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# Legumes Regenerate Pastures

Derrick Moot

New Zealand's specialist land-based university


Photo: S Larsen
Lincoln University

85 post grads + 40 visiting interns/scholars

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Sustainable Farming Fund
Ministry of Agriculture and Forestry
Te Manatū Ahuwhenua, Ngāherehere

beef+lamb new zealand

Seed Force
the power to grow

agri-nutrients Ballance

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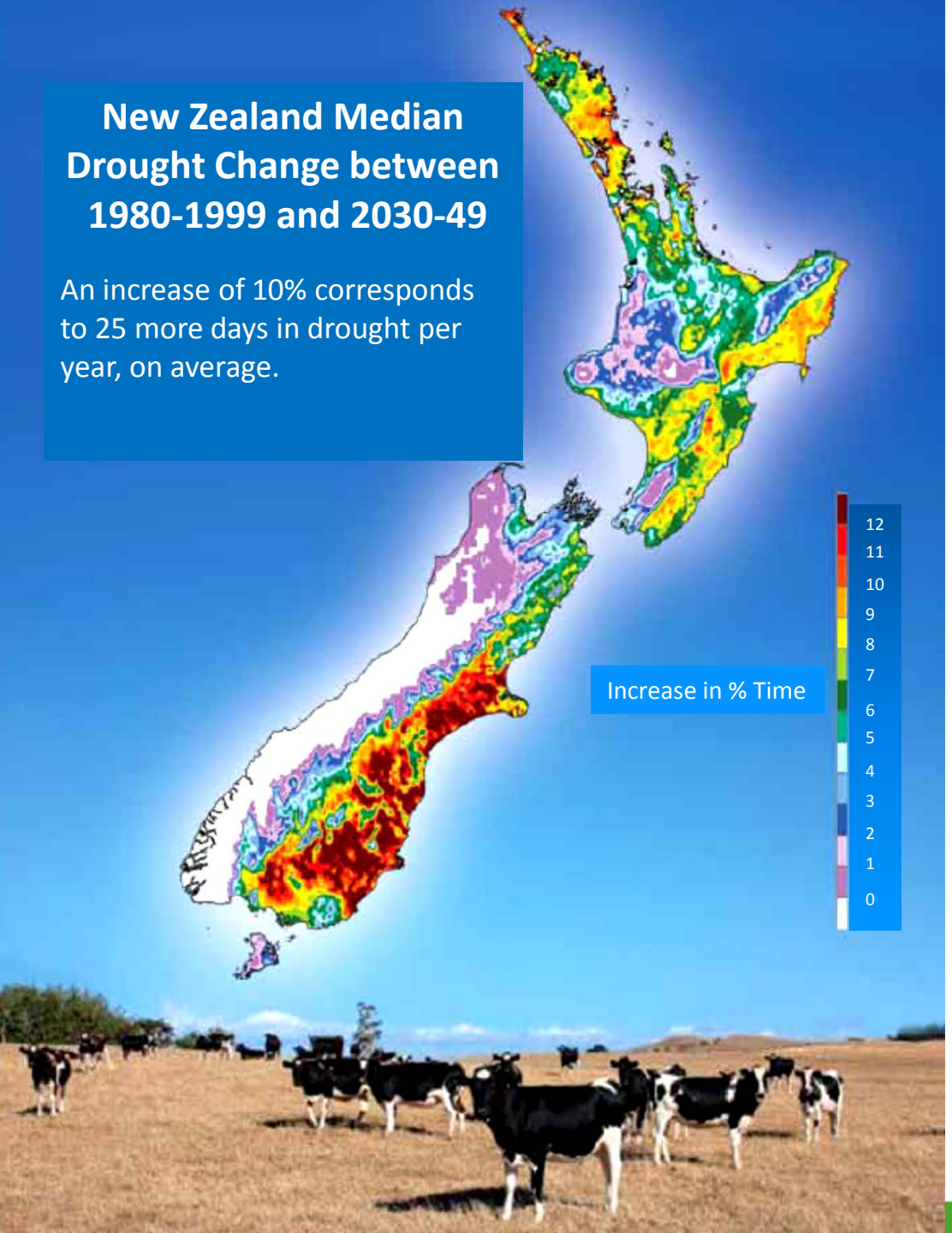
# Agricultural Science

- Background science – NTW
- Dryland case study – lucerne
- Hill country – annual clovers
- High country – lupins and Caucasian clover
- Irrigated dairy pastures – Canterbury's future?
- Reflections of 20 years of applied research

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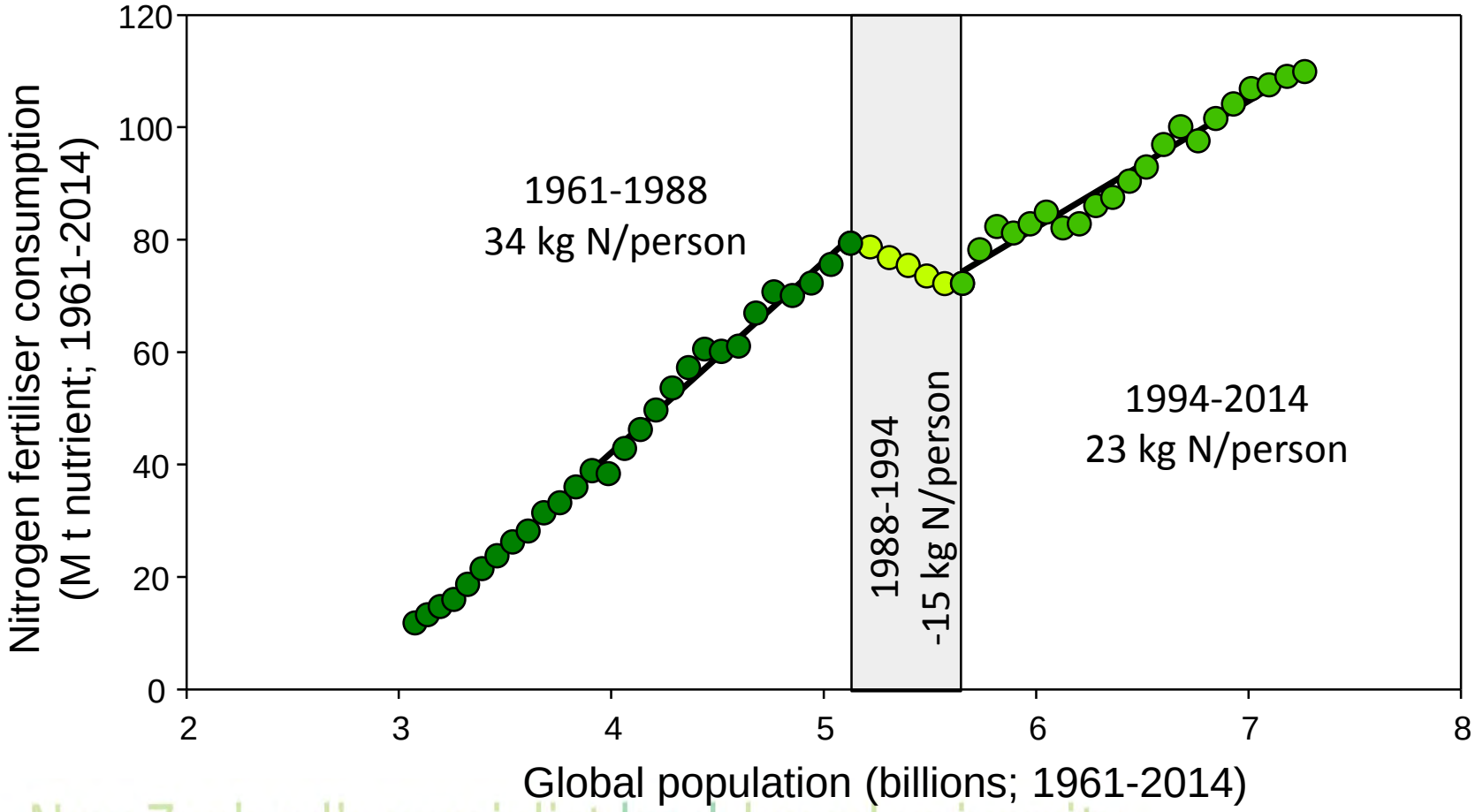
# Predicted climate change in New Zealand by 2040

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

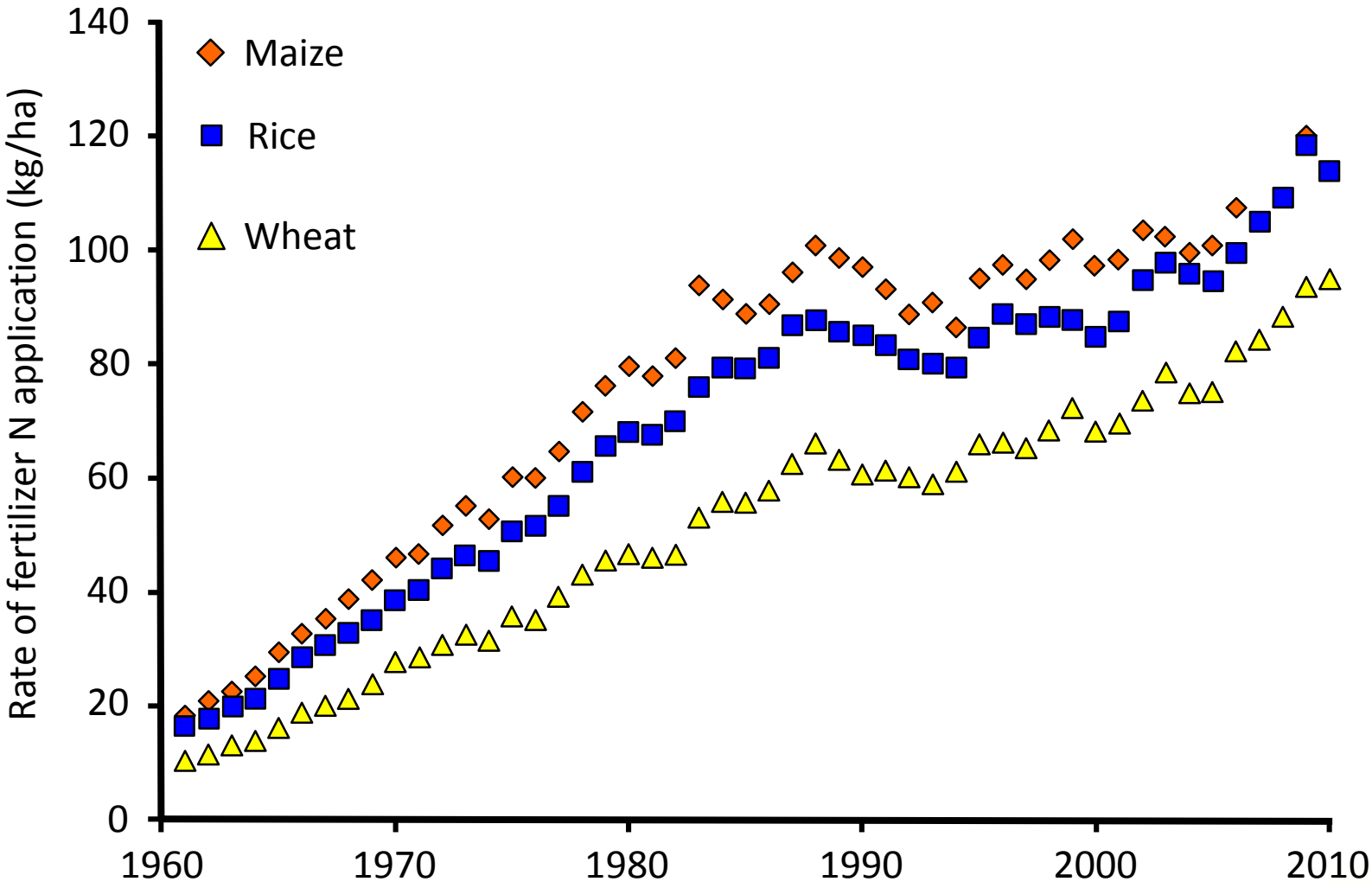
# Global N fertiliser use





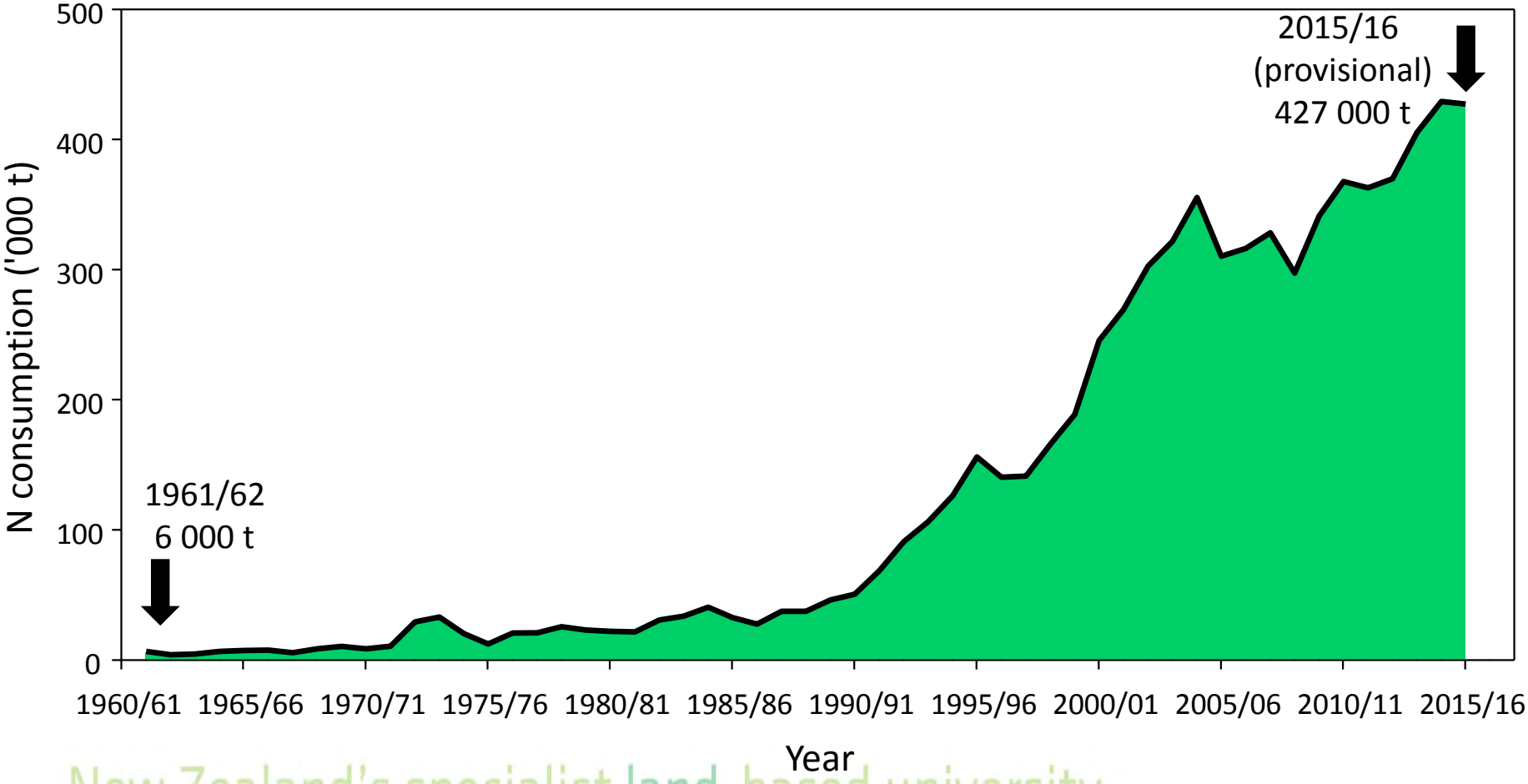

This graph contains data sourced from FAOStat (global population) and IFAData (International Fertilizer Association; Total N consumption)

