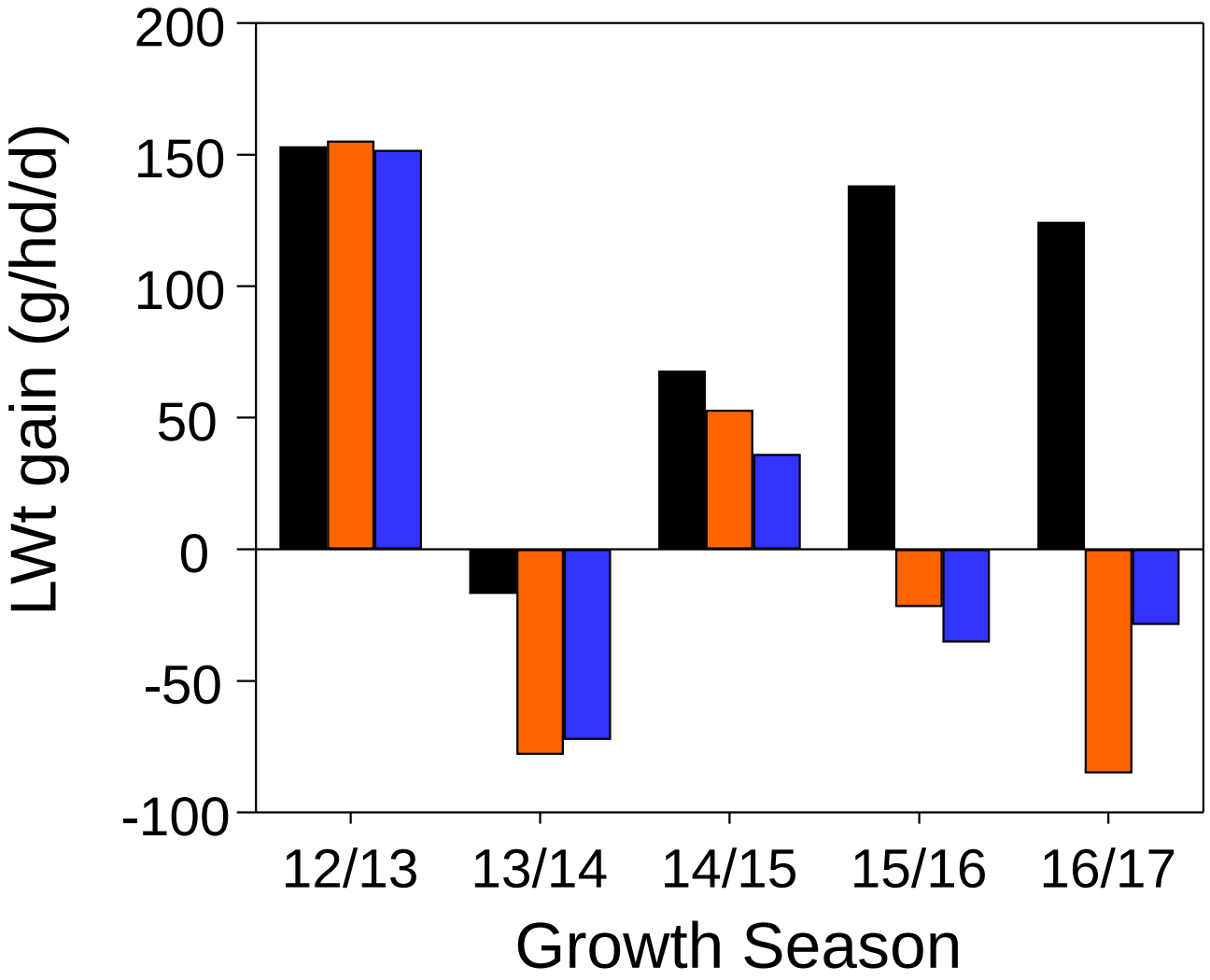
Moot et al. 2019

MaxLucerne – Seasonal weighted LWt gain of twin lambs at foot



Moot et al. 2019

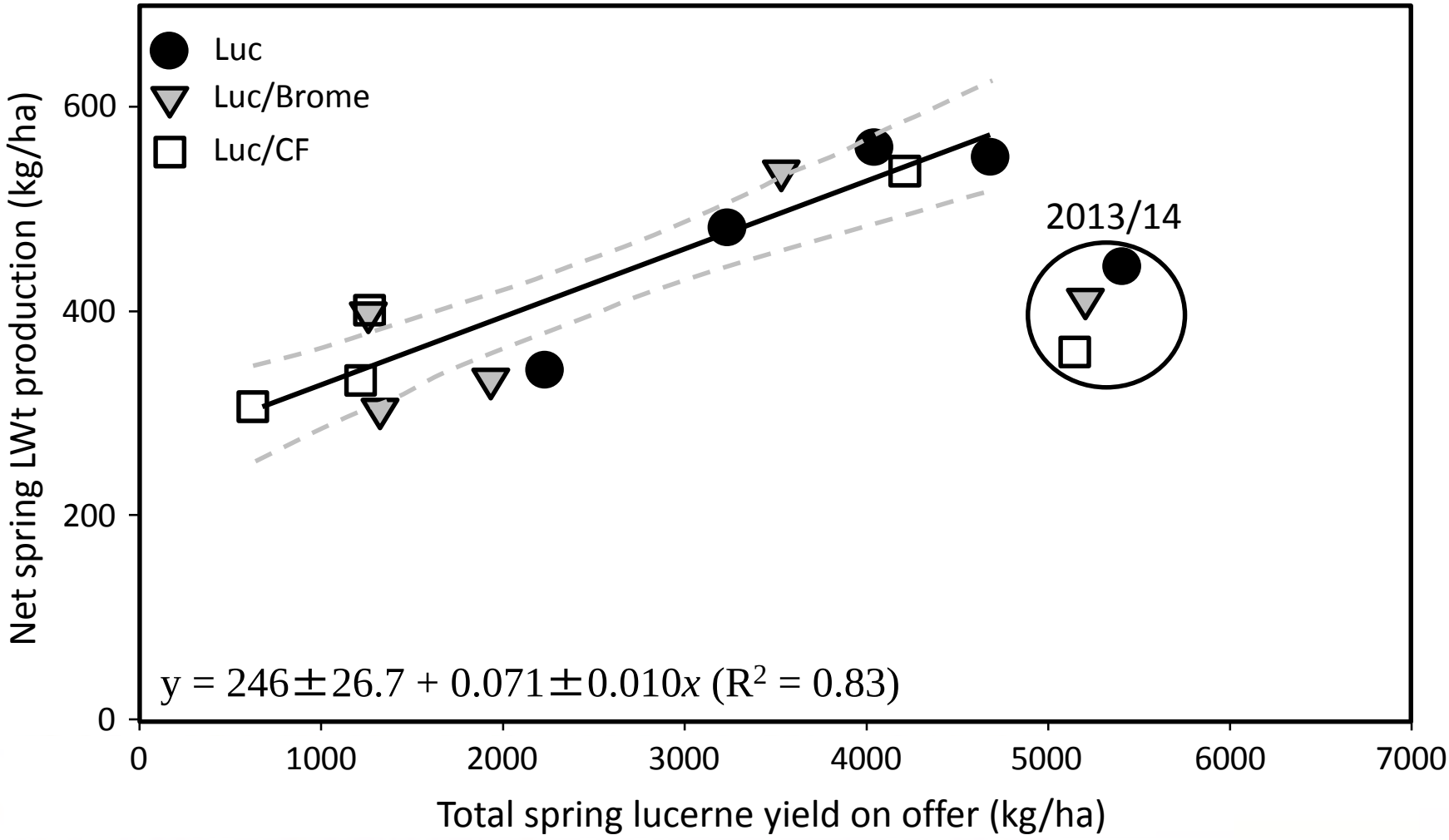
MaxLucerne – Seasonal weighted LWt gain of lactating ewes



Luc
Luc/Brome
Luc/CF

Moot et al. 2019

Spring LWt v Spring lucerne DM at MaxLucerne



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Why did TDM fail to explain LWt?