# Average global N fertilizer application rates in maize, rice, & wheat

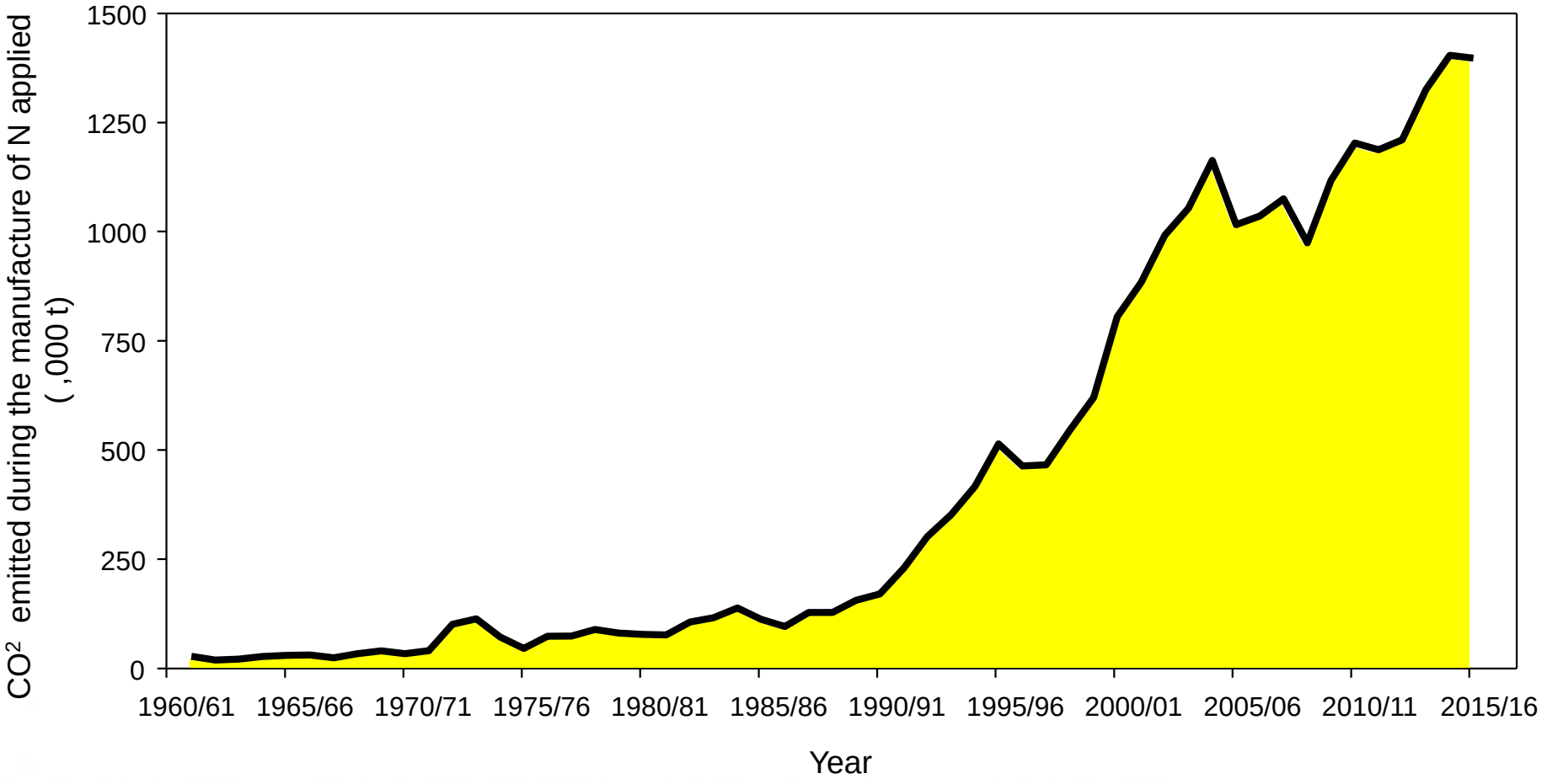



Ladha *et al*. 2016

# Nitrogen applied in NZ



# $CO_2$ emissions generated in the production of N fertiliser




Based on Saunders *et al*., 2006 & Wells 2001 assuming all N consumed in NZ was manufactured using natural gas (including imported N fert)

# Experiment site

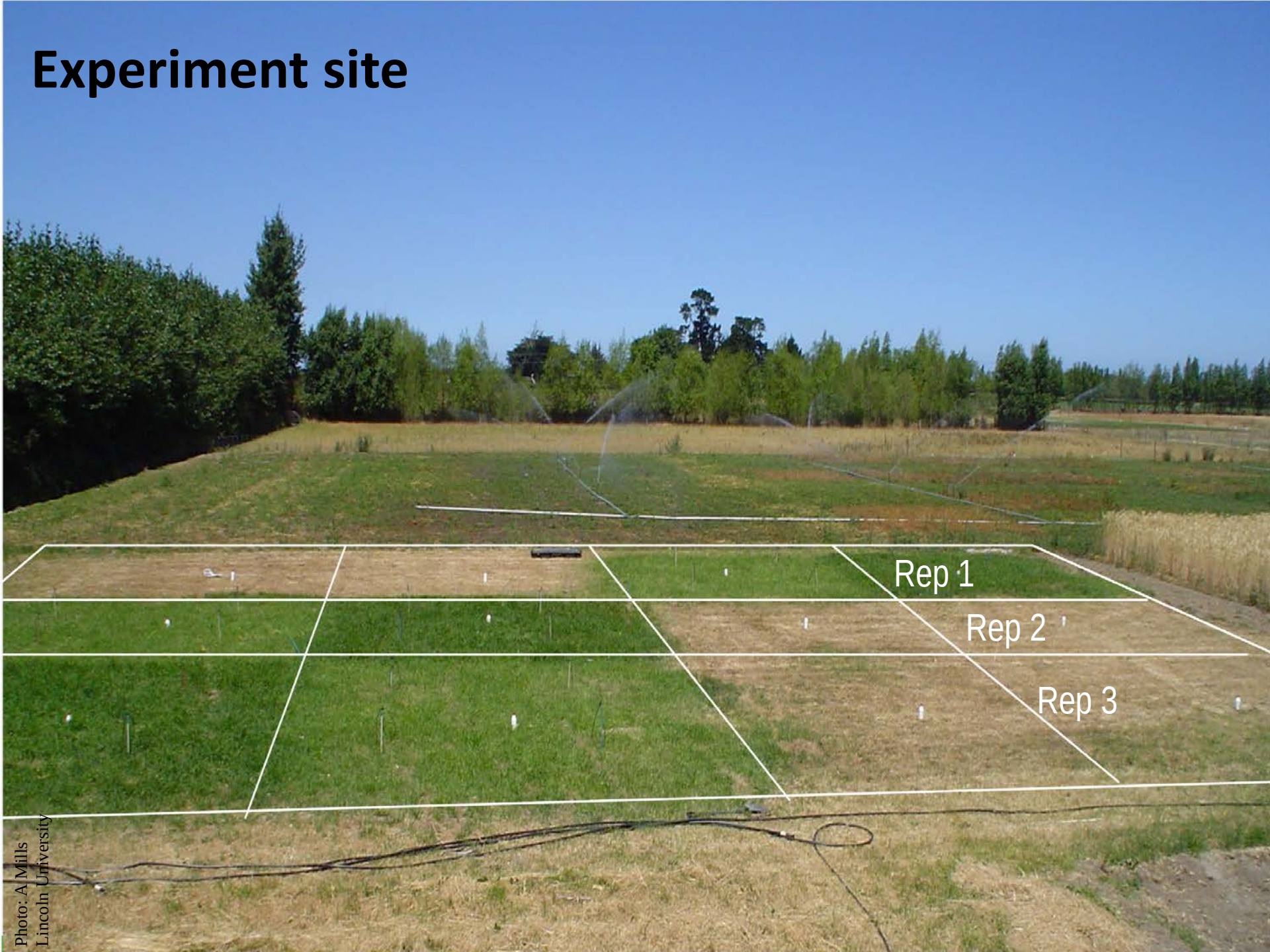
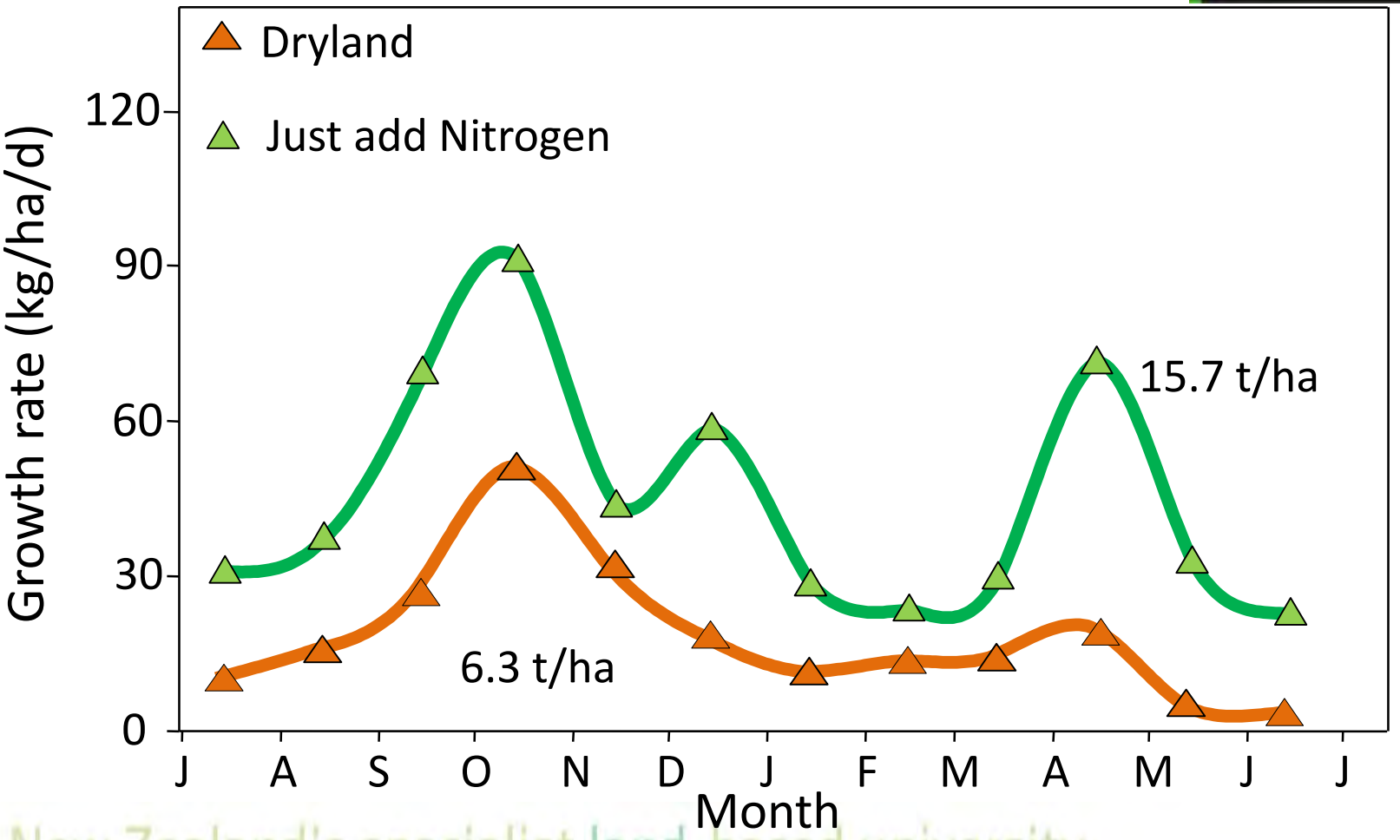



Photo: A Mills
Lincoln University

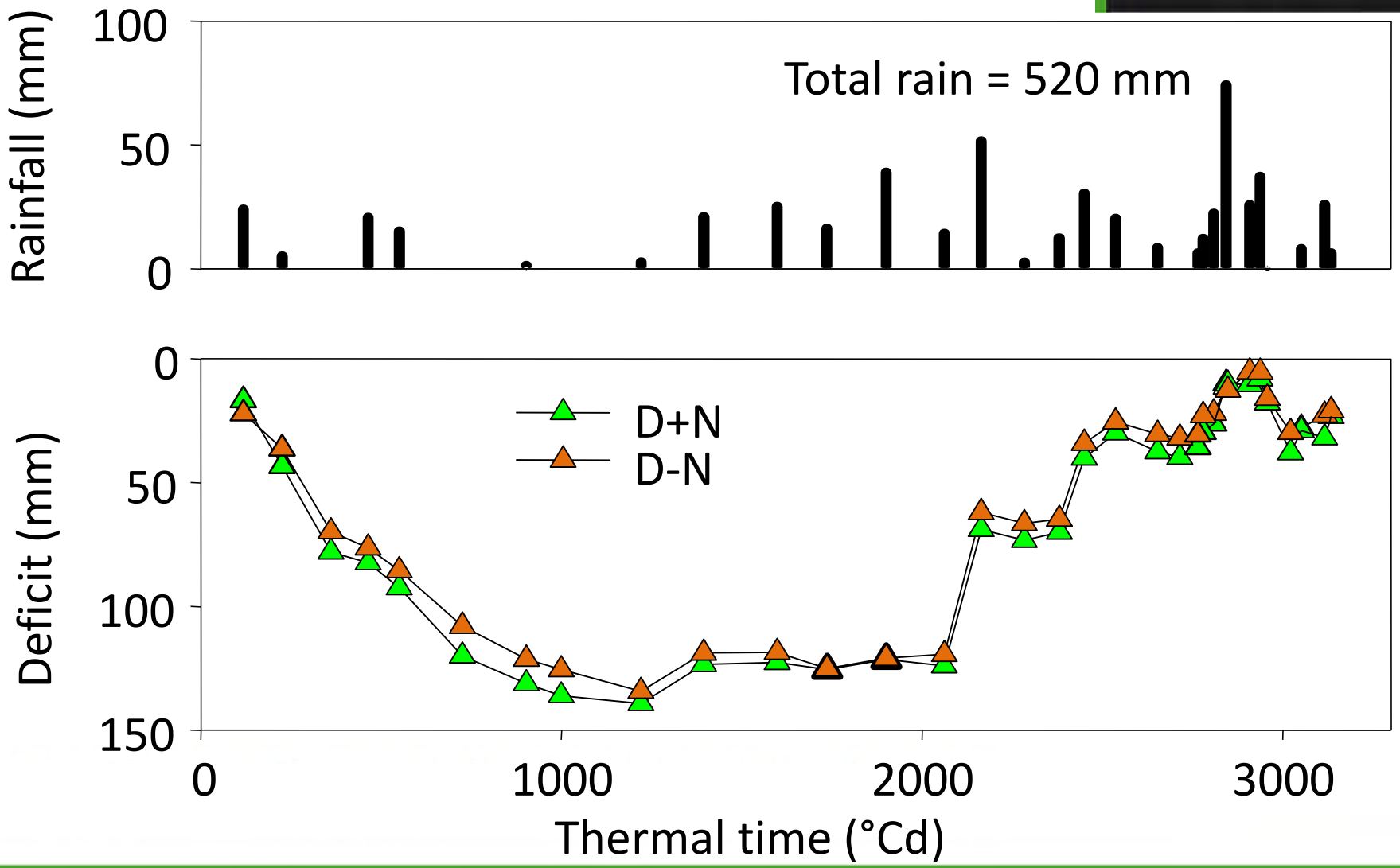
# Growth rates (2 year means)






Mills *et al*. 2006, 2009

# Soil moisture deficit 2003/04




Mills 2007

Photo: DJ Moot
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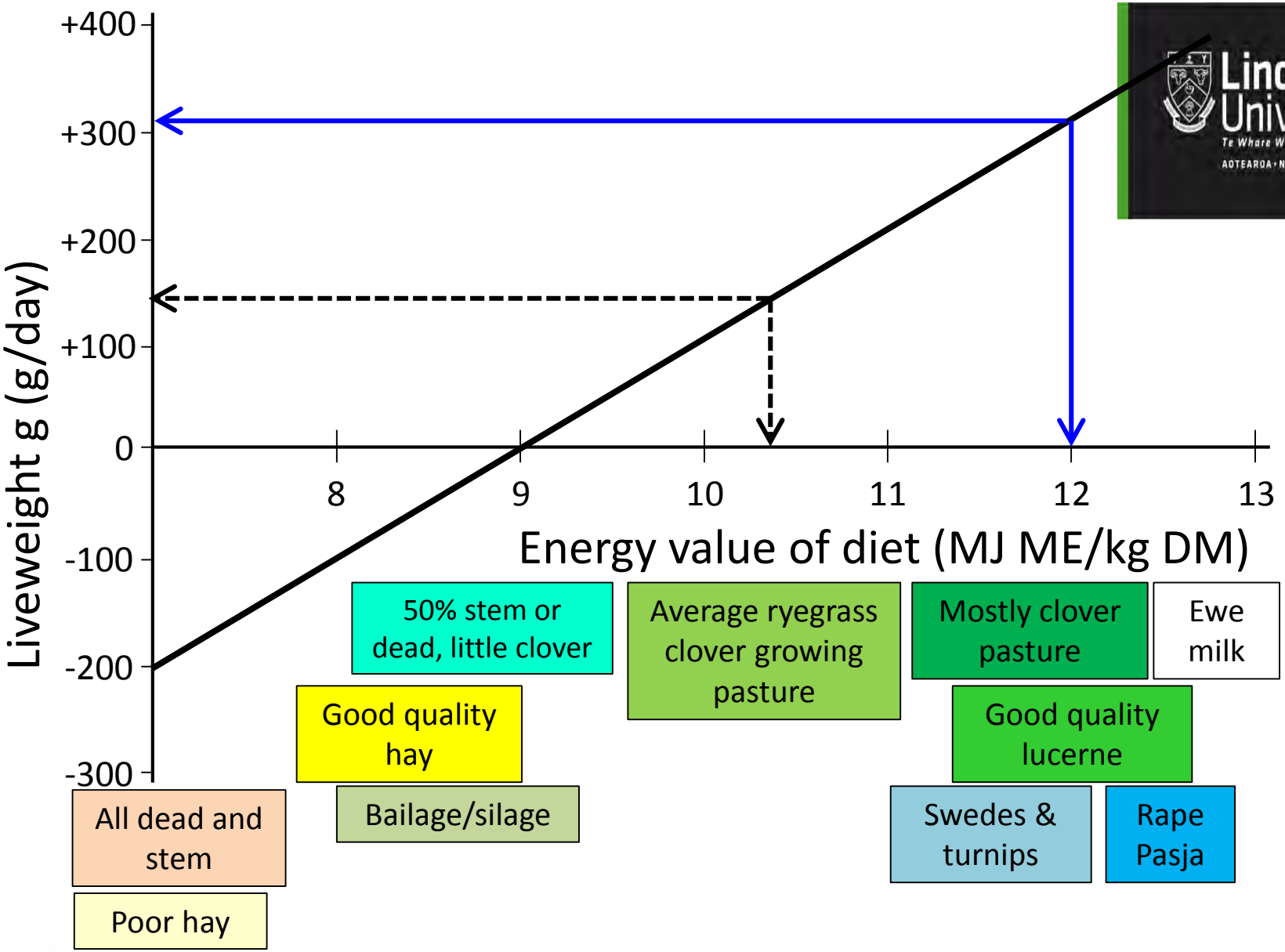
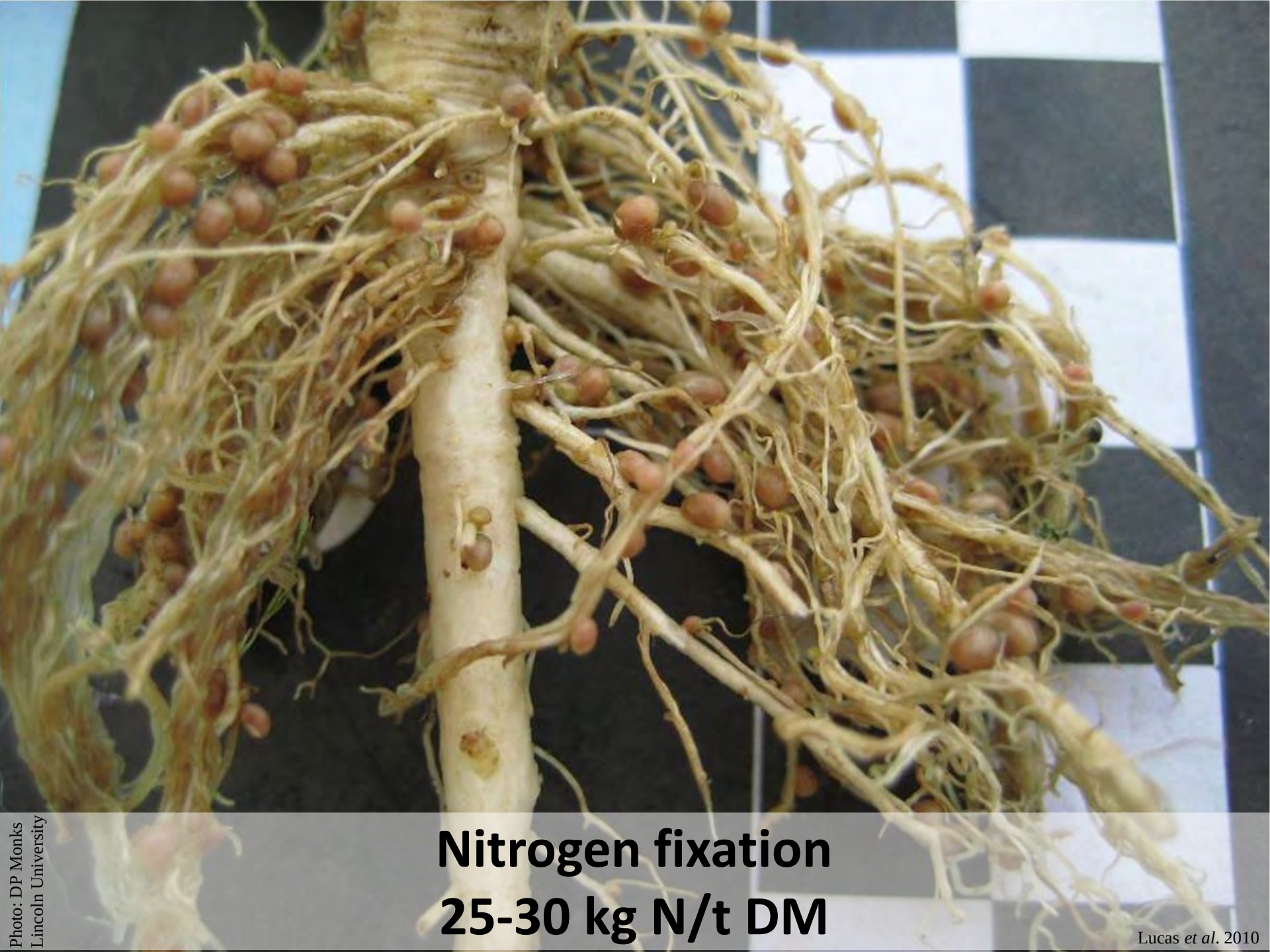




# Nitrogen fixation
# 25-30 kg N/t DM

Photo: DP Monks
Lincoln University

Lucas *et al*. 2010

# Dryland pastures

- Soil water recharge most springs
- Low N fertilizer use
- High spring feed demand – breeding systems
- Adaptable to climate variability – future scenarios
- Sustainable – financially, socially, environmentally
- Limited cultivation possible

***"Sustainability has become regenerative"***

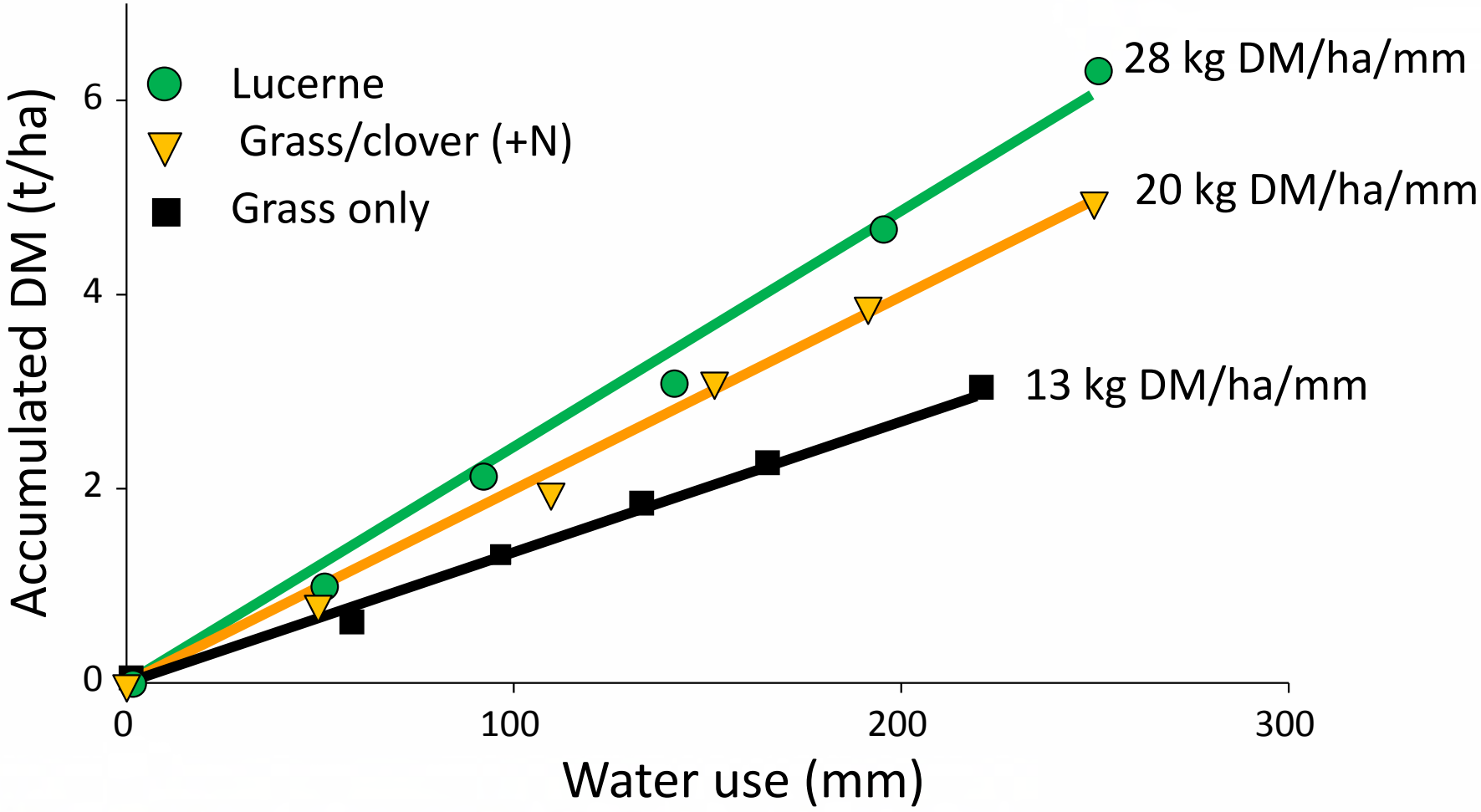
**Case study – Bonavaree farm, Marlborough**

**Over grazed – high erosion risk**

**Financially – no return**

## Dryland lucerne conversion

# Spring WUE





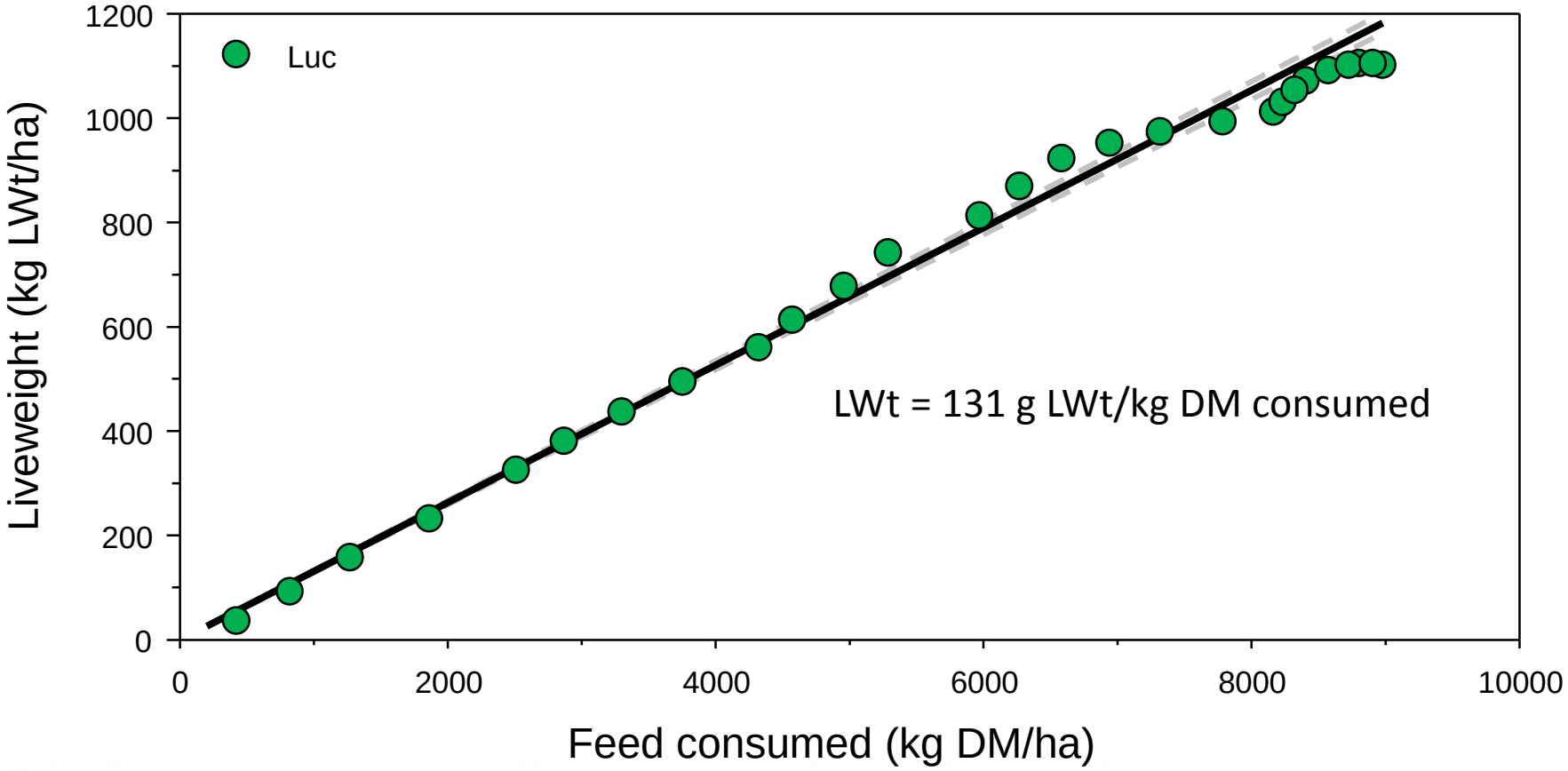

Moot *et al*. 2008

# Bonavaree 14/8/2017

Photo: DJ Moot
Lincoln University


Photo: Doug Avery, Bonavaree

# Relationship between LWt production and feed consumed

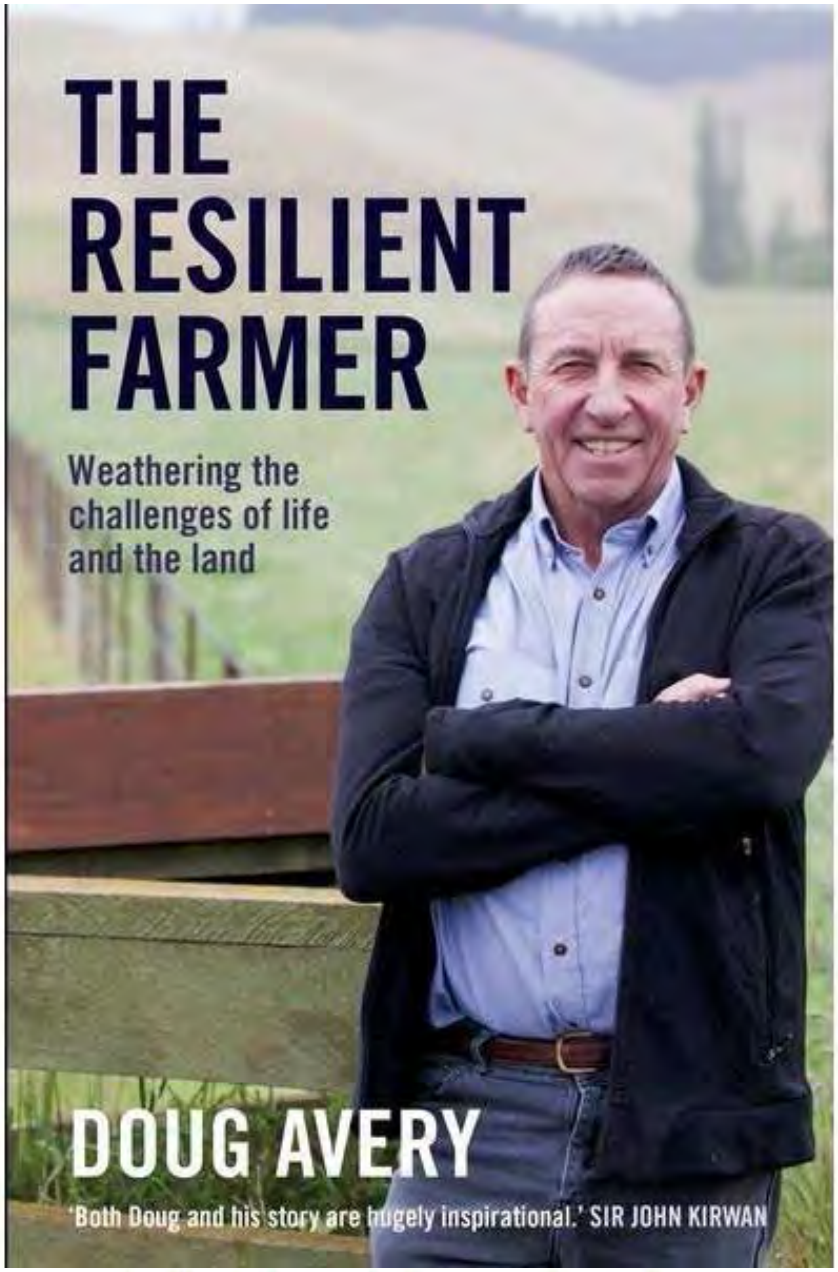





T Ryan-Salter unpublished

# ‘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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# Landscape farming – Bog Roy Station