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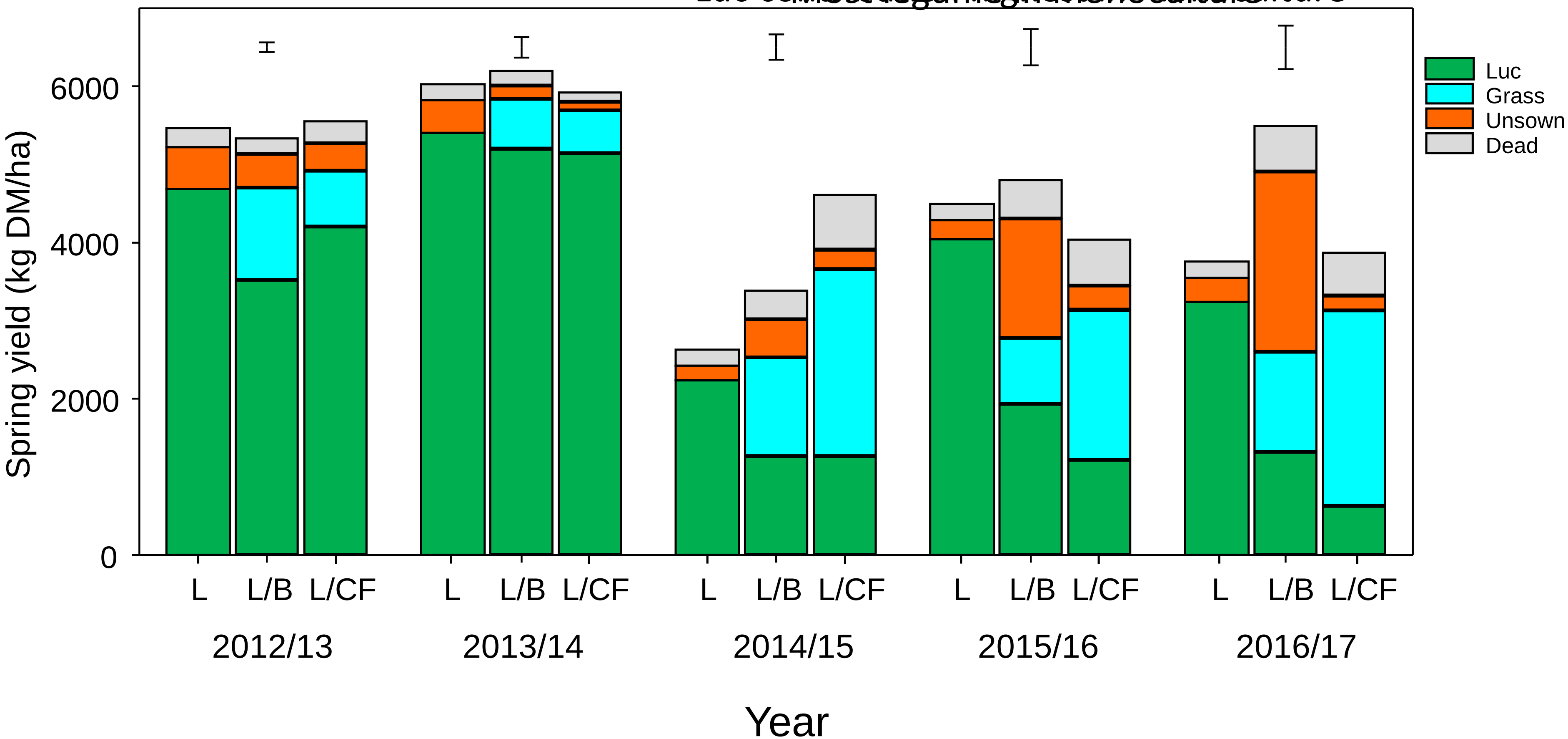
1st dry year
Luc yields down in mixes but extra DM from CF

Wettest year:
Weeds into Luc/Brome
Luc not compromised

Grass at expense of Luc

More weeds than brome
More weeds than lucerne
Increased CF in Luc/Brome
Luc contribution highest in monoculture
Most legume in monoculture