Photo DJ Woot
Lincoln University


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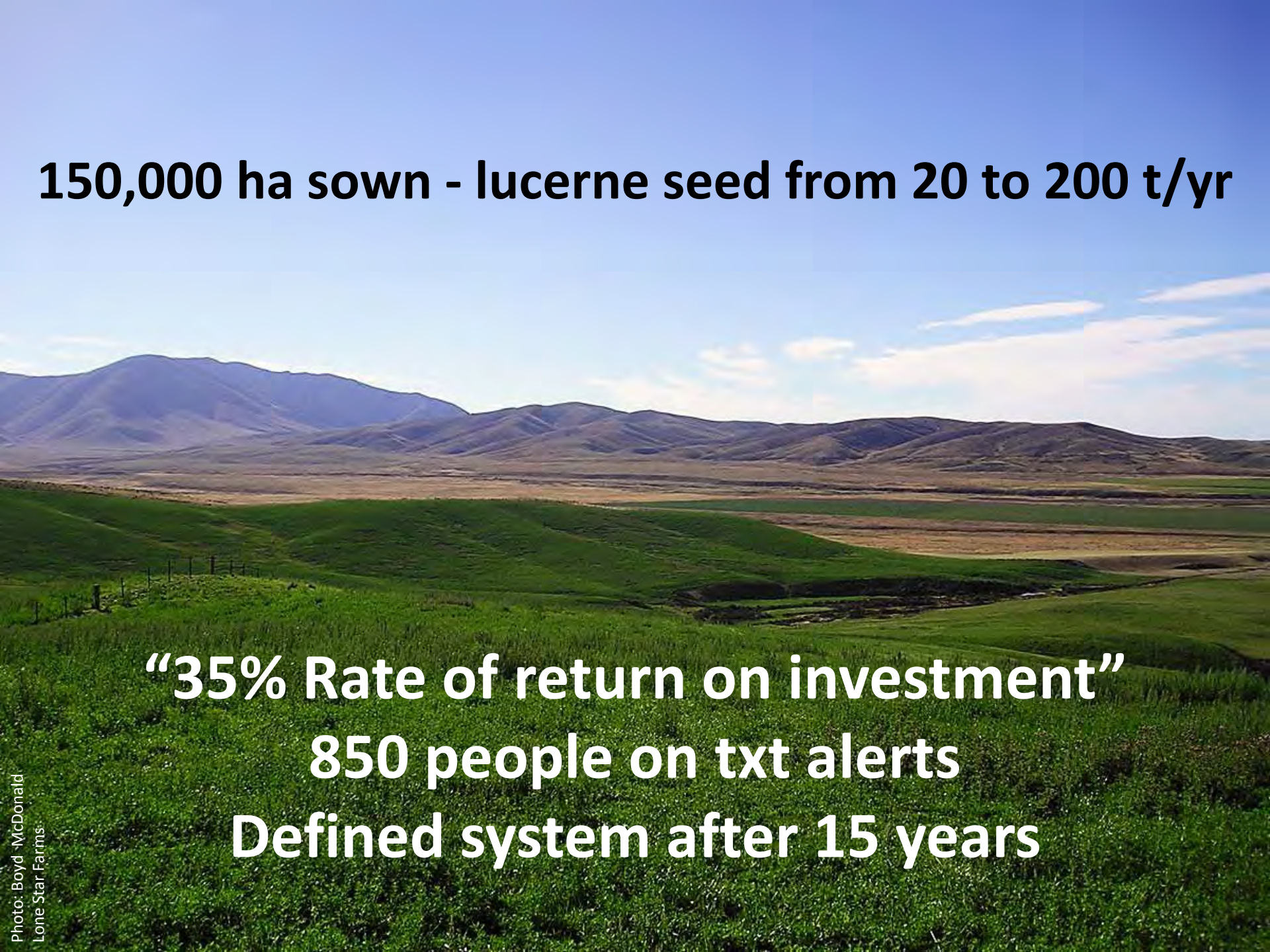
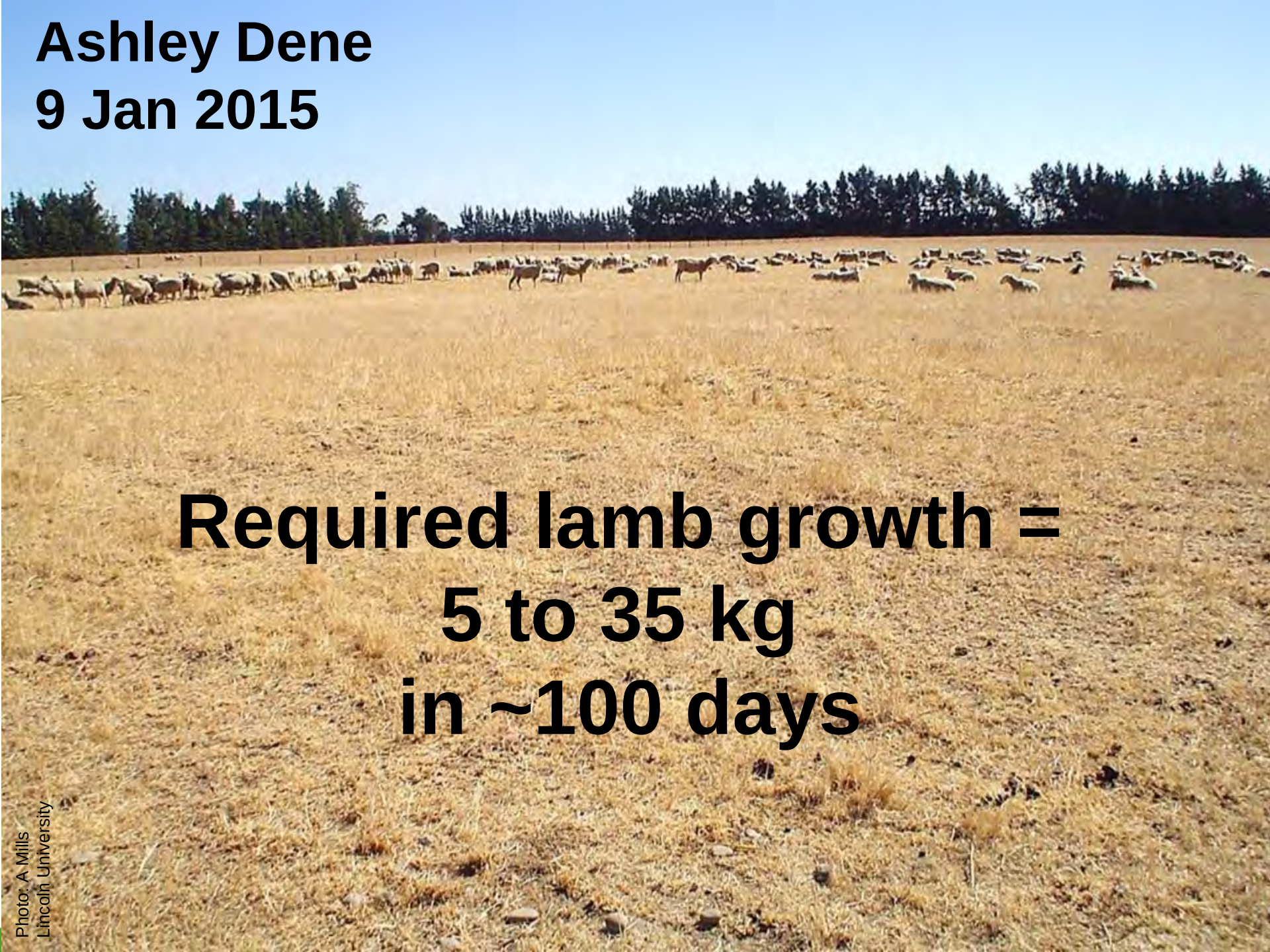
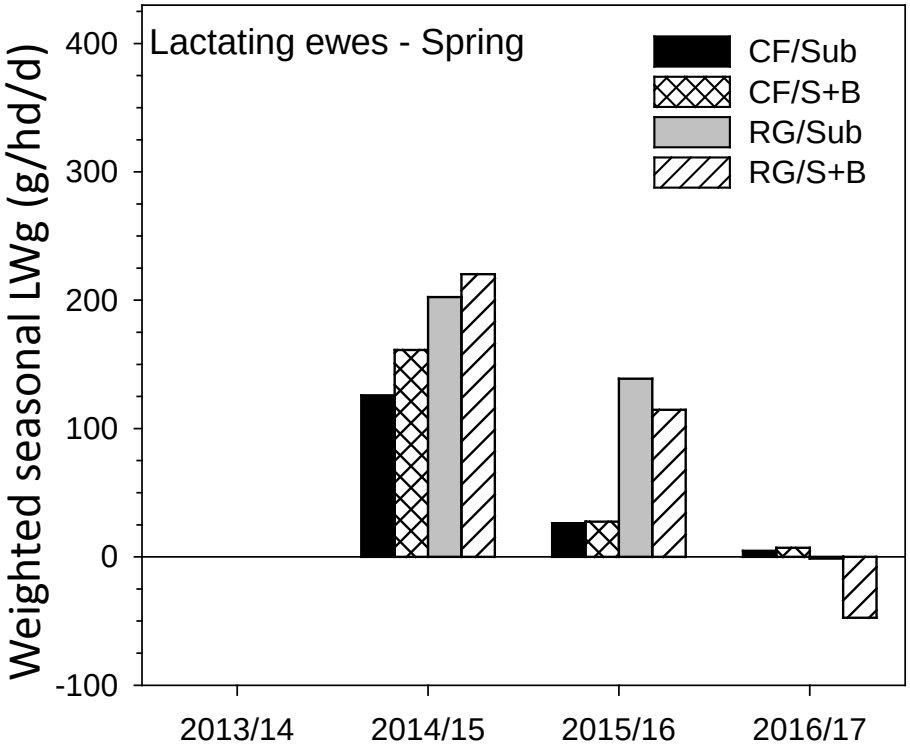
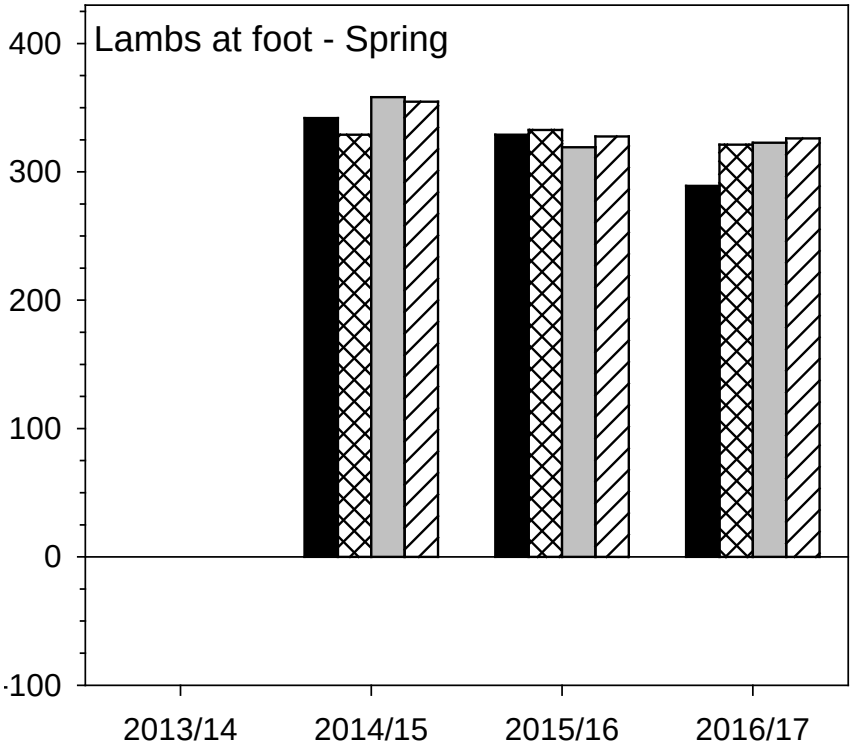

150,000 ha sown - lucerne seed from 20 to 200 t/yr
“35% Rate of return on investment”
850 people on txt alerts
Defined system after 15 years
Photo: Boyd McDonald
Lone Star Farms


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

# MaxAnnuals




Growth Season



Moot *et al*. unpublished

# Tempello

## meat - wool - wine

Photo: Jo Grigg
Tempello

# Uncultivated – grazing only – no seed…

Photo: A Mills
Lincoln University

Tempello, Marlborough
26/2/2016

# Reap the benefits in the following years. You probably only need to repeat this every 10-15 years or so.

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Photo: Jo Grigg
Tempello

# Over 560 ha Tempello Corrie area

In poor price year with $4.40/kg CW and $1.80/kg store ...
$40,000 ahead if lambs 7 kg heavier at weaning.

Tonnes meat from 60 to 76 tonnes despite fewer ewes.


Photo: Doug Avery, Bonavaree

# N deficient North Island Hill Country!



Photo: DJ Moot
Lincoln University
April 2017


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# Sub4Spring

Sustainable Farming Fund

Ministry of Agriculture and Forestry
Te Manatū Ahuwhenua, Ngāherehere

Photo: RJ Lucas
Lincoln University


Photos: RJ Lucas; DJ Moot
Lincoln University


Direct drilled during the drought autumn 2017

# High Country Pastures

Photo: DJ Moot
Lincoln University

NEW ZEALAND merino

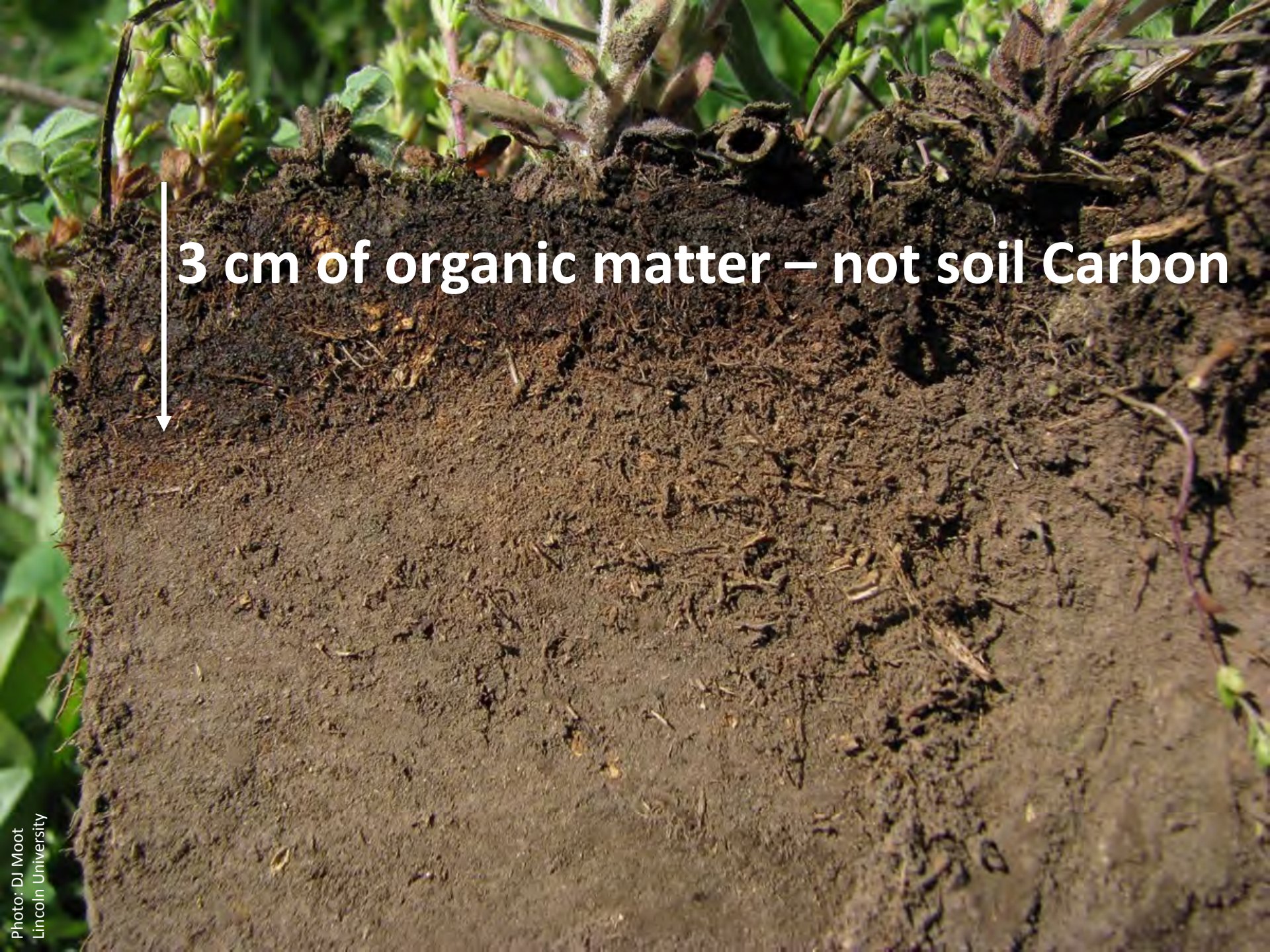


Photo: DJ Moot
Lincoln University

Photo: DJ Moot
Lincoln University


Browntop – *Agrostis capillaris* – stolons and rhizomes

# Autumn herbicide and burn


Photo: KM Pollock
Lincoln University

Photo: DJ Moot
Lincoln University

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Photo: D Hendrie
Lincoln University
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www.flexiseeder.com
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ENABLING TRANSFORMATIONAL
INNOVATION

# Paddocks of lupin

- Sown December 2013
- After 1 year of ryecorn

Photo: KM Pollock
Lincoln University

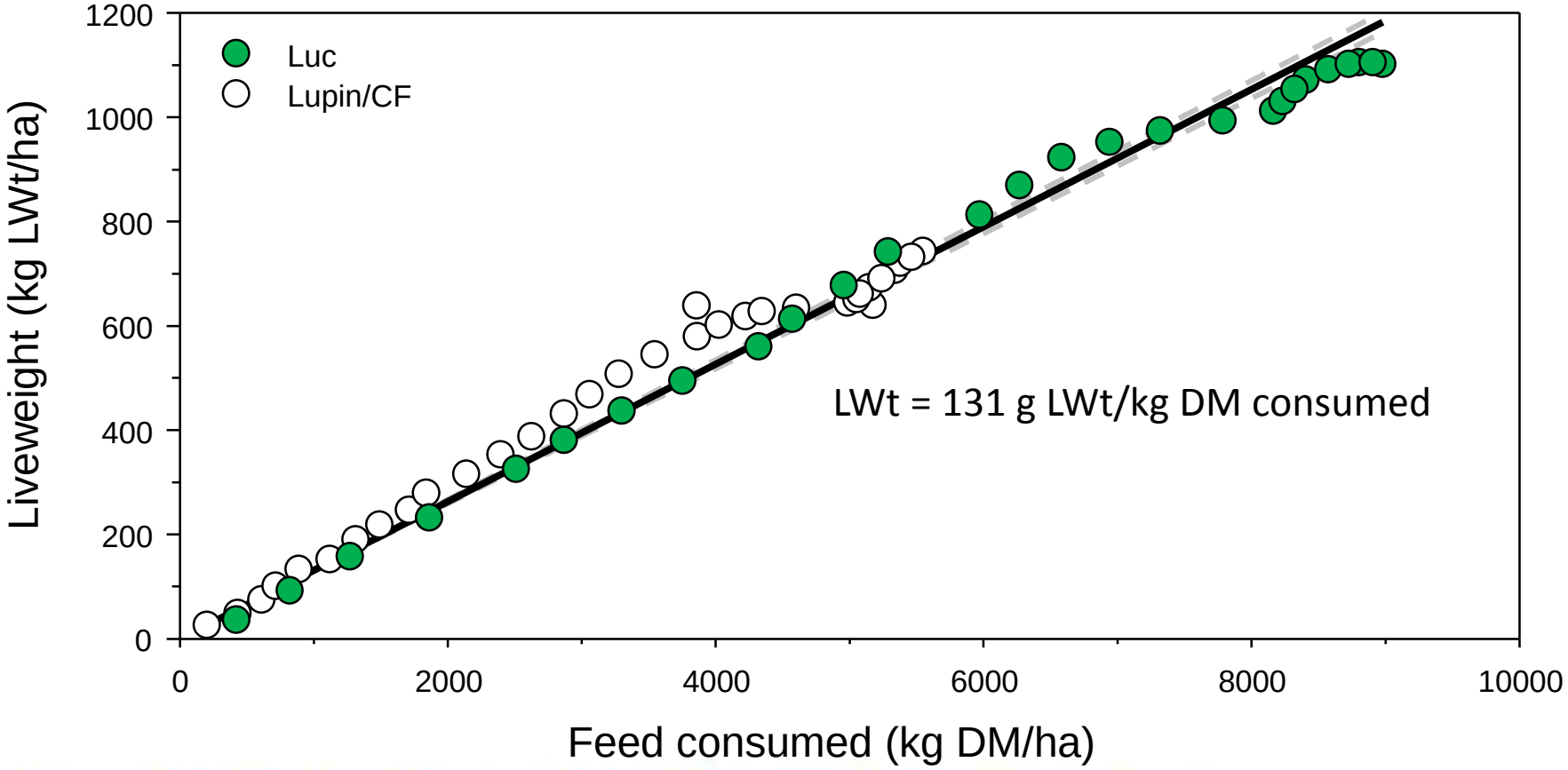

# Seedlings @ 6 weeks after sowing


# Caucasian clover and cocksfoot included in the seed mix


# 4 months after sowing


# Lambs to lupins: 31 Oct 2014

# Relationship between LWt production and feed consumed






T Ryan-Salter unpublished

# Peri urban environment



Photo: Derrick Moot
Lincoln University
9/3/2017

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Photo: Derrick Moot
Lincoln University
9/3/2017

# Californian thistle

Photo: Derrick Moot
Lincoln University


Photo: Derrick Moot
Lincoln University


Photo: Derrick Moot
Lincoln University


Photo: Derrick Moot
Lincoln University



Photo: Derrick Moot
Lincoln University
17/3/2017


Photo: Derrick Moot
Lincoln University

Photo: Derrick Moot
Lincoln University

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**30th August 2017**


Photo: Derrick Moot
Lincoln University
9 March 2017


# Gorse seedlings

21 April 2017


Photo: Derrick Moot
Lincoln University
0118
17 Mar 2017

Photo: Derrick Moot
Lincoln University

# Dryland lessons for Canterbury dairy ?

## Water and nitrogen = ryegrass

## (230,000 ha irrigated dairy)

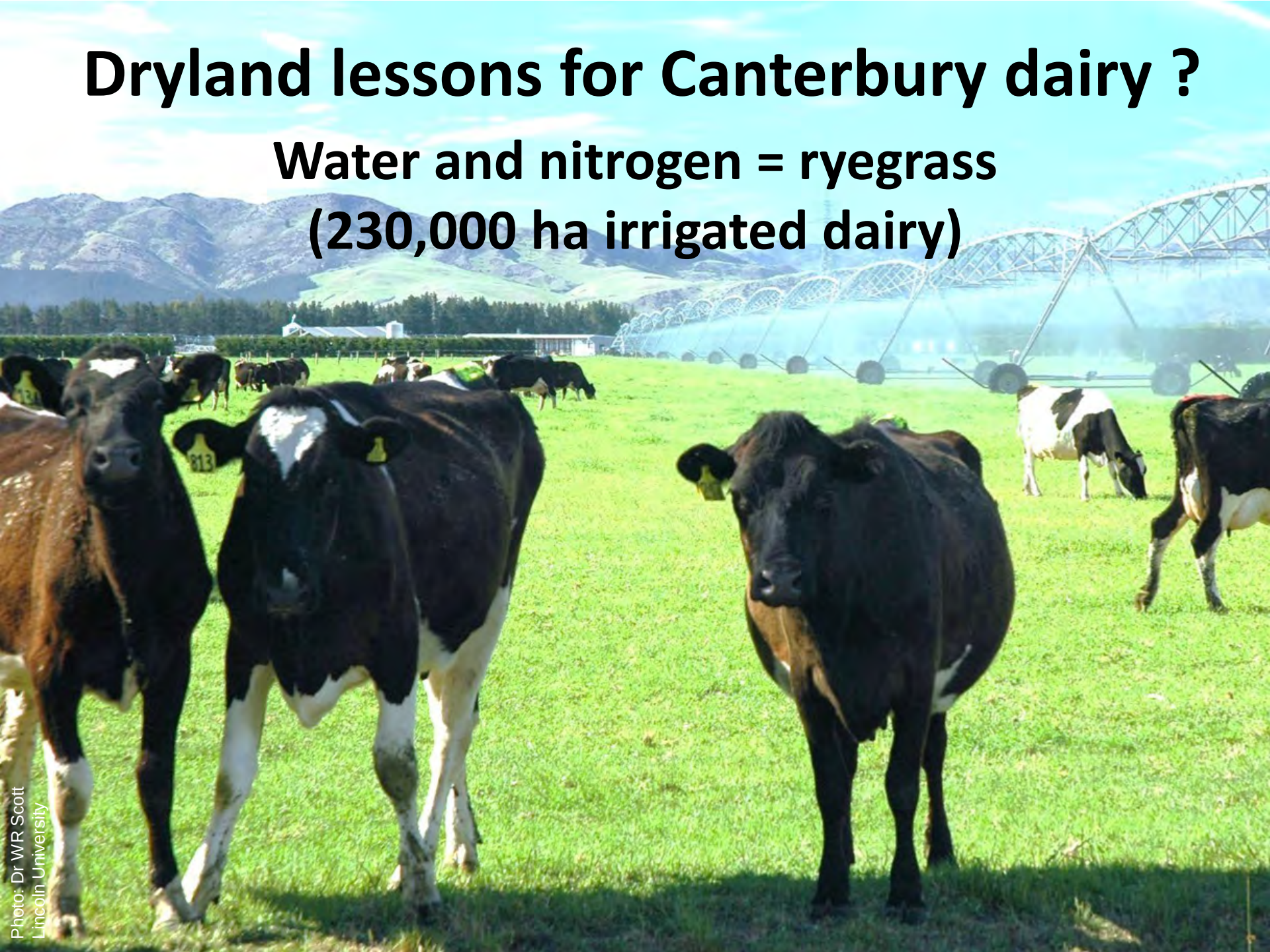
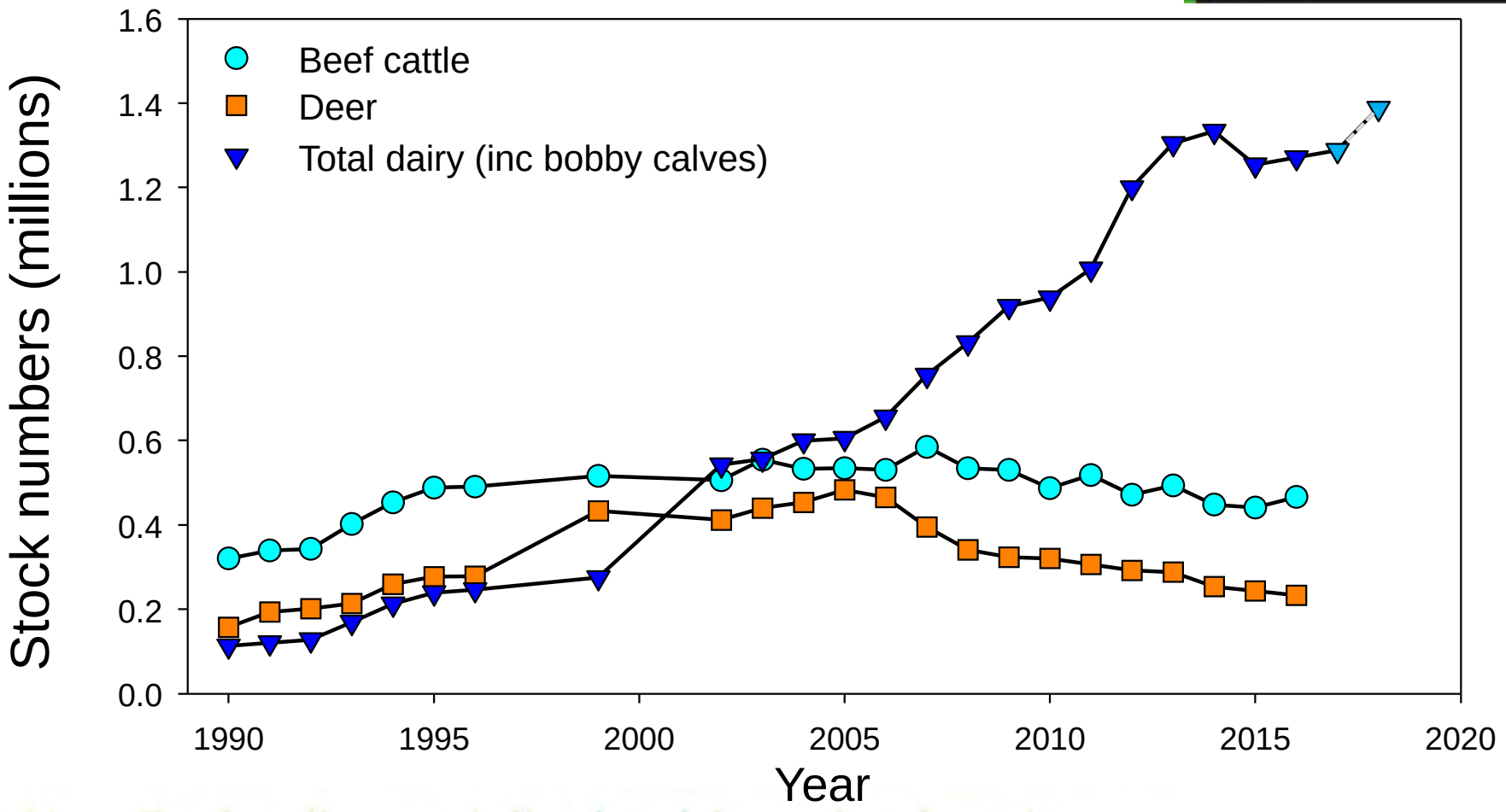


Photo: Dr WR Scott
Lincoln University

# Current Canterbury Dairy Pastures

- Ryegrass based
- Stony shallow soils
- Urine into ground water
- CPW consented 200 kg N/ha
- Stocking rates 3.5 cows/ha