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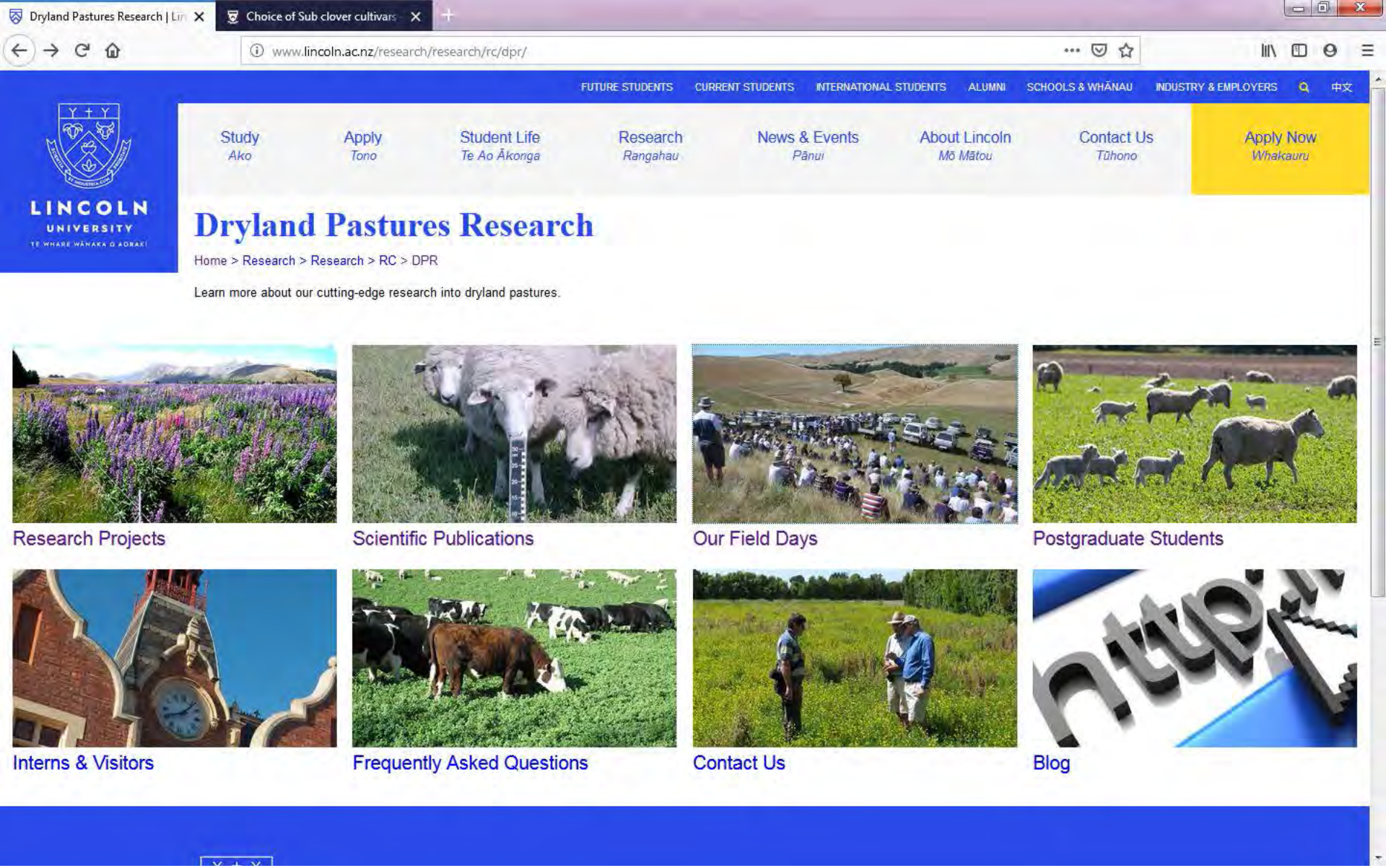
MaxLucerne Oct 2015
Photo: A.Mills
Lincoln University


MaxLucerne Nov 2015
Photo: A.Mills
Lincoln University


40
35
30
25
20
15
10
MaxLucerne 15 Dec 2014
Luc/Brome
Photo M. Smith
Lincoln University

Conclusions

- All plants are N deficient except legumes
- Animals need quantity and quality to grow
- 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!
- Lucerne/grass mixes?????



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

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