# Deer & cattle numbers in Canterbury






Moot *et al.* 2010: Department of Statistics

Photo: DJ Moot
Lincoln University

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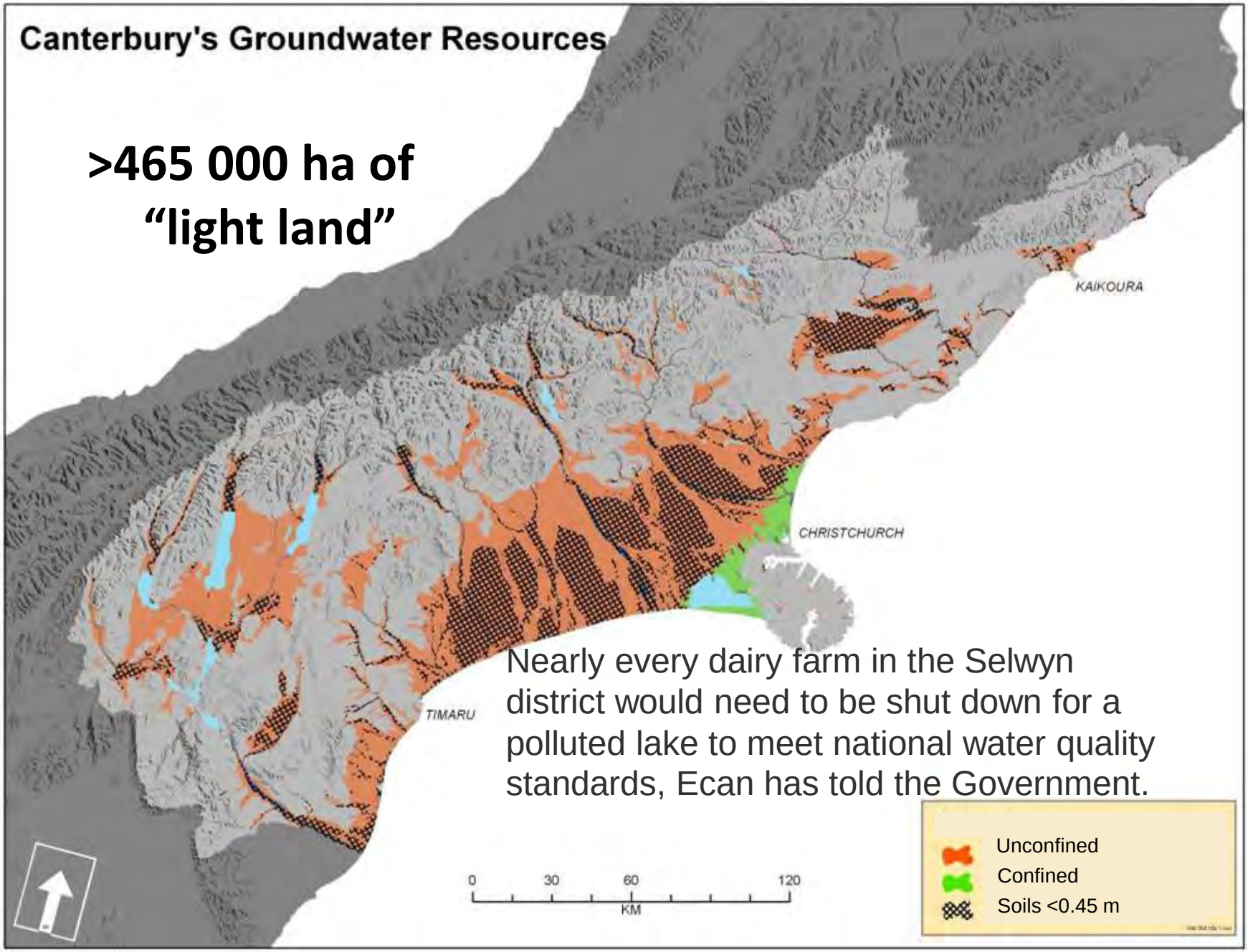
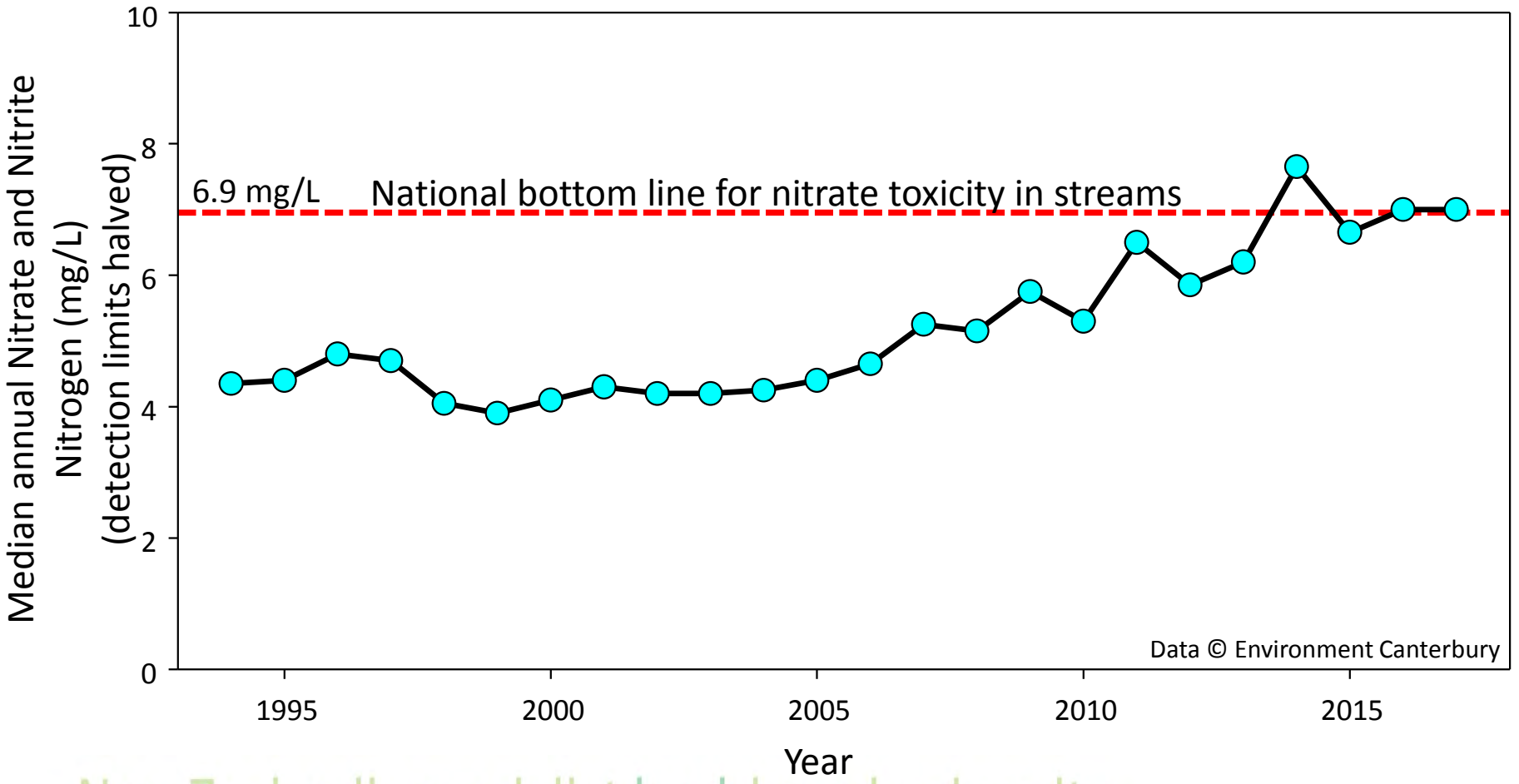
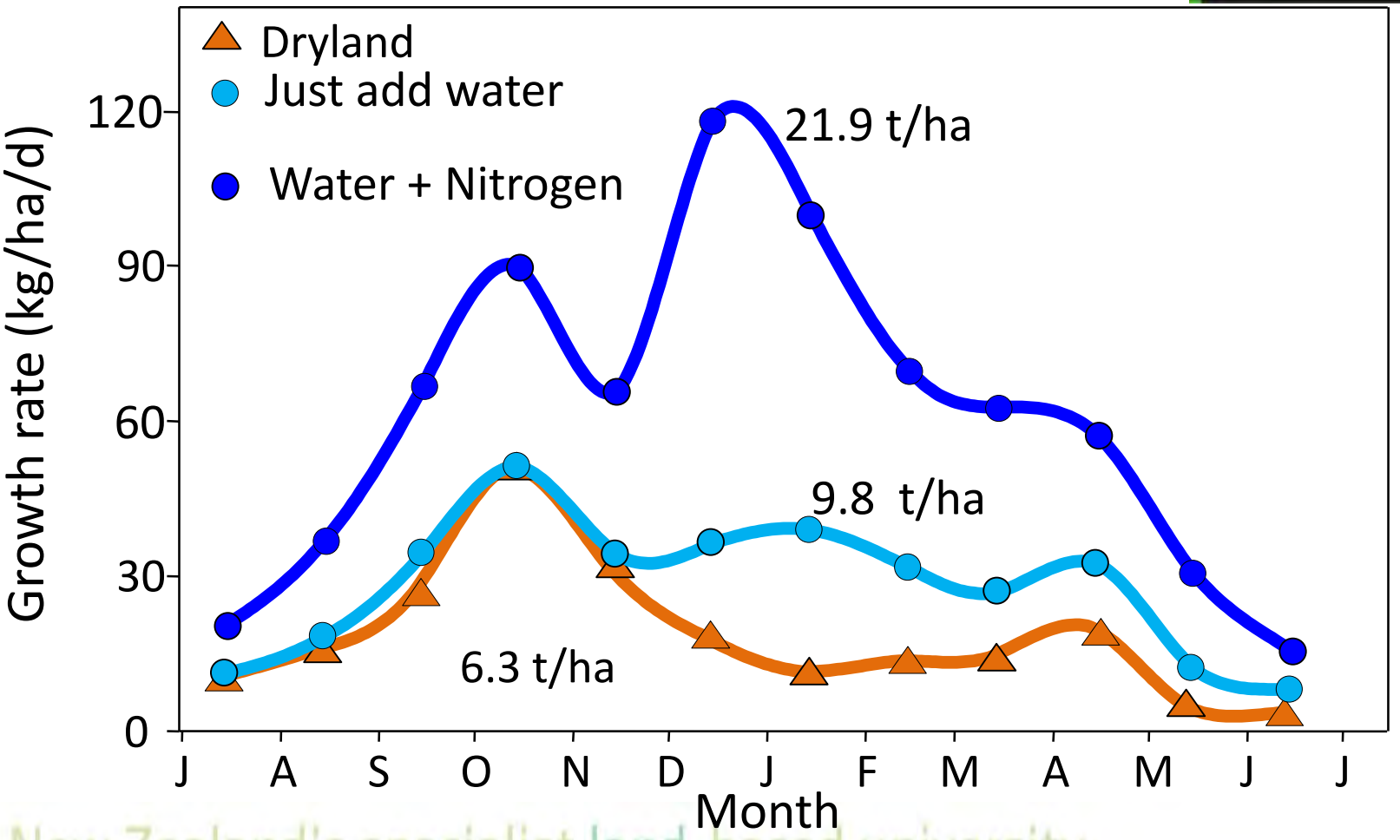



Source: Ken Taylor ECan

# Nitrate + Nitrite measured at Harts Creek, Canterbury



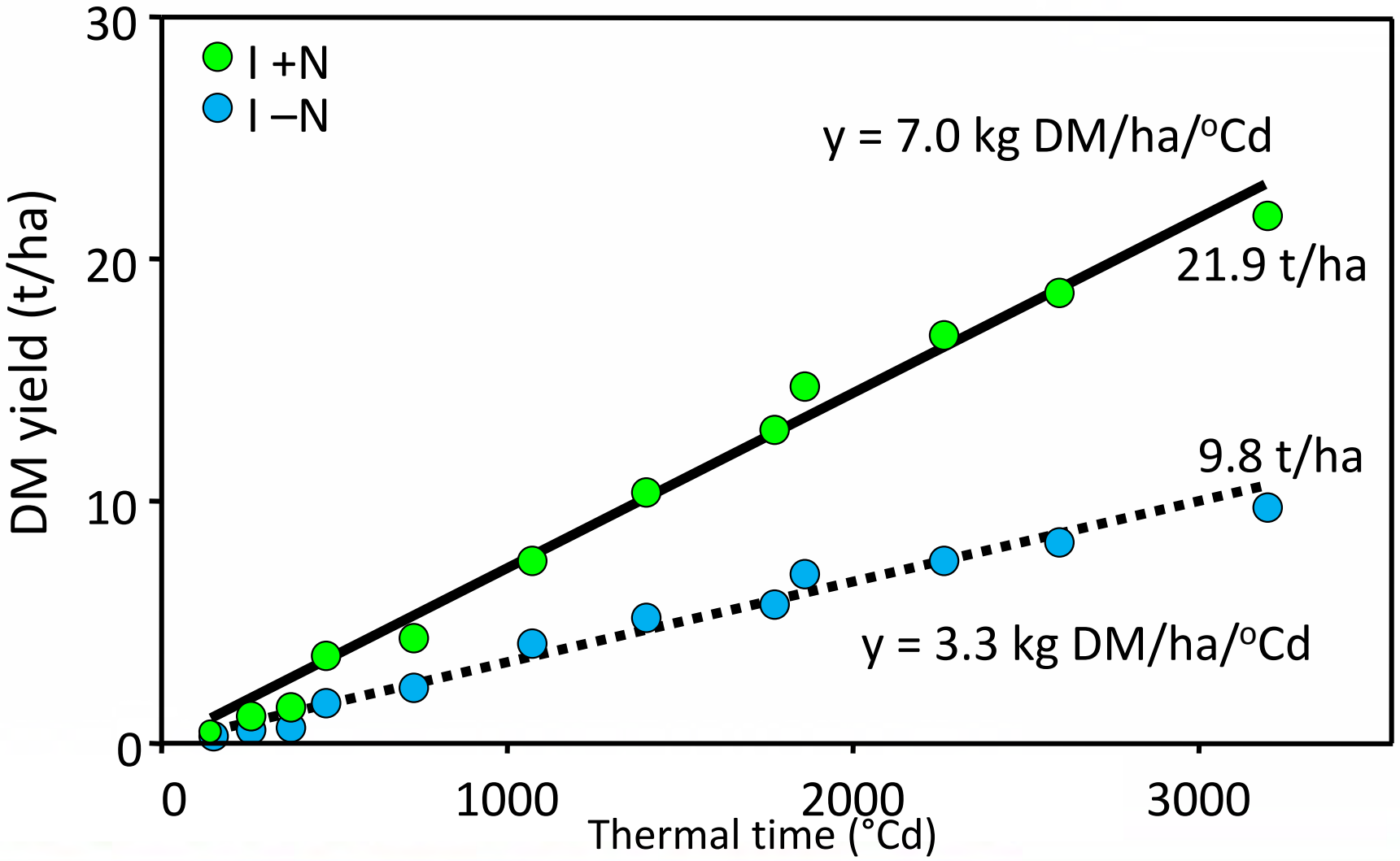
# Growth rates (2 year means)






Mills *et al*. 2006, 2009

# The Nitrogen gap




Mills *et al*. 2006; 2009

# Nitrogen dilution curve

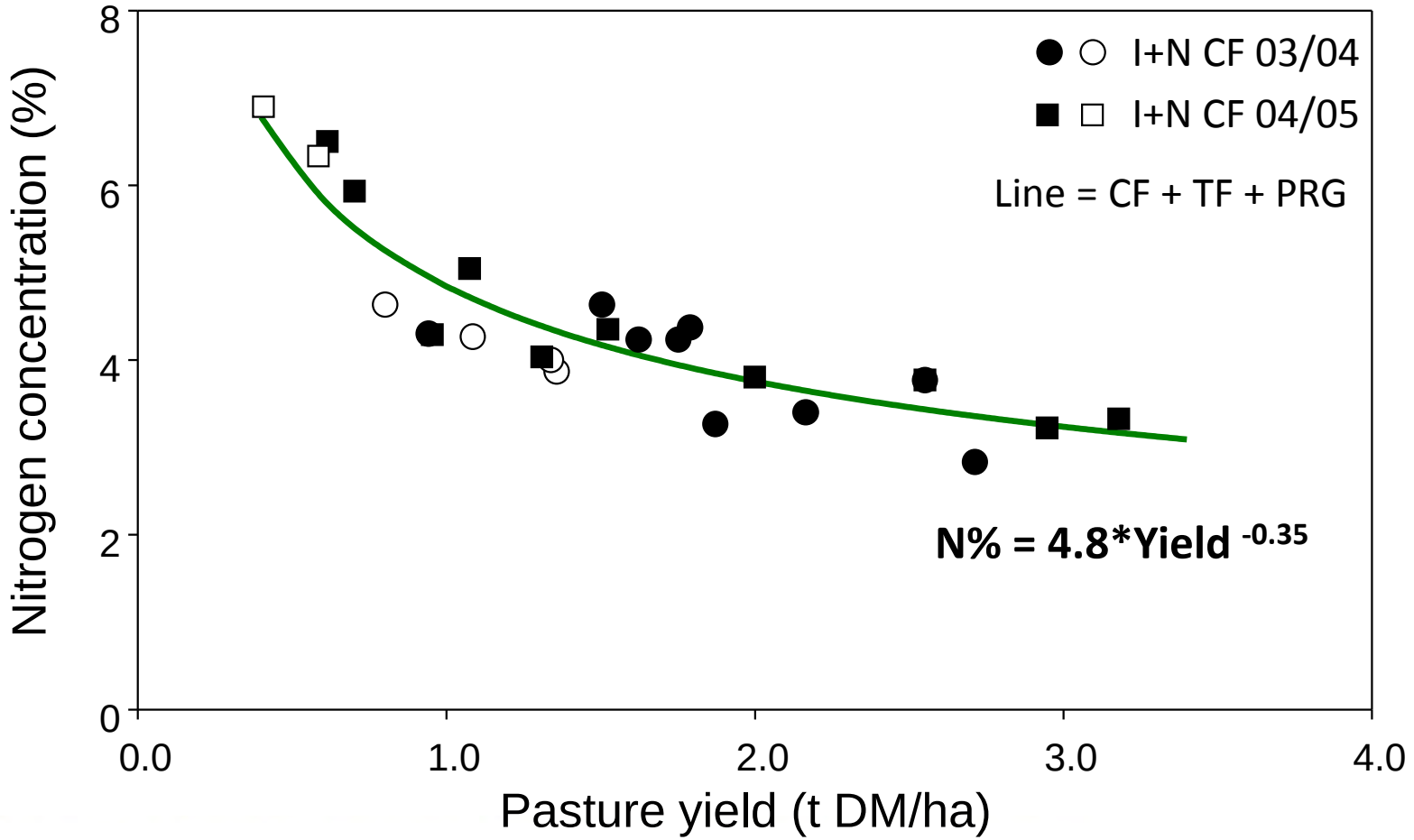
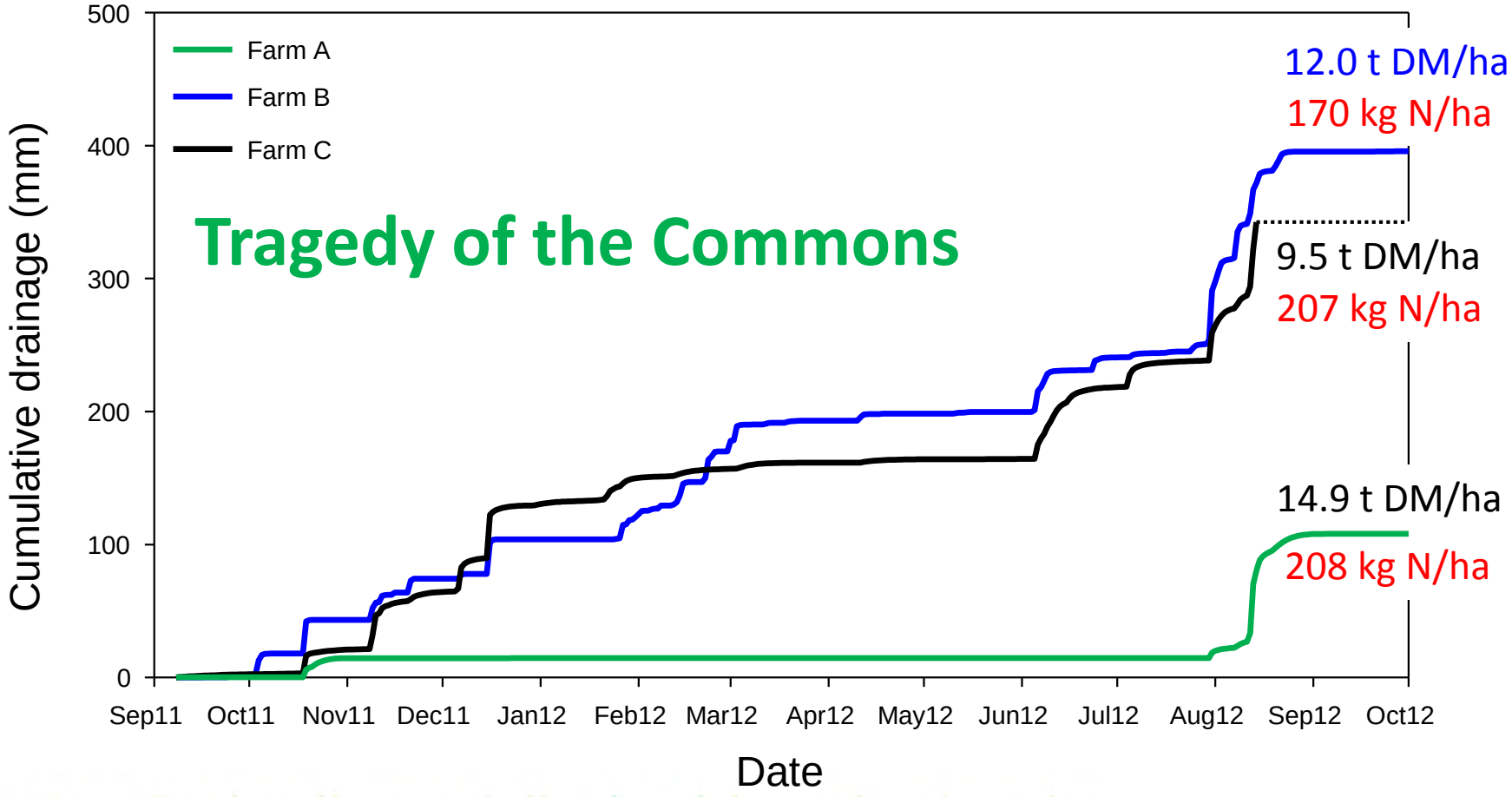



Figure incorporates data from Mills 2007, Lemaire & Salette 1982, Soussana *et al*. 1996

# Fenced water ways, large herds – N deficient pastures

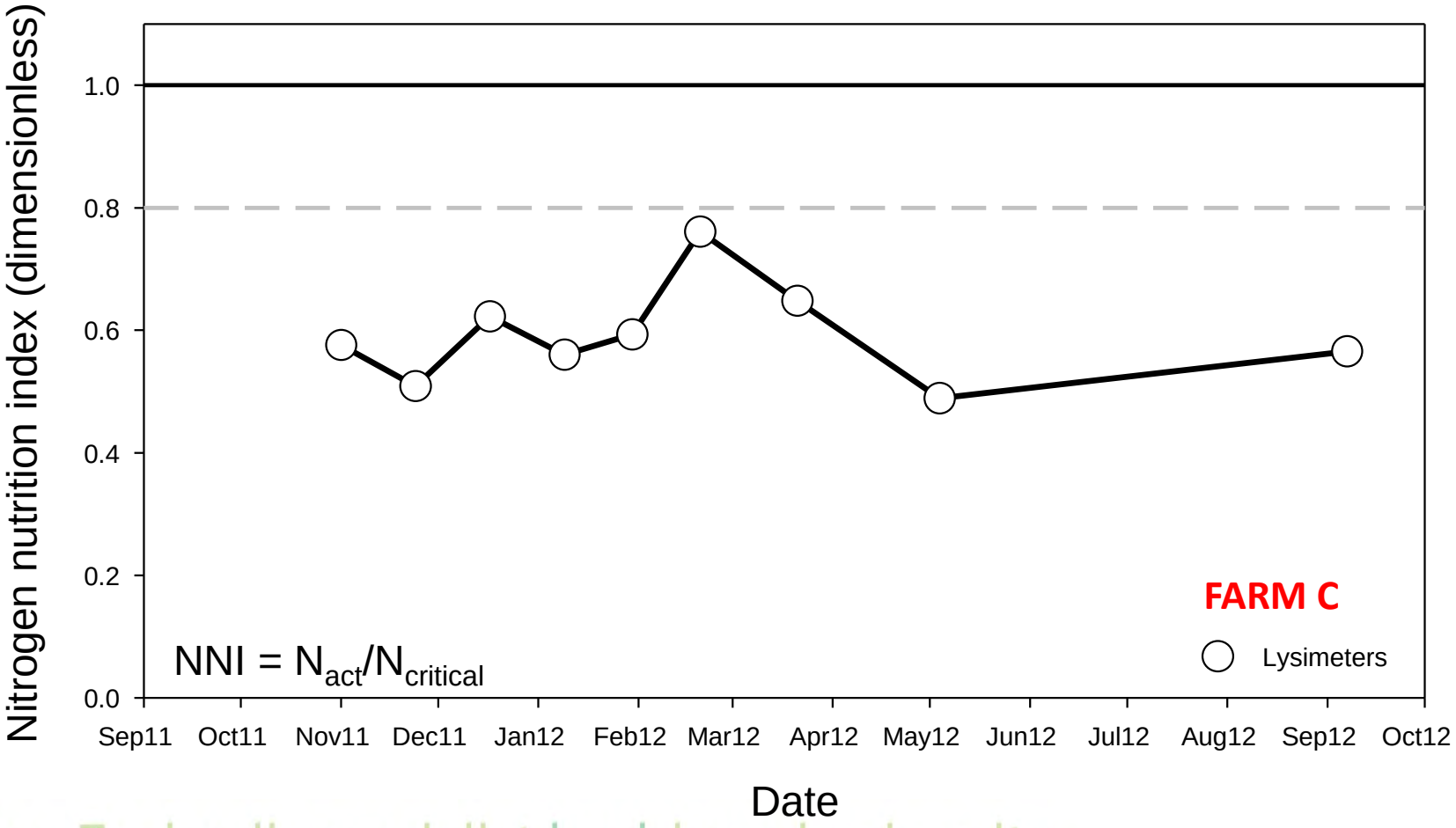
Photo: DJ Moot
Lincoln University

# Cumulative drainage (mm)



# Nitrogen nutrition index

Over irrigated under fertilized

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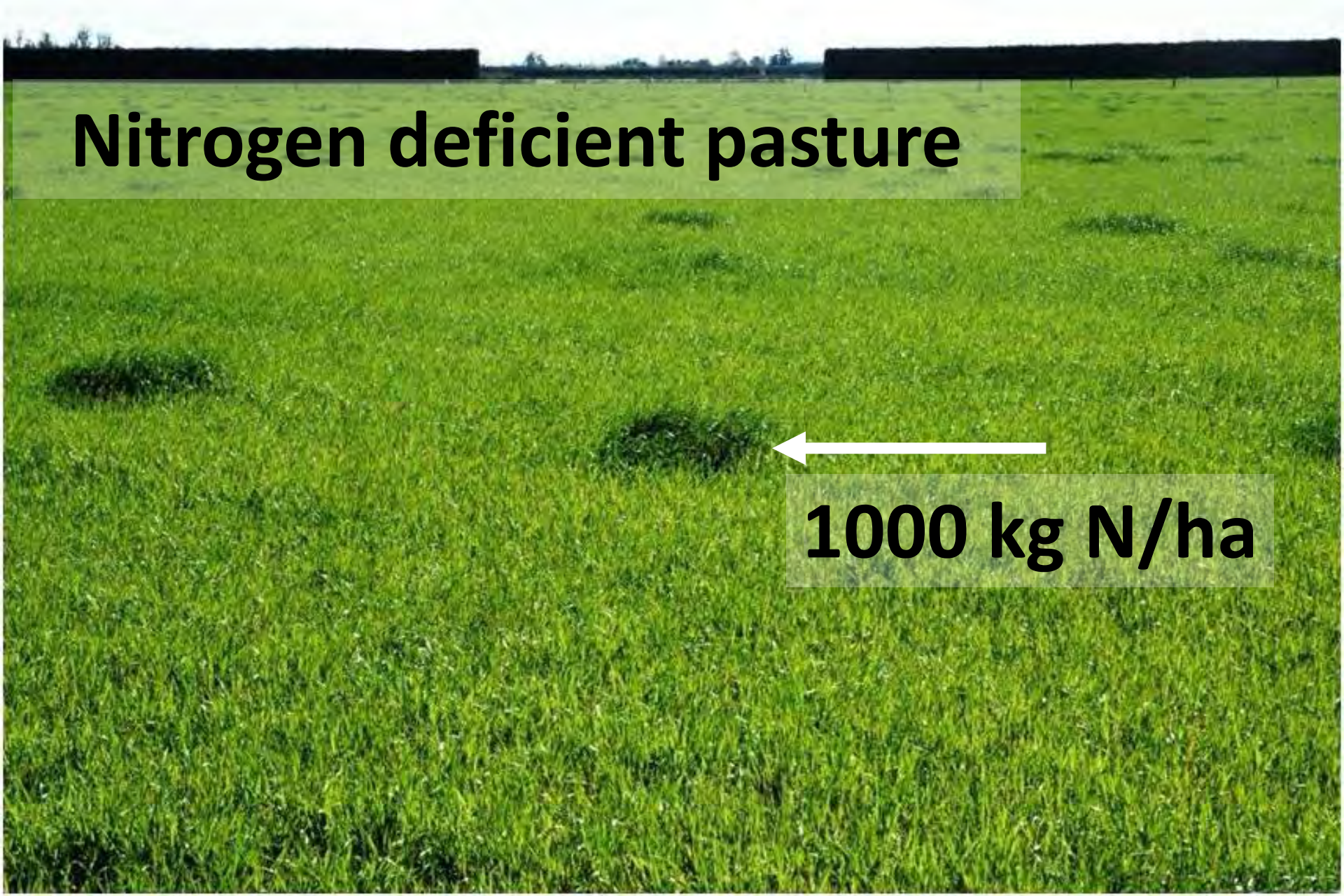
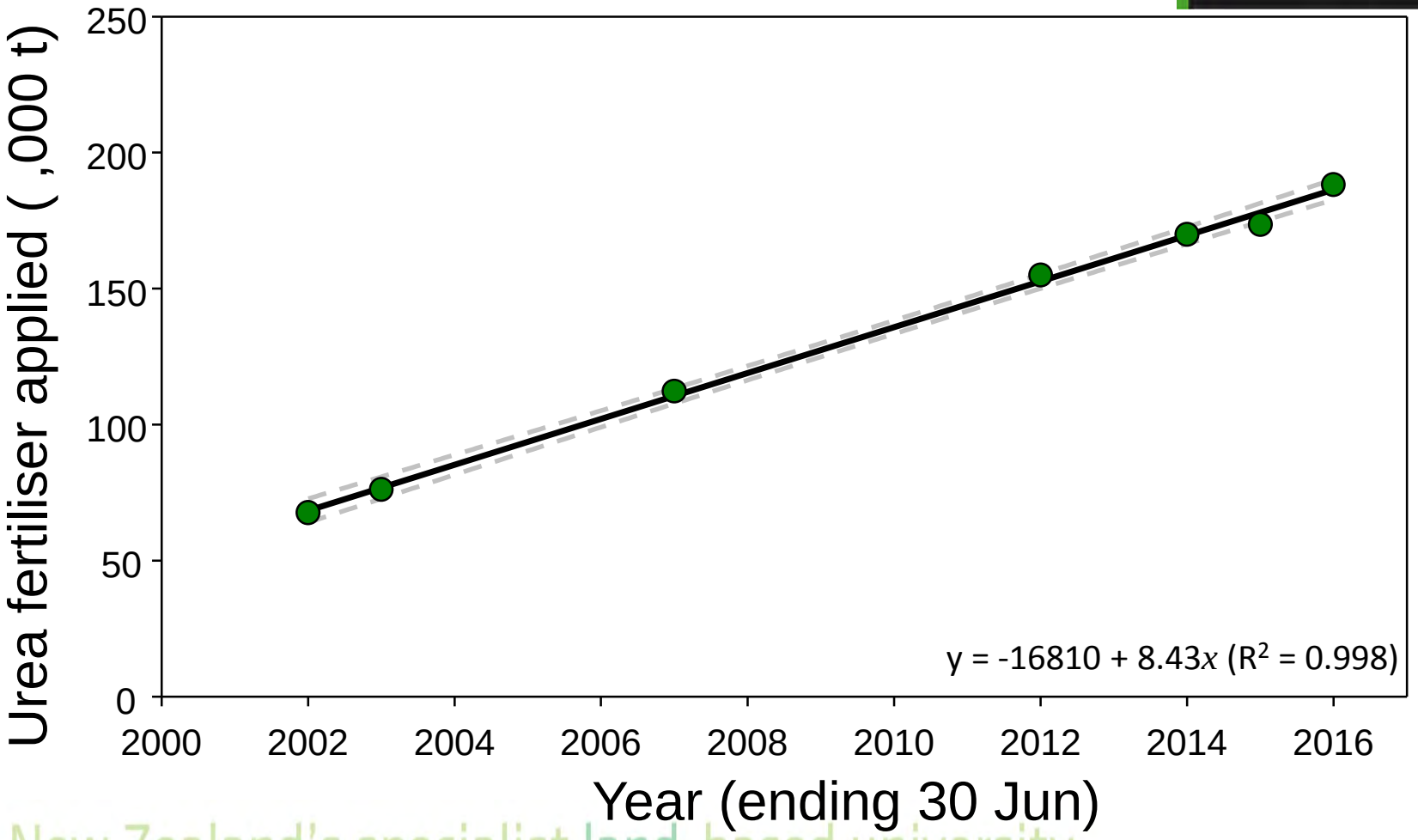

Nitrogen deficient pasture
1000 kg N/ha

# Urea use in Canterbury

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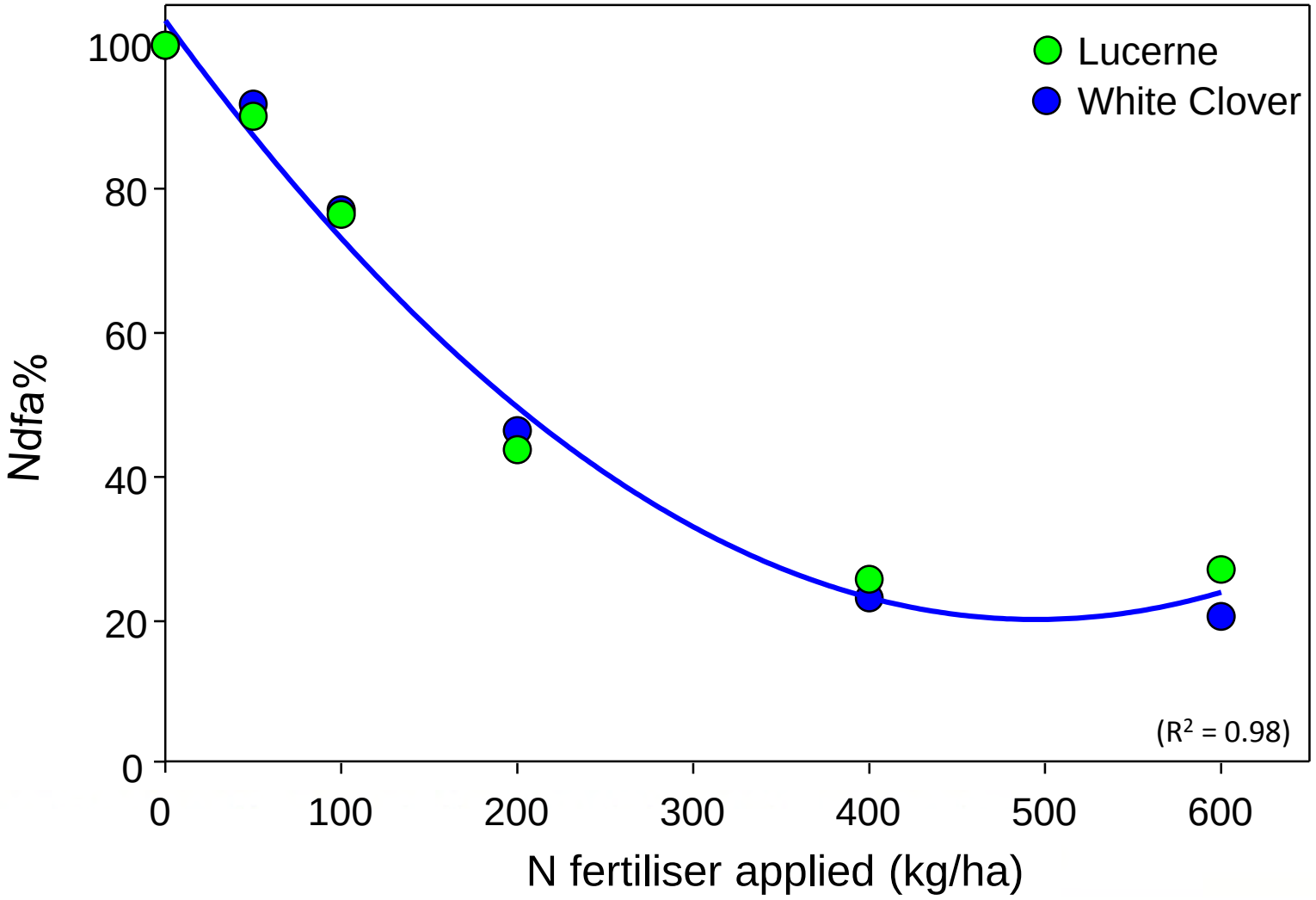
# Contributions from BNF




Ryan-Salter unpublished

# Future dairy pastures

- Farm environment plans
- Levy on irrigation water used
- Mandatory soil water budget for irrigation events
- Levy on nitrogen fertilizer – ETS
- Levy on methane emissions – ETS
- CPW (200 kg N/ha)
- Divergent systems – low (≤3.0 cows) vs high (4+ cows)/ha

# System 1 – high legume low SR pasture fed cows


**Tall fescue, red and white clovers 29 August 2017**
**“keeps growing under water restrictions”**

# Irrigated red clover

Photo: DJ Moot
Lincoln University

# Dryland dairy grazing lucerne

**October 2016** ***"once on lucerne - 2000 litres extra milk overnight"***

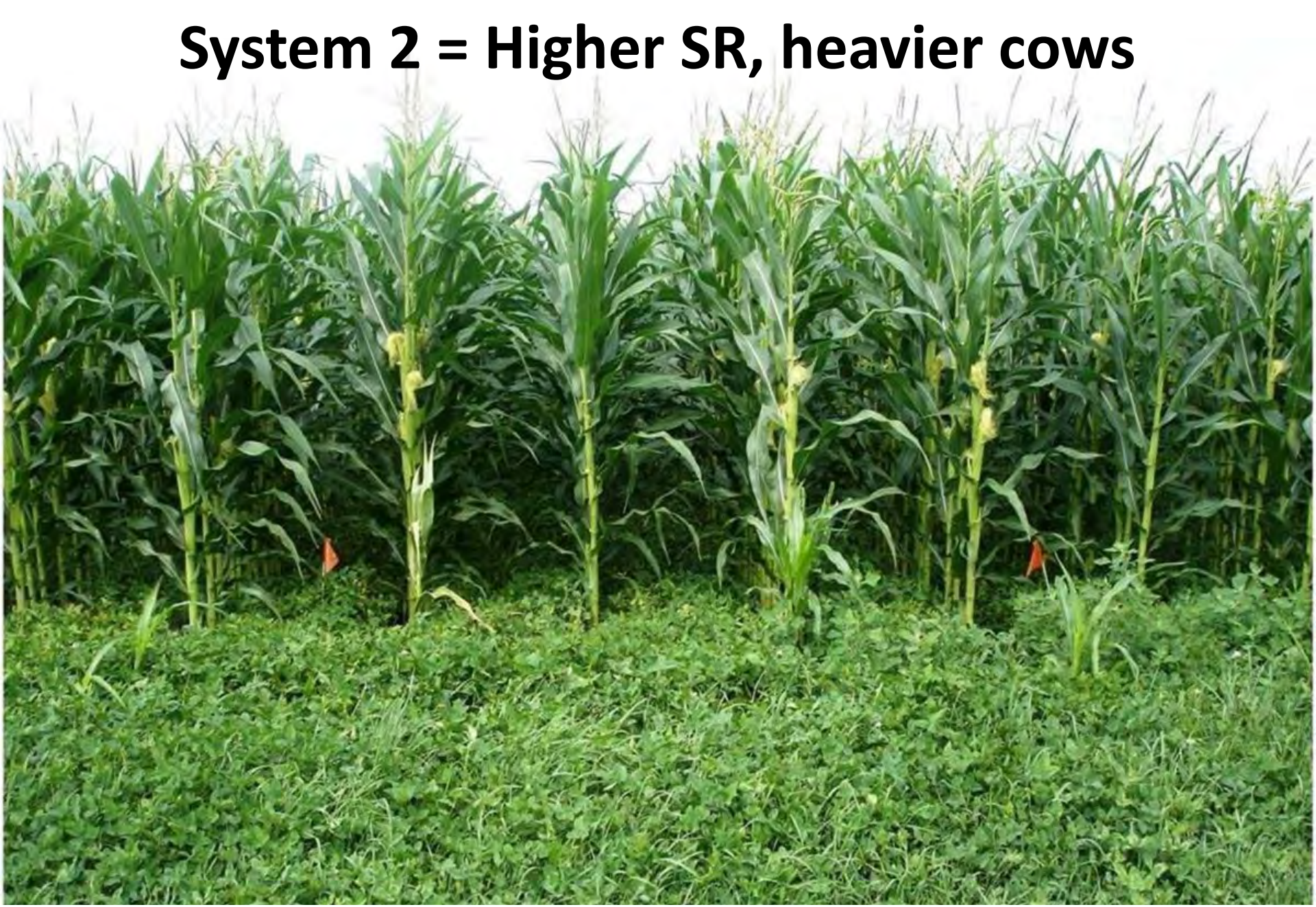
# Changed irrigation management

Photo: DJ Moot
Lincoln University

# Mandatory catch-crop?

Photo: DJ Moot, Lincoln University

# System 2 = Higher SR, heavier cows



Nutrients carried on and off farm = US indoor systems


# Cereals – total mixed ration

# System 2 – High SR – housing or partial housing

Photo: DJ Moot
Lincoln University

# Requirement = Overseer for lucerne

Photo: DJ Moot
Lincoln University


Reflections

# Changes over 20 years in research

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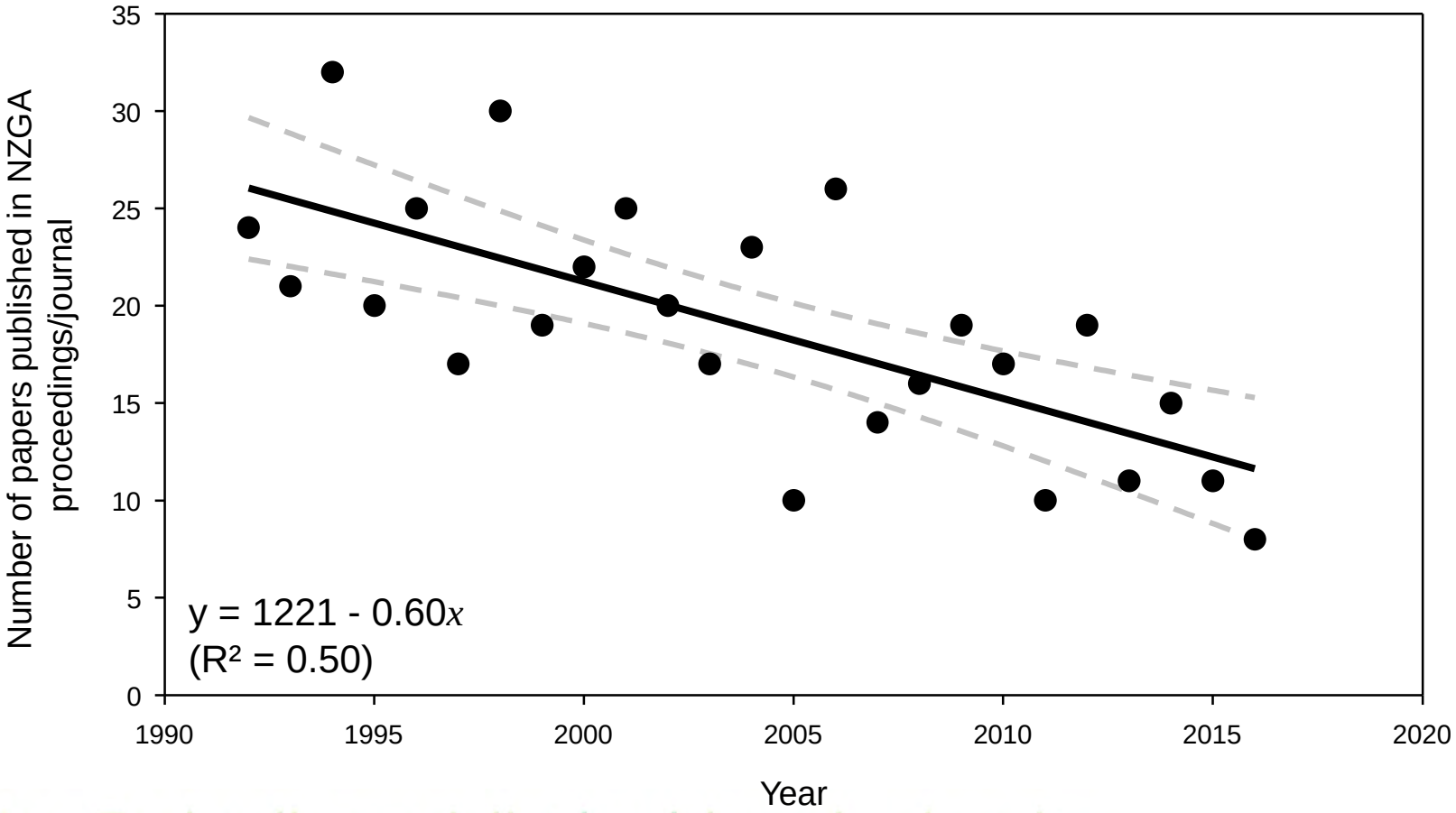
***Farmers no longer trusted as guardians of our land***

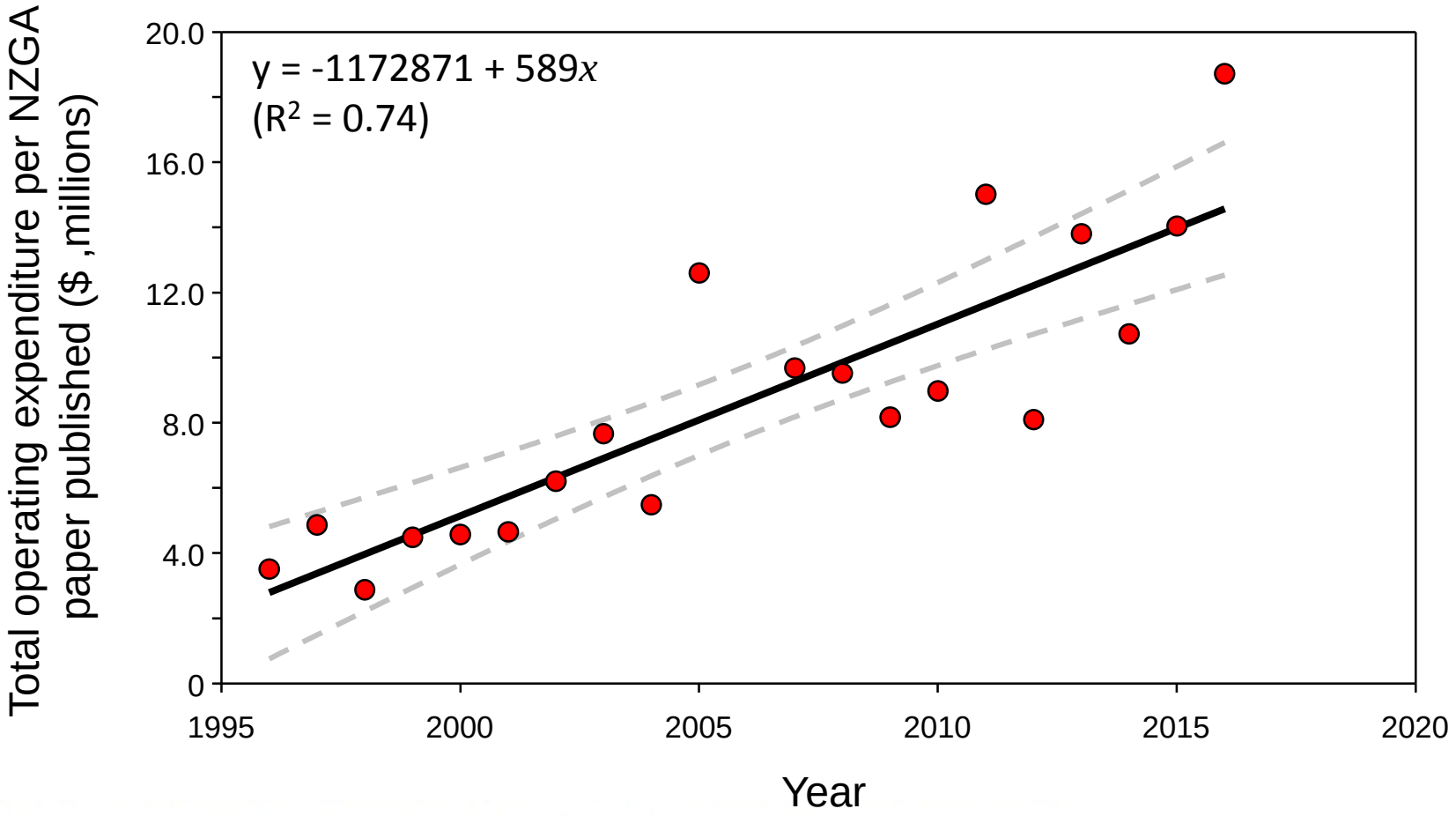
- Industry leaders on the wrong side of science debates
- Scientists silenced by CRI reforms
- Minimal funding for 'public good' applied research
- Market failure for sheep and beef farmers
- Land prices inflated by overseas investment
- Biotechnology – yet to deliver in the field

- Vibrant, dynamic, positive industry to work in

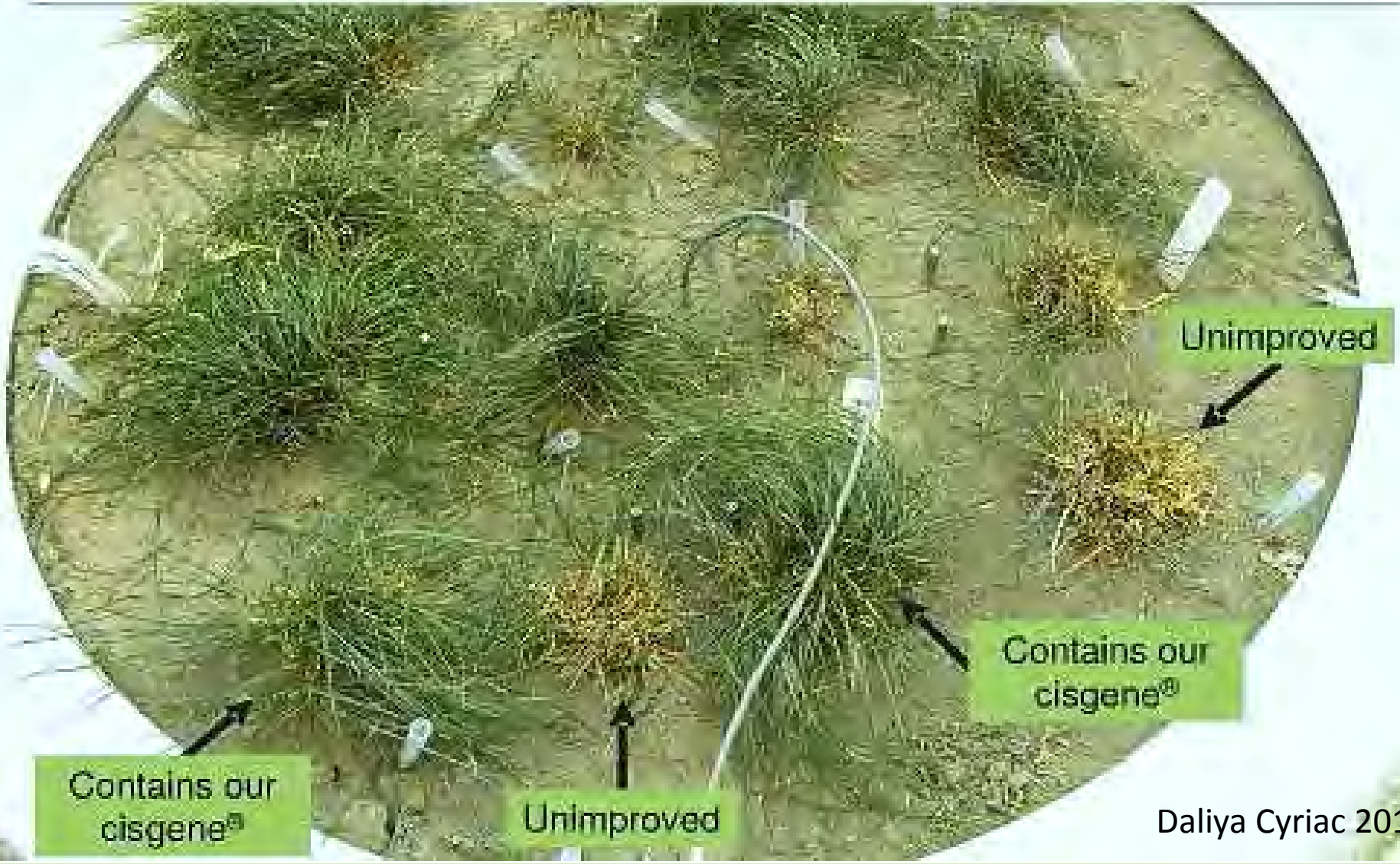
# AgR lead author NZGA publications



# AgR expenditure per NZGA paper



# Drought tolerant cisgenic® ryegrass in the Biotron




Daliya Cyriac 2017

Photo: Pastoral Genomics

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Our Burger Locations About Us FAQs Press

# THE IMPOSSIBLE BURGER

It's here. A delicious burger made entirely from plants for people who love meat. No more compromises. Ready for an introduction?

# Conclusions

- Nitrogen feeds and pollutes the world
- Biology cannot be fooled
- Regenerative legume systems exist!
- Application to other farm systems
- Agricultural science capacity is diminished
- Regulation – more is coming
- Clean/synthetic proteins = opportunity/the end or Ag

***Excellent agricultural science only happens in the field***

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Lemaire, G. and Salette, J. 1982. The effects of temperature and fertilizer nitrogen on the spring growth of tall fescue and cocksfoot. *Grass and Forage Science*, **37**, 191-198.

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.

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